FACTORS AFFECTING THE EATING BEHAVIOUR OF INDIVIDUALS WITH AND WITHOUT AUTISM SPECTRUM CONDITIONS

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ABSTRACT

Previous research has shown that children with Autism Spectrum Conditions (ASC) frequently present with aberrant eating behaviour. Although typically developing children may also face eating difficulties, these difficulties seem to be more prevalent and more severe in children with ASC. The present thesis aimed to explore the prevalence of the following problematic behaviour: food neophobia, eating selectivity, rigid/perseverant eating behaviour and selectivity in terms of texture, in a sample of 254 children (103 children with ASC and 151 control children). This thesis also explored whether the existence of early feeding problems may link with a more problematic current eating behaviour, or higher sensory sensitivity. Associations between a more problematic social-communication and behavioural profile and problems in eating and sensory sensitivity were also investigated.

Despite the health benefits, vegetables are commonly identified as one of the least preferred food categories. Therefore, the present thesis aimed to identify, in two observational studies, how factors such as food neophobia, sensory sensitivity and previous vegetable eating experiences can affect the willingness to try real food vegetable options, in a sample of 53 typically developing pre-schoolers and 77 adults with and without autistic traits. Overall, children with ASC presented a significantly more problematic profile in terms of eating, sensory, social-communication and behavioural performance than the control group. However, findings highlighted that generally there are more similarities than differences in the observed relationships between the factors affecting the eating behaviour of children with and without ASC.

For my grandmother and my parents

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LIST OF ABBREVIATIONS

ASC: Autism Spectrum Conditions

CFNS: Child Food Neophobia Scale

FNS: Food Neophobia Scale

FBC: Feeding Behaviour Checklist

SSP: Short Sensory Profile

AASP: Adult Sensory Profile

SDQ: The Strengths and Difficulties Questionnaire

SCQ: Social Communication Questionnaire

AQ: Autism Spectrum Quotient

DVFT: Disliked Vegetable offered in Familiar Texture

LVUT: Liked Vegetable offered in Unfamiliar Texture

RBV: Raw Blemished Vegetable

RV: Raw Vegetable

ARFID: Avoidant/restrictive food intake disorder

CHAPTER ONE

LITERATURE REVIEW

1.1 Overview of the literature review

This thesis explores eating difficulties in children aged 2-14 years with and without autism spectrum conditions (ASC) and researches the variables that can affect willingness to try vegetables in pre-schoolers and young adults. The aim of this literature review is to outline key factors that have been identified as negatively affecting eating in children, to recount the relevant knowledge of how these factors affect eating in children with ASC, and also to highlight gaps in the research. The review will be divided into two sections. The first section will focus on reviewing the current relevant knowledge on how early feeding behaviour, food neophobia, selective eating and sensory sensitivity can affect eating in typically developing children. The second section will summarise what is known about how these factors can affect eating in children with ASC, and highlight, based on previous literature, any differences in the eating behaviour of children with ASC and typically developing children.

1.2 Factors affecting eating in a typically developing population

1.2.1 Development of early feeding behaviour

Early feeding experiences start in utero, when flavours and odours from the diet of the mother pass into the amniotic fluid, and later on during infancy, into the breast milk (Hepper, 1995; Schaal, Marlier & Soussignan, 2000; Mennella, Jagnow, & Beauchamp, 2001). Infants are born with innate taste predispositions; research suggests that babies naturally prefer sweet tastes and tend to reject bitter and sour tastes (Crook, 1978; Harris, Thomas & Booth 1990; Rosenstein & Oster 1988). It is also believed that along with the innate preference to certain tastes, infants also have the ability to learn food preferences through exposure to new foods and flavours (Birch, 1999).

Parental feeding practices can have a great influence on children's eating experiences. Choices such as whether the infant will be breast or formula fed can have an effect on the flavour and sensory experiences the infant receives (Birch, 1998; Mennella & Beauchamp, 1991; Mennella & Beauchamp, 1999). Breastfeeding is a substantially different sensory experience from formula feeding, as breast fed infants receive milk of different flavours and odours that vary according to the diet of the mothers (Sullivan & Birch, 1994). Although it is generally accepted that flavours can be transmitted from the nursing mother's diet to her milk, there is not yet a detailed picture on how early experiences with flavours passed to the infant through breast milk can actually affect the development of eating preferences. One study showed that 2-6 year old children who had been breastfed were more likely to have an earlier introduction to vegetables (Cooke et al., 2004). Similarly, data from other studies suggest that breastfeeding can facilitate the acceptance of new foods during the introduction of solids (Hausner, Nicklaus, Issanchou, Mølgaard & Møller, 2010; Sullivan & Birch, 1994). An Australian study compared the 24-hour food intake of 2287 children aged 2–8 years and found that children who had been breastfed were more likely to consume healthy foods such as fruits and vegetables or wholegrain bread

(Grieger, Scott & Cobiac 2011). Some studies confound breast feeding itself and the socio-economic status of the mother and the effect that this may have on infant diet, with mothers from more privileged socio-economic backgrounds being more likely to breastfeed and for longer (Bentley, Dee, & Jensen, 2003; Brion et al., 2011). Whether breastfeeding can have a direct influence on dietary habits in childhood is an ongoing debate, as it could be that mothers who are generally more concerned about their child's diet may be more likely to breastfeed and subsequently promote the consumption of healthy food in the child's diet (Forestell & Mennella, 2007).

1.2.2 Introduction and timing of the introduction to solids

When the formula/breast milk becomes nutritionally inadequate the child transitions to the introduction of solid food (Williamson & Beatty, 2015). The successful transition to this feeding stage depends on the development of oral-motor and sensory-motor skills necessary to ensure successful deglutition of food (Arvedson, 2006; Gisel 1991; Rogers & Arvedson, 2005). Literature suggests that the first year of life is a 'sensitive period' for the introduction of new foods as infants are more 'open' to new flavours and textures. More specifically, some researchers have identified that an early introduction to solid food (earlier than 7 months) plays a determining role in food preferences (Birch & Marlin 1982; Cashdan, 1994; Coulthard, Harris & Fogel, 2014). Exposure to a wider range of flavours and textures in this period is linked with an easier acceptance (occasionally even after only one exposure) of new food later in childhood (Birch, Gunder, Grimm-Thomas & Laing 1998; Illingworth & Lister 1964).

As they get older infants develop better oral sensory-motor skills that allow them to successfully process thicker and lumpy foods, enabling them to progress to food options closer to the family food (Arvedson, 2006). At this stage children become more independent, show greater interest in touching the food and are able to manage finger food consisting of solids which easily dissolve in the mouth, such as pieces of soft fruits e.g. pears, bananas, or cooked vegetables (Delaney & Arvedson, 2008; Stevenson & Allaire, 1991). Over time children enhance their knowledge of where a food comes from and become more aware of the sensory qualities of food (appearance, texture, smell, taste) and the anticipated consequences of consumption. All of this information gradually shapes their food acceptance patterns (Rozin, Fallon & Mandell, 1984; Harris & Coulthard, 2016). Adding to this, it is widely accepted that early exposure to foods including fruits and vegetables can have a positive impact on the amount and variety of fruit and vegetables that children consume (Cooke et al., 2004; Scott, Chih & Oddy, 2012). A longitudinal study found that children who had an earlier introduction to lumpy solids (prior to 6 months) were less selective and less likely to refuse food at the age of 7 years in comparison to children who had a later introduction to lumpy foods (from 10 months and onwards) (Coulthard, Harris & Emmett, 2009).

The transition from one feeding stage to the next requires a certain level of development if the child is to progress successfully to a more demanding feeding regime. Research has shown that problems in early feeding (e.g. late introduction to solids) can have a negative impact on the variety of food consumed in later childhood (Birch et al., 1998, Coulthard, Harris & Emmett, 2009). This may eventually result in greater problems in the processing and acceptance of foods of a more demanding texture (Blossfeld, Collins, Kiely & Delahunty, 2007; Clark & Laing, 1990; Lundy et al., 1998). However, more research is needed in order to better identify any associations between early feeding difficulties and the existence of food related problems, such as rigid eating, texture selectivity and sensory sensitivity in later childhood.

1.2.3 Food neophobia

Food neophobia is an eating disturbance defined as fear of trying new foods (Marcontell, Laster & Johnson, 2003). During the second year of life both the mother’s practices and the child’s acceptance pattern for a variety of foods change (Skinner et al., 2002). The more mobile young toddlers become, the more likely they are to find and consume inedible objects in their environment when without parental guidance. It has been suggested that food neophobia develops at this age and works as a protective mechanism to prevent the ingestion of potentially toxic chemicals and other unsafe food or poisonous components (Birch et al., 1998; Cashdan, 1998; Wright, 1991). Consequently, during this ‘neophobic’ stage toddlers are more reluctant to try new foods or may even stop eating food that they used to eat if it differs in presentation from the norm (Brown & Harris, 2012a).

1.2.3.1 Food neophobia and age

The extent of the food neophobic response is considered to be an hereditary trait, therefore some children might appear more neophobic than others (Faith, Heo, Keller, & Pietrobelli, 2013; Wardle & Cooke, 2008). The neophobic response can result in the rejection of an unknown food on-sight (Harris, Blissett & Johnson, 2000), begins at around 18 to 30 months (Addessi, Galloway, Visalberghi & Birch, 2005; Cashdan, 1998; Cooke, Wardle & Gibson, 2003; Harper & Sanders, 1975) and can persist until 4 to 6 years (Cashdan, 1994; Pelchat & Pliner, 1995; Pliner, 1994; Pliner & Loewen, 1997). A research study by Nicklaus, (2009) suggests that food neophobia gradually fades away from the age of 5 to 8 years, while other research suggests that food neophobia can manifest, in a lesser form, into adulthood (Dovey, Staples, Gibson & Halford, 2008; McFarlane & Pliner, 1997).

A study from Hursti and Sjödén (1997) examined food neophobia levels in 7-17 year old children and their parents. The findings showed that overall the children were more neophobic than the adults, with older children being less food neophobic than the younger children of the sample. Hursti and Sjödén (1997) also found, in agreement with some other studies (Koivisto &Sjödén, 1996; Pelchat & Pliner, 1986; Pliner, 1994; Tuorila et al., 2001), that the male adults (fathers) were more food neophobic than the females (mothers) of the sample. However, there is also a body of research suggesting no gender differences in the existence of food neophobia in adults (Knaapila, et al., 2015; Pliner & Hobden, 1992). This disparity in the literature highlights the need for more research, since there is not yet a clear picture on whether food neophobia differs according to gender (McFarlane & Pliner, 1997).

1.2.3.2 Food neophobia and food preferences

Food neophobia has been identified as one of the most common factors affecting food choices and the willingness to try food (Brown & Harris, 2012b). Children presenting this trait eat only a limited number of foods and develop a cognitive aversion, as well as behavioural avoidance, of new foods (Singer, Ambuel, Wade, & Jaffe, 1992). A U.K study of children aged 2-6 years showed that fruit and vegetable consumption was inversely related to child neophobia, while lower levels of food neophobia were associated with greater enjoyment of food (Cooke et al., 2004). In line with this research, Cooke, Carnell & Wardle (2006) estimated that highly neophobic pre-schoolers have a fruit and vegetable intake that is 35% lower than that of low neophobic children. Studies have shown that the neophobic food response is most evident towards vegetables of the brassica family (such as cabbages, broccoli & brussels sprouts) and citrus fruits (Cashdan, 1998; Glander, 1982). Similarly, a recent study with a sample of 249 pre-schoolers from a wide ethnic background noticed significant associations between food neophobia and lower vegetable intake, as well as limited dietary variety (Johnson, Davies, Boles, Gavin & Bellows, 2015). Another study, with a sample of 210 pre-schoolers aged 3-5 years, also found that children with higher levels of food neophobia ate fewer food items overall (Kaar, Shapiro, Fell & Johnson, 2016).

To date the majority of research has focused on examining how food neophobia affects the willingness to try new foods, and there is a rather unclear picture of how food neophobia levels can interfere with the willingness to try foods of different levels of familiarity. Furthermore, given that food neophobia can appear even in children who developed normal feeding patterns as infants, more thorough research is needed to explore whether the presence of food neophobia is more severe in cases of a problematic early feeding background. Further research is also needed to specifically explore any associations between food neophobia and difficulties in the introduction to solids, or the later transition from lumpy solids to family food.

1.2.4 Selective ('picky') eating

In the literature, selective eating (also referred to as picky or fussy eating) has not been effectively defined, as researchers have previously used this term to describe various eating behaviours (Lafraire, Rioux, Giboreau, & Picard, 2016). The term commonly refers to the rejection of a large number of foods (Galloway, Fiorito, Lee, & Birch, 2005) both familiar and unfamiliar (Carruth, Ziegler, Gordon & Barr, 2004), consequently selective eaters follow a limited diet (Carruth et al., 1998; Cooke, Wardle & Gibson, 2003; Jacobi, Agras, Bryson & Hammer, 2003) and in some cases eat an inadequate amount of food (Rydell, Dahl & Sundelin, 1995). As with food neophobia, picky/selective eating has been linked with a lower intake of vegetables in children aged between 3.5 and 5.5 years (Jacobi, Agras, Bryson & Hammer, 2003) and with lower fruit and vegetable consumption in children aged between 1 and 4.8 years (Brown & Harris, 2012b). It is believed that rejection of food due to the food neophobic response normally happens before tasting, while rejection to food due to picky/ selective eating does not occur before tasting (Brown, 2010).

Selective eating has also been linked with a rigid eating profile. For instance, in a sample of children aged 5-12 years, selective eaters had an adherence to certain food items, or foods of a specific colour, and preferred their foods to not touch (mix) on the plate (Zampollo, Kniffin, Wansink & Shimizu, 2012). Research examining factors that can increase willingness to try food suggested that children may adhere to a product based on the appearance of packaging, insist on one brand only (Bryant-Waugh, Markham, Kreipe & Walsh, 2010) or show a greater preference for vegetables cut in geometric shapes (Olsen, Ritz, Kramer & Møller, 2012). In addition, Wardle & Cooke (2008) highlighted that children may show sensitivity to local changes in their food, as foods with 'bits' or lumps were generally less preferred, while other aspects such as the food presentation (e.g. number of items on the plate) or preparation methods can also affect food acceptance (Carruth et al., 1998; Zampollo, Kniffin, Wansink & Shimizu, 2012). A contamination response between liked and disliked food can also be seen in children as young as 20 months (Brown & Harris, 2012b). Following on from this, Brown, Harris, Bell and Lines (2012), in a sample of young children aged 4-6 years, revealed that disliked food could function as a contaminator when it touches a liked food, and consequently the willingness to eat the liked food decreases.

In the literature, some links have been reported between early feeding problems and picky/selective eating in childhood. Galloway, Lee and Birch (2003), found that girls of around 7 years of age who had been breastfed for less than 6 months showed greater selectivity, while Brown and Harris (2012b), and Mason, Harris and Blissett (2005) revealed that children who had a difficult transition from milk to solid food, and from pureed to lumpy textured food, were more likely to reject known and previously accepted foods from their diet. Based on the findings of this research it would be interesting to further explore how problems in other early feeding stages, such as the transition to lumpy solids, or the later transition from lumpy solids to family food, are associated with eating selectivity in later childhood.

1.2.5 Sensory sensitivity

Sensory sensitivity is a recently identified factor affecting food choices, and can play a key role in deciding whether a food is going to be refused (Smith, Roux, Naidoo & Venter, 2005). Sensory sensitivity (or sensory hyper-reactivity) reflects how individuals perceive and respond to the sensory information received from their environment (Coulthard & Blissett, 2009; Dunn, 1999). For the purpose of this thesis the term sensory sensitivity will be used to describe heightened reactivity and a lower threshold for the environmental sensory input (Dunn, 1999; Naish & Harris, 2012).

Rozin, Haidt, McCauley and Imada (1997) suggested that the sensory characteristics of food (e.g., smell, taste, texture, appearance) may lead to rejection, due to fear of negative post-ingestive consequences, or due to triggering feelings of disgust. In line with this, visual factors associated with food appearance can often affect willingness to try food and food consumption. For instance, Addessi, Galloway, Visalberghi and Birch, (2005) found that preschool children were more likely to successfully model an adult when the adult's food was the same colour as their own food. Research has also shown that when fruits and vegetables have spots, or are discoloured due to bruising, willingness to try decreases in both children and adolescents (Krølner et all., 2011).

When a food is tasted it also provides access to the non-taste properties of the food such as the feeling of the food in the mouth (Dazeley & Houston-Price 2015). Children generally show greater preference for crispy and crunchy textures over slimy textures (Szczesniak, 2002). Smell also plays a very important role in our ability to detect the properties of food (Murphy & Cain 1980). Research in an adult population showed that more highly food neophobic individuals rated the smell of a food as being less pleasant, and their sniffing process was less vigorous in comparison to individuals with lower levels of food neophobia (Raudenbush, Schroth, Reilley & Frank, 1998). Adding to this field of research, Monnery-Patris et al., (2015), in a sample of 123 toddlers aged 20-22 months, found that the more neophobic boys were more responsive to odours, possibly explaining why the neophobic response is followed by rejection of food before being tasted.

Researchers, using the Short Sensory Profile, (Dunn, 1999) have tried to explore the associations between tactile, visual and smell-taste sensitivity and food acceptance. Smith, Roux, Naidoo, & Venter (2005) found that children who were more sensitive to touch (tactile sensitivity), were more likely to refuse to eat food due to a dislike of taste or texture in comparison with children with normal responses to touch. Coulthard and Blissett (2009) revealed that, in a sample of typically developing children aged 2-5 years, those with higher sensitivity to visual stimuli (e.g. covers eyes or squints to protect eyes from light) were more food neophobic. This study also found that children with taste/smell and tactile sensitivity consumed fewer fruits and vegetables.

However, at present there has been little research on how problems in the early feeding stages may link with subsequent eating difficulties (including food neophobia) and sensory sensitivity in childhood.

1.3 Factors affecting eating behaviour in children with ASC

1.3.1 Autism spectrum conditions

Autistic spectrum conditions (ASC) are a set of neuro-developmental disorders which present a variety of challenges, including impairments in social skills, communication, and restricted and repetitive interests and behaviours. Hyper-or hypo-reactivity to sensory input or unusual interest in sensory aspects of the environment has also been added to the criteria for ASC in the most recent edition of DSM (DSM-V, APA, 2013) (DSM IV-TR, APA 2000).

Since the earliest diagnostic description of ASC, eating difficulties have been observed to co-exist on a widespread basis in the ASC population (Kanner, 1943). The prevalence of problematic eating behaviour in ASC has been reported to be as high as 90% (Kodak & Piazza, 2008) with close to 70% of children described as selective eaters (Twachtman-Reilly, Amaral & Zebrowski, 2008). Based on such evidence, some clinicians and researchers have suggested that abnormal eating behaviour should be included in the symptomatology and be among the early diagnostic indicators of ASC (Ritvo & Freeman, 1977). In line with this, evidence coming from more recent research has suggested that the presence of feeding difficulties in infancy should alert parents and clinicians as an early sign of autism (Keen, 2008; Twachtman-Reilly et al., 2008). Therefore, more research on the onset and correlates of these difficulties and the impact that early feeding stages can have on subsequent eating behaviour in children with ASC would be beneficial.

1.3.2 Early feeding behaviour in children with ASC

Early feeding stages such as breastfeeding and the introduction to solid foods have been shown to have an impact on the eating behaviour of typically developing children (Hausner, Nicklaus, Issanchou, Mølgaard & Møller, 2010). Given that eating problems in children with ASC is still a developing research field there are very few studies looking at how early feeding problems can affect or predict eating behaviour in later childhood in children with ASC. Williams, Dalrymple and Neal (2000) collected some descriptive data regarding early feeding behaviour from 100 parents of children with ASC aged between 22 months and 10 years. Cross-sectional data showed that 44% had been breastfed, with 10% of these children still breastfeeding at one year, while 88% (of the sample) were bottle fed for some period of time. For a small percentage of children this early period was problematic, 18% of the children had difficulty with sucking in infancy, but by the age of one year 67% of the sample were able to be spoon-fed. Among the children having sucking problems, over 75% presented insistence on routines later in life, while 72% of this group tended to eat non-edibles in childhood. Although this study is one of the earliest to provide some information on the early feeding behaviour of children with ASC, a comparison group was not included.

Emond, Emmett, Steer and Golding (2010) compared the early feeding behaviour of a large typically developing sample (approximately 13971 cases) with the data of 79 infants who received a subsequent diagnosis of ASC. Feeding and dietary data were collected at the age of 6, 15, 24, 38 and 54 months. The results suggested that, although there were no significant variations in their diet at 6 months old (including breastfeeding), a later transfer to solid food was observed in the ASC population, and infants with ASC were more frequently described as 'slow feeders' by the mothers. At 15 and 54 months, parents of children with ASC reported significantly more difficulties in feeding their children, and more children with ASC were reported as 'very picky' at these ages in comparison to the control group. It was also noticed that from 15 months old, children with ASC started having a more selective diet and increased their selectivity over time. A food inventory of 56 food items at the age of 38 months showed that children with ASC consumed significantly fewer fresh fruits, vegetables and salads than their typically developing peers (Emond, Emmett, Steer & Golding, 2010). Although this study is a valuable source for shaping a better understanding of the presence of early feeding problems in children with ASC, the recording of the data discontinued at 54 months, which does not help us to gain an understanding of whether selective continues into middle childhood.

In a later study, Brisson and colleagues (2012) collected family videos of 48 children with ASC and 46 typically developing control group children. For this study the research team isolated the feeding situations and psychologists coded the infants' anticipation behaviour in both groups at the age of 3, 4, 5 and 6 months. The research team counted each time the parent held the spoon out to the infant's mouth with the aim of feeding them. Every successful anticipation behaviour (every time the infant opened their mouth before the spoon touched their mouth) was counted, while cases when the infant was looking in another direction as the spoon was approaching their mouths were not considered. Although there was no difference between the two groups regarding the number of attempts to feed, the results showed that children in the control group who at first did not have successful anticipation skills managed to gain these skills in later months. However, this did not happen with the ASC infants. More specifically, results showed that fewer ASC infants managed to successfully anticipate at least 50% of the attempts than did infants in the control group. In an attempt to explain these findings the research team suggested that since spoon feeding is a repeated action, the control group could learn how to best react when they see the spoon. It may be that infants with ASC needed more time to react and understand a goal-directed behaviour, such as spoon feeding (Hamilton, 2009). Although this study was conducted in a small sample, it suggests that this early eating behaviour could be a potential indicator of an ASC diagnosis.

The successful transition from one feeding stage to another (e.g. from pureed to lumpy food) depends on the development of the child during the first years of life (Gisel 1991; Reilly, Skuse, Mathisen & Wolke, 1995). Consequently, children with developmental problems may struggle during the transition to the next feeding stage due to previous unsuccessful feeding experiences. For example, inexperience with certain textures may be a result of physiological conditions such as sensory sensitivity or poor chewing skills (Field, Garland & Williams, 2003), which may in turn further limit the child’s ability to progress to a more challenging feeding stage. Furthermore, although there is some research on how feeding experiences during infancy may affect later feeding stages, little is known about how early feeding problems can contribute to the development of food neophobia, selective eating or the appearance of sensory sensitivity, not only in children with ASC but also in typically developing children.

1.3.3 Food neophobia in children with ASC

Individuals in the ASC population have been identified as being resistant to change and unwilling to embrace new things, whether this might be new clothing or visiting a new place (Gotham et al., 2013). In line with this, research has shown that generally neophobic individuals (e.g. avoiding new situations and people) are also more food neophobic (Otis, 1984; Pelchat & Pliner, 1986; Pliner & Hobden, 1992).

Although numerous studies have reported the high rates of unwillingness to try novel foods in children with ASC (Klein & Nowak, 1999; Kozlowski, Matson, Fodstad & Moree 2011; Nadon, Feldman, Dunn & Gisel, 2011; Schreck, Williams & Smith, 2004; Whiteley, Rodgers & Shattock, 2000; Williams, Dalrymple & Neal, 2000), only Martins, Young and Robson (2008) have previously measured food neophobia in children with ASC with the use of the Child Food Neophobia Scale

(Pliner, 1994). In this study the level of food neophobia in 41 children with ASC, 12 typically developing siblings of the ASC group, and 41 typically developing children aged between 2 and 12 years was compared. The data showed that children with ASC had poorer self-feeding skills and presented with higher food neophobia levels than the other two groups. More research is needed to see whether these findings can be replicated, and to investigate any links between food neophobia and early feeding problems in this population.

1.3.4 Eating problems in children with ASC

1.3.4.1 Selective eating

Abnormal eating behaviours such as extreme food selectivity and food refusal have been identified as major reasons for the referral of children with ASC to nutritional services (Bandini et al., 2010). Research studies have also noted a high prevalence of children with ASC who are underweight (Burklow et al., 1998), or show extreme food selectivity, eating only 5-6 or fewer different foods, and this may be their typical food repertoire for years (Jacobi, Agras, Bryson & Hammer, 2003).

Schreck, Williams and Smith (2004) explored eating behaviour in 138 children with ASC and 298 typically developing children aged between 7 and 9.5 years. The Children's Eating Behavior Inventory (CEBI) was used to evaluate eating behaviour and to discover the extent to which these behaviours were a problem for the family. In addition, parents reported, with the use of a food preference inventory, whether their child ate an age-appropriate range of food from 5 food groups (fruits, vegetables, dairy, proteins, and starches) and what type of foods they usually preferred. The data showed that children with ASC were more 'picky' and had a less varied eating repertoire. However, given the small age range of the study (7-9.5 years) these findings cannot be generalised to younger and older children.

Schreck and Williams (2006) also used the data collected from the previous study (Schreck, Williams & Smith, 2004) in order to identify whether children with

ASC had a higher preference for specific types of foods. The results highlighted that children with ASC commonly presented with various idiosyncratic eating behaviour patterns. Many children with ASC showed food refusal (57%), were highly selective (72%), would refuse to eat if they were not provided with particular utensils (48.6%), or would not eat if the food touched different foods on the plate (13.8%). In another study Williams, Dalrymple & Neal, (2000) examined parental reports of factors affecting eating selectivity in children with ASC. The results suggested that food appearance (58%), taste (45%), smell (36%) and the temperament of the child (22%) were the most commonly reported factors affecting food selectivity in these children.

In a cross-sectional study, Nadon, Feldman, Dunn and Gisel (2011b) compared the eating behaviour of 48 children with ASC and 48 typically developing siblings aged 3-12 years. The questionnaire used in this research was the Eating Profile (Nadon, 2007) and covered 11 different domains, such as health issues, food preferences for both the children and the family, eating behaviours and the autonomy of the child during mealtimes, in addition to the strategies that parents used when their child demonstrated challenging mealtime behaviour. Although eating problems were present in both groups, the results indicated a higher prevalence of eating problems relating to oral-motor difficulties (e.g. drooling, coughing, gagging, and vomiting during mealtime) in children with ASC. Additionally, the ASC group was more likely to have a food preference repertoire consisting of fewer than 20 different types of food and were less likely to be successfully introduced to a new food. However, the study did not assess whether there were any associations between these eating difficulties and sensory sensitivity in the sample.

1.3.4.2 Rigid/ perseverant eating behaviour

One of the first studies to compare eating behaviour between typically developing children and children diagnosed with ASC was conducted in 1986 by Raiten and Massaro. Parents of 40 children with ASC (mean age 10.6 years) and 34 typically developing children (mean age 8.8 years) completed a questionnaire about their child's health and eating behaviour and also recorded a 7-day dietary intake of their children. The study showed that individuals with ASC were more likely to insist on the same foods or have ritualistic behaviour during mealtime than were the typically developing participants. However, no statistical analysis was carried out and therefore the data could not be used to give a valid picture of the wider ASC population. In line with ASC symptomatology, insistence on sameness, such as eating the same food every day (Schreck, Williams & Smith 2004), or mealtime routines and ritualised behaviour, such as only using certain utensils, are commonly reported eating problems of this population. In addition to this, it is commonly noted that individuals with autism pay extra attention to the local details of the food, with parents' reports indicating that their child would only eat a certain food item if it was in specific branded packaging or presented in a prescribed manner (Cornish, 1998; Rogers, Magill-Evans & Rempel, 2012).

1.3.4.3 Selectivity in terms of texture

Whiteley, Rodgers and Shattock (2000) conducted a qualitative analysis of parental reports of 100 children with ASC aged 2-16 years in order to investigate in depth, the feeding habits and food preferences of this population. The results of this project revealed that children with ASC were highly selective in their food preferences. Data indicated that the texture of food can affect the food preferences of children with ASC. It was noted that children with ASC showed a higher preference for dry, crispy and crunchy foods (such as dry breakfast cereals) and ‘soft foods’ (such as mashed potatoes or rice pudding). These findings were supported by another study which compared the eating behaviour of 53 children with ASC and 58 typically developing children aged 3-11 years, and found that although texture was reported among the most common factors affecting eating selectivity in both groups, the rates were significantly higher in children with ASC (77.4%) in comparison to the control group (36.2 %) (Whiteley, Rodgers & Shattock, 2000). However, another study that also explored texture and selective eating in children with ASC found a greater preference for pureed foods (Schreck, Williams & Smith, 2004). Irrespective of the reported difference about the most preferred food texture in this population, most studies agree that texture generally plays an important role in the eating choices of children with ASC (Cornish, 1998; Rogers, Magill-Evans & Rempel, 2012; Williams, Dalrymple & Neal, 2000

1.4 Sensory sensitivity in children with ASC

Sensory sensitivity has been suggested as one of the most common factors likely to influence eating behaviour in children with ASC (Ayres, 1979; Dunn, Myles & Orr, 2002; Watling, Deitz & White, 2001), with some researchers highlighting sensory sensitivity as an important variable determining food selectivity in children with ASC (Cermak, Curtin & Bandini, 2010). Published reports and research studies describe numerous cases in which individuals with ASC and their caregivers have reported that sensory sensitivity can affect the daily life of ASC populations (Dunn, Myles & Orr, 2002; Kern et al., 2006; Leekam, Nieto, Libby, Wing & Gould, 2007).

The earliest research on how sensory sensitivity can affect eating behaviour in children with ASC were mainly based on studies using non-standardised measures (Jasmin et al., 2009; Keen, 2008; Nadon et al., 2011a, 2011b; Schaaf et al., 2011), or parental reports which suggested that an association may exist between sensory sensitivity and restricted diet or the avoidance of certain textures in children with ASC (Legge, 2002; Twachtman-Reilly, Amaral & Zebrowski, 2008).

A small number of later studies have used the Short Sensory Profile (SSP, Dunn, 1999) to measure sensory sensitivity in children with ASC, and have provided data that can be compared with subsequent studies measuring sensory sensitivity in both children with and without ASC. Nadon, Feldman, Dunn and Gisel (2011) explored the associations between sensory sensitivity and the existence of eating problems in a sample of 95 children with ASC aged between 3 and 10 years. Their results showed that children with "definite" sensory problems in tactile sensitivity, taste-smell and visual/auditory sensitivity had a higher number of eating problems than the children with typical sensory performance. Moreover, this study revealed that children in the 'definite difference' group had significantly higher mean scores for eating problems when compared with the other two groups of 'probable difference' and 'typical performance'. The data also showed higher mean scores for eating problems in the 'definite difference' groups within the modalities of: taste-smell (M=18, SD=5.2), visual-auditory sensitivity (M=17.6, SD=6.1) and tactile sensitivity (M=15.6, SD=6.4). In addition, it was noted that the children with a 'definite difference' in terms of tactile sensitivity also presented problems in the social aspects of mealtime, or presented with rigidness in terms of food brands, the method of cooking, colour, texture, or the temperature of the food. However, apart from this example, the research team did not provide further details on whether sensory sensitivity in each of these modalities was linked to more specific eating problems or behaviours. Although this study has provided a valuable input into this body of research, there was unfortunately no comparison control group.

Zobel-Lachiusa, Andrianopoulos, Mailloux and Cermak (2015) conducted the first study which explored the association between mealtime behaviour problems and sensory differences in a sample of 34 children with ASC and 34 typically developing children aged 5-12 years. In this study the SSP (Dunn, 1999) and the Sensory Eating Checklist, a modified version of Eating Checklist (Yack, Sutton & Aquilla, 2003) was used in order to measure the sensory processing performance of the sample, while the TIE (Touch Inventory for Elementary School-

Aged Children, Royeen & Fortune, 1990), a child-reported measure, was chosen to measure children's tactile sensitivity. Additionally, the Brief Autism Mealtime Behavior Inventory (BAMBI, Lukens & Linscheid, 2008) was used to measure mealtime behaviour in both children with ASC and typically developing children. The BAMBI is a parent-report questionnaire consisting of 18 statements relating to children's mealtime behaviours (e.g. "My child is flexible about mealtime routines", "My child is willing to try new foods," and "My child cries or screams during mealtimes," etc.). The results revealed significantly more prevalent sensory differences in children with ASC, and higher sensory sensitivity was associated with the existence of mealtime problems. However, this study did not specify which areas of mealtime behaviour were more problematic. Moreover, although this study was among the first to measure and compare sensory sensitivity and mealtime behaviour in children with and without ASC, it had a number of limitations. Firstly, the sample used in this study could be considered as a self-selected sample as, according to the research team, parents may not have offered to participate if there was not a personal interest in, or concern about, their child's sensory and eating behaviours. The research team also failed to describe which areas of mealtime were more problematic in the ASC group (e.g. selective eating, rigidness, unwillingness to try new food) or how individual SSP subcategories (visual, tactile and taste-smell sensitivity) were related to problematic mealtime behaviours. These limitations show that future research is needed to examine how sensory sensitivity is related to specific eating behaviours in ASC groups and whether these more specific problematic eating behaviours, such as unwillingness to try new foods (food neophobia), are more prevalent in the ASC population.

1.5 Behavioural and social-communication skills as a determinant of children's eating behaviour

Depending on the occasion, mealtimes may require increased levels of social interaction which, in cases of children with greater social and communication difficulties, may compromise their ability to eat successfully, particularly in social settings. Crowded settings such as school cafeterias, restaurants or family gatherings may put extra pressure on these children and increase their anxiety levels (Twachtman-Reilly et al., 2008). Anxiety in turn can result in a decrease in appetite (Bryant-Waugh, Markham, Kreipe & Walsh, 2010), which a child with communication problems may find difficult to explain, consequently lack of appetite may be perceived as extreme food selectivity or 'fussiness'.

Social and communication skills are a commonly neglected area in research into eating behaviour in children. When children start consuming the same food as the rest of the family they are expected to perceive a series of social cues and effectively react to the physical and social environment of the mealtime (e.g. when is the time to eat, where is the place to eat, following table manners). From early infancy children are also expected to learn by imitating the eating related behaviours of parents and siblings (Birch, McPhee, Sullivan & Johnson, 1989). Typically developing children tend to imitate others and start trying new foods if they observe others eating them, however, those who struggle with social imitation are more likely to exhibit food neophobia (Harris, 2000). In line with this, previous research has identified a link between the fruit and vegetable intake of parents and their children, which highlights the fact that, if children have the skills to imitate and model their parent's eating behaviours, this can have a positive impact on the variety of their food intake (Fisher, Mitchell, Smiciklas-Wright & Birch, 2002; Gibson, Wardle & Watts, 1998).

Twachtman-Reilly, Amaral and Zebrowski (2008) investigated the mealtime multisensory experience and attempted to describe the potential challenges for children with ASC who also face sensory sensitivity. They described how a school cafeteria could be a place where noise levels can be high (e.g. plates banging, cutlery noises, chatting), smell stimuli may be intense (smell from food cooking, smell from food eaten nearby, cleaning products or perfumes) and visual flickering from fluorescent lights or people moving around the room may be distracting. In line with this, Hilton et al (2010), using the Short Sensory Profile (SSP, Dunn, 1999), compared sensory processing skills between 26 typically developing 6-10 year olds and 36 high functioning children with autism of the same age and found a moderate to strong correlation between social difficulties and atypical sensory processing performance in both groups.

Children's inability to tolerate certain sensory inputs may result in negative social and behavioural responses, such as becoming upset, aggressive or having temper tantrums, whether they have an ASC or not. Consequently, it is difficult to be sure whether aberrant mealtime behaviour, reported both in children with and without ASC (Carruth et al., 1998; Rogers, Magill-Evans & Rempel, 2012), (such as avoiding the meal table or the dining room, socially withdrawing from the whole experience, spitting or throwing food) may appear due to 'fussiness' in terms of eating, or as a coping technique in response to an overwhelming sensory input.

1.6 Brief description of the limitations of the reviewed research

Although food neophobia in typically developing children has been widely explored, at present only one study has looked at the association between food neophobia and different aspects of sensory sensitivity in typically developing children with the use of standardised measures (Coulthard & Blissett, 2009). Therefore more research is needed in order to replicate these findings in a larger sample.

Previous research has demonstrated a link between the timing of the introduction to solid food and the subsequent eating behaviour of children at 7 years old (Coulthard, Harris & Emmett, 2009). More research would be beneficial in order to shape a more detailed picture of how difficulties in early feeding stages (and especially problems in the transition from baby food to family food) can affect or predict eating behaviour throughout childhood. Furthermore, it remains to be explored whether there is a link between early feeding problems and the development of higher levels of food neophobia.

Unlike food neohobia, which is a clearly defined eating behaviour in children, measured by the Child Food Neophobia Scale (CFNS), many eating behaviours have been characterised as ‘picky’/selective eating and there is no consensus regarding which eating behaviours constitute this term across research studies. This lack of clarity is a major limitation, as various research studies use the ‘picky’/selective eating umbrella term to describe behaviours such as rigidness in terms of eating (e.g. adherence to brands, packaging, utensils) (Bryant-Waugh et al., 2010; Cornish, 1998), selectivity in terms of texture (Field, Garland &

Williams, 2003; Smith, Roux, Naidoo & Venter, 2005), fussiness (Carruth et al., 1998; Rogers, Magill-Evans & Rempel, 2012) or lower food intake (Cooke et al., 2003), while a series of different measures have been used to assess these varied eating behaviours (Lafraire, Rioux, Giboreau & Picard, 2016). This is a common phenomenon in research investigating eating behaviour both in typically developing children and in children with ASC (Nadon, Feldman, Dunn & Gisel, 2011; Zobel-Lachiusa et al., 2015). Consequently this makes any comparison between the populations of these studies difficult.

In typically developing children the use of the CFNS creates a common ground for exploring food neophobia. In research exploring eating in children with ASC, although unwillingness to try new foods is commonly reported, the study by Martins, Young and Robson (2008) is the only one to have used the CFNS to compare food neophobia levels between typically developing children and children with ASC. Although this study forms the basis for future research, the sample used was small. This highlights the need for further research that will replicate the findings in a larger sample.

Previous research has shown a link between visual sensitivity and higher levels of food neophobia in typically developing children (Coulthard & Blissett, 2009). However, since the SSP (Dunn, 1999), or any other measurement of sensory performance, was not used in the study of Martins, Young & Robson (2008) we cannot be sure whether, in children with ASC, there is also an association between sensory sensitivity and higher levels of food neophobia. Studies focusing on comparing eating behaviour of children with ASC and children in the control group presented further technical limitations, such as using a limited age range (Schreck, Williams & Smith, 2004) and small (Brisson et al.,2012) or geographically restricted samples (Zobel-Lachiusa et al., 2015) which compromise the generalisation of the findings.

1.7 Overall summary of the review and directions for this thesis

The research reviewed has suggested that early feeding problems, food neophobia and sensory sensitivity are potential factors affecting eating behaviour in children with typical development. Previous research studies consisting of both cross-sectional (Galloway, Lee & Birch, 2003) and longitudinal data (Coulthard, Harris & Emmett, 2009) have indicated links between difficulties during early feeding stages (breastfeeding and introduction to solids) and later eating behaviour in childhood. More specifically, it was found that girls who had been breastfed for less than 6 months showed higher food selectivity,(Galloway, Lee & Birch,2003) and children who presented a difficult transition from milk to solid food were more likely to reject a known food which was previously accepted (Brown & Harris, 2012b). In line with this research, a link has been suggested between early exposure (before the age of 10 months) to a wider range of flavours and textures and the later acceptance of foods varying in texture (Birch, Gunder, Grimm-Thomas & Laing 1998; Blossfeld, Collins, Kiely & Delahunty, 2007; Coulthard, Harris & Fogel, 2016; Northstone & Emmett, 2013). However, more research is needed to investigate how other early feeding stages can impact on selective eating and food neophobia in childhood.

Food neophobia has been identified as the most common factor contributing to selective eating behaviour in children (Brown & Harris, 2012; Cooke et al., 2004). Research into sensory sensitivity has suggested a link between tactile sensitivity and selective eating, as well as a link between tactile sensitivity and selectivity in terms of texture (Smith, Roux, Naidoo & Venter, 2005). Similarly, Coulthard and Blissett (2009) revealed a link between taste-smell and tactile sensitivity and higher fruit and vegetable selectivity. Their study also showed an association between visual sensitivity and higher food neophobia. It would therefore be interesting to explore any associations between rigidness in terms of eating and sensory sensitivity. Similarly, early feeding problems need to be further explored as a potential predictor of higher food neophobia and sensory sensitivity in childhood, and the exact sensory domain which drives the neophobic response of food refusal on sight.

Although previous research has not revealed a direct link between social skills and selective eating, higher sensory sensitivity has been found to co-exist with poorer social responses in both children with and without ASC (Hilton et al., 2010). In line with this, some researchers suggest that, although there might not be a direct relationship of cause and effect between eating and social skills, it may be that the existence of sensory sensitivity negatively affects social-communication and/or other aspects of behaviour such as eating (Twachtman-Reilly et al., 2008).

Figure 1.1 demonstrates the relationships reviewed in the existing research in both typically developing children and those with ASC. It can clearly be seen that previous research investigating eating behaviour in typically developing children has provided a relatively clear image of the role certain factors play in the eating behaviours of these individuals. However, further research is needed to define the role of factors such as early feeding problems, food neophobia and sensory sensitivity and the association between them.

In contrast, given that research on eating behaviour in children with ASC is still a developing field, very little is known about the extent to which previously recognised factors affecting eating behaviour in typically developing children impact on the eating behaviour of children with ASC (Figure 1.1). An association has been suggested between tactile sensitivity and problematic social responses at mealtimes, as well as rigidness in terms of brands, ways of preparation, colour, texture and temperature of the food (Nadon, Feldman, Dunn and Gisel, 2011). However, these associations need further investigation in a larger sample of children with ASC, while the presence of a control group would be ideal in order to examine whether these associations appear in a typically developing child sample or are ASC specific.

Zobel-Lachiusa et al. (2015) observed a correlation between sensory sensitivity and the existence of mealtime problems, however this study failed to detail which areas of mealtime were more problematic in the ASC group (e.g. selective eating, rigidness). Therefore, in Figure 1.1 potential associations are indicated with dashed arrows, including the potential links between sensory sensitivity with selective eating, rigid/ perseverant eating and selectivity in terms of texture.

Research into the impact that early feeding problems have on the later eating behaviour of children with ASC is still at an early stage. Therefore, the prevalence of these difficulties needs to be investigated in order to progress to exploring associations between the existence of early feeding problems and sensory sensitivity, eating selectivity, rigid eating and/or food neophobia in this population. Similarly, very little is known about how food neophobia may link with sensory sensitivity in children with ASC. Consequently, current research has to be based on the associations between food neophobia and sensory sensitivity in typically developing populations in order to shape research hypotheses. This thesis will establish a more concrete picture of the observed associations between factors affecting eating behaviour in children with typical development. Then, based upon this knowledge, hypotheses will be shaped for the factors affecting eating behaviour in children with ASC and the associations between them.

1.8 Aims of the thesis

This thesis aims to investigate the factors affecting the eating behaviour of children with and without ASC (Figure 1.1). One of the primary aims is to look at ways in which early feeding problems, food neophobia, sensory sensitivity and the existence of autistic traits or an ASC diagnosis can interfere with eating behaviour, and to identify any association between these factors. Secondly, this thesis aims to explore links between problematic eating, sensory sensitivity and the existence of social-communicational and behavioural/emotional problems in children with and without ASC aged 2-14 years.

Additionally, given that children in both typically developing and ASC populations are highly selective about specific foods, in particular, vegetables Chapters 5 and Chapter 6 will look at how food neophobia and sensory sensitivity can interact with vegetable preferences and willingness to try various vegetables options in both children and young adults with and without autistic traits.

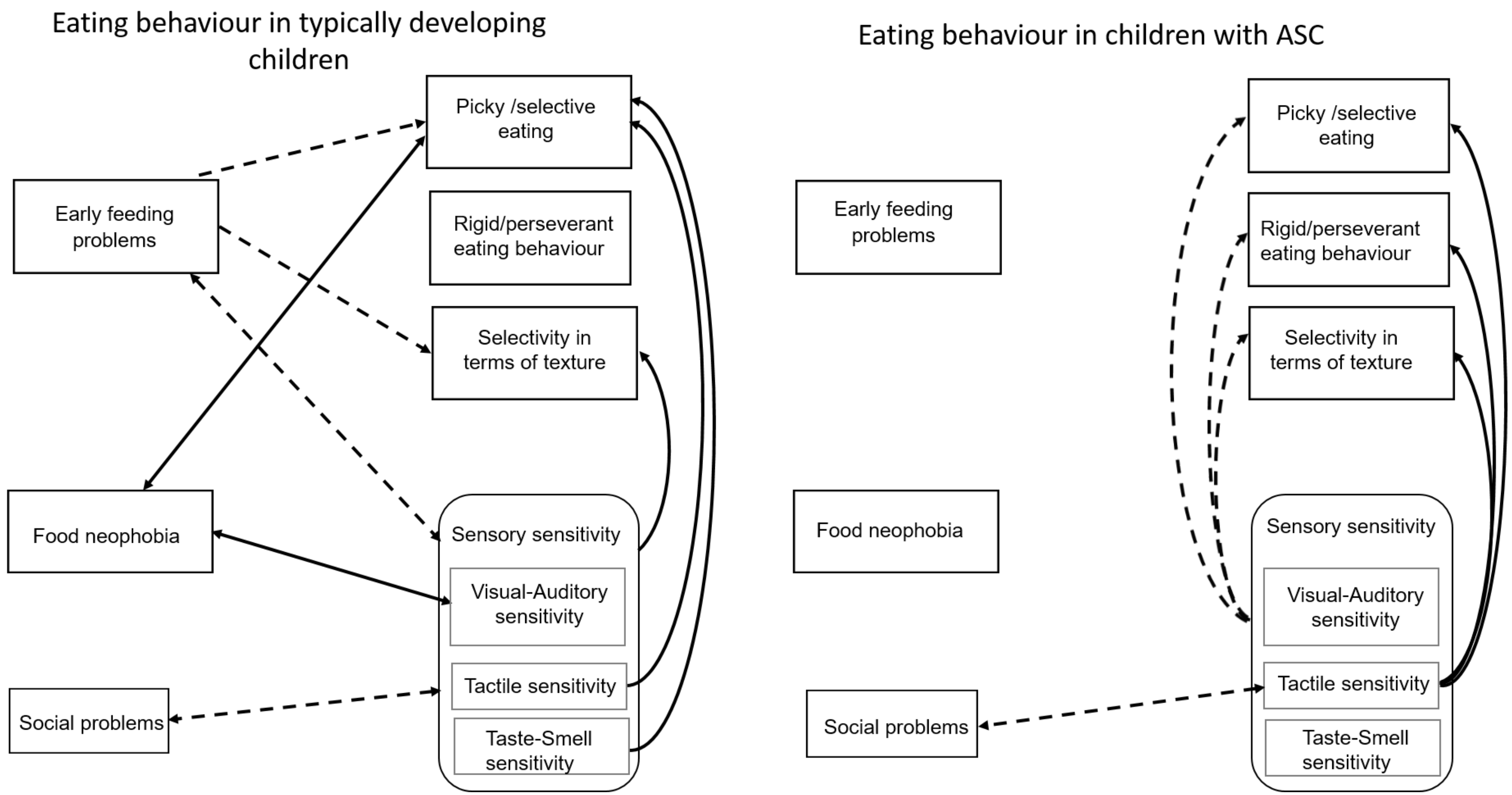


Figure 1.1 This model represents the known relationships between the factors affecting eating behaviour based on the reviewed research. Solid arrows represent associations resulting from high-quality or replicated research in typically developing children (left) and children with ASC (right). Dashed arrows represent associations documented in the literature coming from less robust evidence which therefore need to be investigated further.

CHAPTER 2

GENERAL METHODOLOGY

2.1 Introduction

This chapter will provide an overview of the methods used in this thesis. Three individual research projects consisting of three participant samples were run; detailed information is given about the measures used and the research designs of these studies.

2.2 Ethics and governance

Ethical approval was granted for each of the research studies from the Science, Technology, Engineering and Mathematics Ethical Review Committee of the University of Birmingham. For study A, “Investigating eating behaviour in children with and without autism spectrum conditions (ASC) between 2 and 14 years old”, the Ethical Review Reference Number (ERN) was 13-0310, and approval was granted on 3.6.13. For study B, “Vegetable texture preference in children” the ERN was 14-0074, and approval was granted on 16.5.14. For study C “Vegetable consumption in young adults”, the ERN was 14-0063 and approval was granted on 10.2.14.

2.3 Overview of the studies

2.3.1 Study A: Investigating eating behaviour in children with and without autism spectrum conditions (ASC) aged 2-14 years old

2.3.1.1 Sample

Parents of typically developing children and children with ASC completed an electronic questionnaire (more information below). This method is cost effective and provides a greater access to a sufficient number of participants coming from a wide range of socio-economic and ethnic backgrounds. The analysis of the data collected from this sample forms Chapter 3 and Chapter 4.

2.3.1.2 Recruitment procedure

After ethical permission was granted from the research committee of the University of Birmingham, participants were recruited online through internet based parent support groups, networks and ASC specific parent support groups. Support group and network leaders were contacted in advance and asked to give their permission for a link to the research to be posted on their support group's/network's/organisation's website. Participants were also recruited through adverts placed on the websites of Autism Education Trust and Autism West Midlands, on parenting and children related blogs, forums and Facebook groups. If children suffered from any serious neurological impairment that may be related to poor growth, for example cerebral palsy or Rett syndrome, they were excluded from the sample. In addition, children with severe chronic medical conditions such as cardiac problems, respiratory disease, metabolic disease of any kind, or heart, kidney or liver disease were also excluded.

2.3.1.3 Measures used in study A

In study A (from which data were presented in Chapter 3 and Chapter 4) demographic and additional information questionnaires were used to collect information on the background of the parents and their children. The Eating Behaviour Questionnaire was used to collect information on the existence of early feeding problems in the sample, while the Feeding Behaviour Checklist (FBC) was used in order to explore the eating behaviour of the children. The FBC also included four questions from the adapted Child Food Neophobia Scale (CFNS) in order to measure food neophobia levels of the children. The Strengths and Difficulties Questionnaire (SDQ) was used to assess behaviour, and the Social Communication Questionnaire (SCQ) was used to measure the social and communicational skills of the sample (data demonstrated in Chapter 4). Further information on all of these measures can be seen in section 2.5 below.

2.3.2 Study B: Vegetable texture preference in children

2.3.2.1 Sample

In study B, parents of typically developing children aged 3-4.5 years were recruited from local nurseries in Birmingham. The analysis of the data collected forms Chapter 5.

2.3.2.2 Recruitment procedure

For the recruitment of toddlers aged 3-4.5 years, nurseries in the Birmingham area were contacted by telephone. After discussing with head teachers who had expressed an interest in participating in the study, a full participation pack was sent to them, consisting of the questionnaire, the information sheet and a consent form, for them to check before giving consent to run the study in their nursery. It was then arranged for participation packs to be sent to parents. Children with developmental disorders or compromised development due to syndromes or learning difficulties were excluded. Parents who wanted their child to take part in the research returned the completed consent forms and questionnaires in the envelope provided and placed them in a designated post box (See appendix C-1). Teachers and other members of staff did not have access to the individual information provided by the parents regarding their children. As compensation each nursery was entered into a prize draw for a £20 Amazon voucher.

2.3.2.3 Measures used in study B

In study B demographic and additional information questionnaires were used to collect background information on the children and parents of the sample. The Short Sensory Profile (SSP) was used to measure the sensory processing behaviour and the Child Food Neophobia Scale (CFNS) was used to measure food neophobia levels in the pre-schoolers. A vegetable preferences inventory was used to identify the vegetable preferences of children and parents. Finally, children were visually exposed to real food which they were asked to rate with the use of a willingness to try food scale. More information on each of these measures can be found in section 2.5.

2.3.3 Study C: Vegetable consumption in young adults

2.3.1 *Sample*

In study C, young adults aged 17-35 years were recruited. Participants were under/postgraduate students at the University of Birmingham. The analysis of the data can be found in Chapter 6.

2.3.2 *Recruitment procedure*

Adults aged between 17-35 years were recruited through the University of Birmingham research participation scheme and were invited to complete an electronic questionnaire and attend the observational part of the study. The main requirement of the participants was to live permanently in the United Kingdom, regardless of their nationality. These requirements were set to ensure that all of the participants had access to the same variety of vegetables from local shops and supermarkets. As a compensation for participation in this study students received academic credits and they were also offered a packet of crisps after completing the second part of the study, as a small incentive.

2.3.3 Measures used in Study C

In study C demographic and additional information questionnaires were used in order to collect information about the young adults of the sample. The Adult Sensory Profile (AASP) was used to measure sensory processing behaviour and the Food Neophobia Scale (FNS) was used to measure food neophobia.

Table 2.1 Summary Overview of the studies

	Study A *N=254*		**Study B** *N=53*	**Study C** *N=77*
	Chapter Three	Chapter Four	Chapter Five	Chapter Six
Age of the sample	2-14 years		3-4.5 years	17-35 years
Questionnaires				
Demographic and additional background information	X	X	X	X
Early Eating Behaviour Questionnaire	X	X		
Child Food Neophobia Scale (CFNS)	X (Only four questions embodied in FBC)	X (Only four questions embodied in FBC)	X (six-item version of CFNS)	
Food Neophobia Scale (FNS)				X
Feeding Behaviour Checklist (FBC)	X	X		
Short Sensory Profile (SSP)	X	X	X	
Adult Sensory Profile (AASP)				X
The Strengths and Difficulties Questionnaire (SDQ)		X		
Social Communication Questionnaire (SCQ)		X		
Autism Spectrum Quotient (AQ)				X
Vegetable preferences inventory			X	X
Other assessments				
Visual food exposure			X	X
'Willingness to try' food rating scales			X	X

2.4 Measures of children's and young adults' eating behaviour

2.4.1 Early eating behaviour questionnaire

Parents in study A (Chapter 3, See Appendix A-1) were asked to report if their child had any problems during the following stages: breast/bottle feeding, the transition from breast to bottle, the introduction to complementary food (from milk to pureed food), the transition from pureed to lumpy food, the transition from lumpy solids to family food, the finger food feeding stage and finally during the toddler feeding period (around 18 months).

2.4.2 The adapted Child Food Neophobia Scale (CFNS, Cooke et al., 2004; Pliner, 1994)

Food neophobia has been described as a personality trait, evincing the avoidance of new and unfamiliar foods. The CFNS was originally created by Pliner (1994) however, in later research (Cooke et al., 2004; Cooke, Wardle & Gibson, 2003) a revised version included six items of the original CFNS. The six item CFNS was used in study B (Chapter 5-See Appendix A-2). The six remaining items, known as the 6-item adapted Food Neophobia Scale for children are: 'My child is constantly sampling new and different foods' (reversed score), 'My child doesn't trust new foods', 'If my child doesn't know what's in the foods s/he won't try it', 'My child is afraid to eat things s/he has never eaten before', 'My child is very particular about the foods s/he will eat', 'My child will eat almost anything' (reversed score). Responses were on a 6 point Likert scale from 'strongly disagree' to 'strongly agree'. An overall Food Neophobia score for children was calculated as a sum of the 6 items. Higher scores indicate a higher level of food neophobia. Cronbach's alpha for the 6-item measure was 0.89 (Chapter 5).

In Chapters 3 and Chapter 4 only 4 questions were used from the CFNS, as the factor analysis loadings of the Feeding Behaviour Checklist (see below) indicated that the two (excluded) questions had effectively been replaced by similarly worded statements.

2.4.3 Food Neophobia Scale (FNS, Pliner & Hobden, 1992)

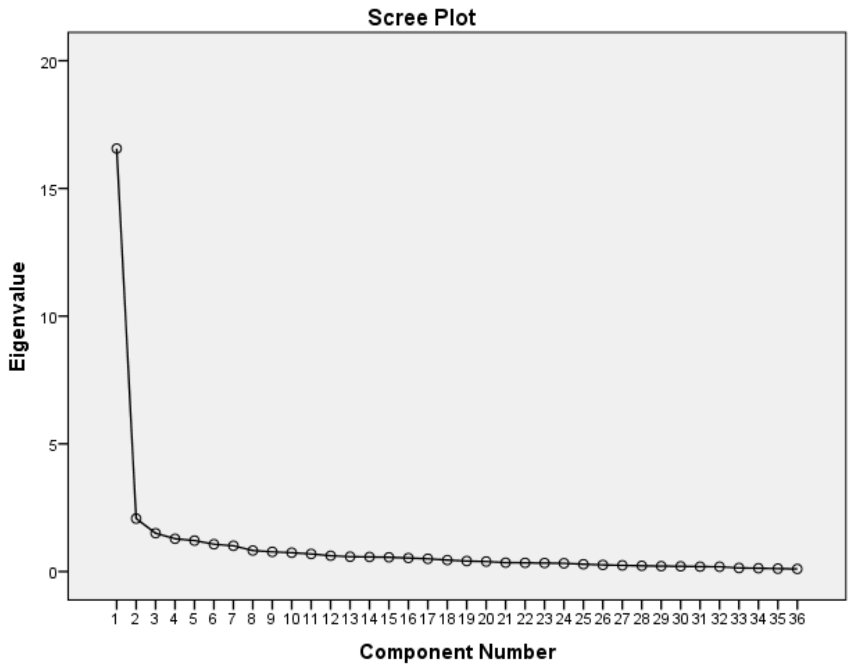
In study C (Chapter 6, See appendix A-3), levels of food neophobia were measured with the use of the adult Food Neophobia Scale (FNS). This 10-item scale created by Pliner and Hobden (1992), offers seven graded response alternatives ranging from “strongly disagree” (1) to “strongly agree” (7) for each of the ten statements. Young adults in study C were asked to complete the FNS. Positively worded statements such as ‘I am constantly sampling new and different foods’, ‘I like foods from different countries’, ‘At dinner parties I will try new foods’, ‘I will eat almost anything’ and ‘I like to try new ethnic restaurants’ receive a reversed score. Higher FNS score indicates greater food neophobia levels. The Cronbach's alpha for the 10-item scale was 0.87.

2.4.4 Feeding Behaviour Checklist (FBC, Harris, in publication)

The Feeding Behaviour Checklist (FBC) was used in Study A, which is a parent-report measure consisting of 34 statements (Harris, in preparation, see appendix A-4). The FBC has been developed as a result of clinical experience and is based on the commonly observed problems in clinically referred children and also includes items from existing measures of eating behaviour such as CFNS (Pliner, 1994). The FBC scores range from a minimum of 34 to a maximum 170.

All of the scale's items are phrased as statements, and the response answer is a 5-point Likert scale ranging from 1 (Never or Strongly Disagree) to 5 (Always or Strongly Agree) depending on the wording of the questions. Question 4 follows a slightly different response wording e.g. 'Finds messy play (e.g. hand painting/muddy, outdoor play)' (1) 'Extremely enjoyable' to (5) 'Refuses to participate'. The statements 16: "Eats food prepared by anybody" and question 22: "Constantly samples new and different foods" are reverse scored. The Cronbach's alpha for the overall score in FBC was 0.96. Higher overall scores in the FBC indicate higher eating difficulty.

Factor analysis was conducted in order to explore the inter-correlation between the variables of the FBC. The results of an oblique rotation of the solution are shown on the scree plot below. Loadings less than 0.30 were excluded. The scree plot (see below) illustrates the curve tailing off after three factors, but there is another drop after four factors before a stable plateau is reached. According to the Kaiser criterion, factors with eigenvalues greater than 1 were retained while the options of two, three, four or seven factors were explored based on the suggestions of the initial factor analysis produced automatically by SPSS. The factor analysis and the calculations of Cronbach's alpha (α=0.966) suggested that a three-factor solution was the most suitable.



The FBC is a result of factor analysis. One could argue that different eating behaviours may have stronger loadings in the ASC group in comparison to the control and therefore factor analysis should have been run separately for the data collected from each group. However, this may have led to two different set of variables and as a result comparison between the scores of the two groups would have been impossible. It was therefore decided that factor analysis will be run for the data collected from the groups and as a result the two groups will have been compared on the same set of variables.

After looking at the statements that load onto the same (sub-category) factor, three common themes were identified. The items loading under each of the three subcategories can be found in the Appendix B-1.

2.4.1 First sub-category of FBC-Eating selectivity

This sub-category consists of a set of 26 statements (Cronbach's $\alpha=0.962$) exploring selective eating behaviour. Some of the key statements (based on greater factor analysis loading) of this sub-category are ‘Becomes anxious around new foods’, ‘Has a diet that consists of only a few foods’, ‘Is afraid to eat things she/he has never had before’.

2.4.2 Second sub-category of FBC- Rigid/perseverant eating behaviour

This sub-category consists of a set of 7 items (Cronbach's α=0.901) measuring adherence to routines and sameness in mealtime behaviour. Key statements for this sub-category (based on the factor analysis loading) are: ‘Only eats/drinks from a particular plate/cup/spoon etc. ‘Becomes upset/irritable when mealtimes don’t follow a typical routine’ and ‘Only eats when specific people are present’.

2.4.3 Third sub-category of FBC- Selectivity in terms of texture

This sub-category consists of a set of 4 statements (Cronbach's α=.794) and focuses on the sample’s food preferences in terms of texture. Key statements (based on the factor analysis loading) are ‘Does not like wet foods (e.g. pasta, foods with sauces)’, and ‘Does not like pureed smooth foods (e.g. vegetable/fruit smoothies, yoghurt)’.

2.5 Short Sensory Profile (SSP, Dunn, 1999; McIntosh, Miller, Shyu & Dunn, 1999)

In order to gather information on the sensory processing of the children, the Short Sensory Profile (SSP, Dunn, 1999, See Appendix A-5) was used in studies A and B (Chapter 3, Chapter 4 and Chapter 5). The Short Sensory Profile is a standardised parent questionnaire consisting of 38 questions designed to measure behaviours associated with abnormal responses to sensory stimuli in children aged 3–10 years (McIntosh et al. 1999). The SSP is an overview of the Sensory Profile (SP, Dunn, 1999), it is shorter and only consists of the SP items that demonstrated the highest discriminative power of atypical sensory processing (Tomchek & Dunn, 2007).

The caregiver rates the child's typical responses to tactile, vestibular, auditory and visual stimuli on a five point Likert scale ranging from 'never' to 'always'. The Short Sensory Profile test has previously been used in order to identify sensory processing difficulties that may have a direct or indirect impact on the sample's eating behaviour (Dunn, 1999). The SSP questionnaire includes five questions which refer to auditory and visual sensitivity (e.g. Responds negatively to unexpected or loud noises), seven questions relevant to tactile sensitivity (e.g. Rubs or scratches out a spot that has been touched) and four questions related to taste/ smell sensitivity (e.g. Avoids certain tastes or food smells that are typically part of children's diets).

There are two ways of scoring the SSP data. One way is to combine the score of each sensory sensitivity domain in order to calculate the overall sensitivity score of the participant. This method of scoring the SSP data was used for Chapter 3, Chapter 4 and Chapter 5. The second way of scoring is based on the reported performance in each sensory sensitivity domain, participants can be divided into groups of *typical performance, probable difference* or *definite difference.* For instance, in visual-auditory processing *typical performance* scores range from 25-19, *probable difference* scores range from 18-16 and *definite difference* is below 15. Taste/smell sensitivity *typical performance* ranges from 20-

15, *probable difference* ranges from 14-12 and *definite difference* below 11. Tactile processing *typical performance* ranges from 35-30, *probable difference* ranges from 29-27 and *definite difference* is below 26 (McIntosh, Miller, Shyu & Dunn, 1999). This method of analysis was used in Chapter 4.

For study A (Chapter 3 and Chapter 4) and study B (Chapter 5) it was decided that only three domains of touch, taste/smell and vision/auditory processing would be examined as they are more relevant to eating (Coulthard & Blissett, 2009; Smith, Roux, Naidoo & Venter, 2005). The Cronbach's alpha for the overall score of the Short Sensory Profile (SSP) is .798. The SSP was chosen as it is the most widely used measure for sensory processing and would allow a comparison of the results of this research with previous studies (Reynolds & Lane, 2008).

2.6 Adult sensory profile (AASP, Brown & Dunn, 2002)

The AASP (Brown & Dunn, 2002, See Appendix A-6) is a self-report 60-item questionnaire that can be completed without supervision by individuals older than 11 years. The AASP refers to everyday sensory processing experiences with responses ranging from almost never (1) to almost always (5) on a 5-point Likert scale. The AASP is organised into 6 sensory processing categories: *taste/smell processing* (e.g. I only eat familiar foods), *movement processing* (e.g. I trip or bump into things), *visual processing* (e.g. I keep the shades down during the day when I am at home), *touch processing* (e.g. I avoid or wear gloves during activities that will make my hands messy), *activity level* (e.g. I work on two or more tasks at the same time) and *auditory processing* (e.g. I startle easily at unexpected or loud noises, for example, vacuum cleaner, dog barking, telephone ringing). The overall sensory profile score is calculated as the sum of the 60 items. Individual scores for each sensory processing category can also be calculated by adding the scores from each sensory category. Higher score in the ASSP indicates a greater sensory processing difficulty.

The AASP was used to measure the sensory processing skills of the young adults in study C (Chapter 6). In order to test the reliability of AASP, the internal consistency (coefficient alpha) method was used. The Cronbach's alpha for the overall AASP (including the three subcategories) was .709.

2.7 The Strengths and Difficulties Questionnaire (SDQ, Goodman, 1997)

In study A (Chapter 3) the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997, See Appendix A-7) was used in order to assess 25 internalising and externalising behaviours of the child sample. The SDQ is a brief parent-report behavioural screening questionnaire for children aged 4-17 years. This assessment tool is organised into 5 thematic scale sections, each with 5 questions. The sections are: the *conduct problems scale* which focuses on aggressive/oppositional behaviour (e.g. Generally obedient, usually does what adults request), the *hyperactivity scale* which examines abnormal behaviours that could be related with hyperactivity or lack of concentration (e.g. 'Restless, overactive, cannot stay still for long'), the *emotional symptoms scale* which refers to worrying/feelings of anxiety (e.g. Many worries, often seems worried), the *peer problems scale* which focuses on problems such as bullying, disrespect or lying to adults (e.g. Often lies or cheats) and the *prosocial scale* which focuses on social skills such as empathy or whether they like sharing or helping others (e.g. 'Considerate of other people's feelings'). The range of responses for the SDQ varies from *not true* (0), *somewhat true* (1), *certainly true* (2). However, statements following a positive wording receive a reversed score. According to the scoring manual, the generated overall score is the sum of all the scales apart from the prosocial scale. A higher total score may indicate an underlying mental health disorder or behavioural difficulties. Lower scores on the prosocial scale are linked with disadvantages in terms of social skills.

Given that the SDQ aims to explore behaviour in children aged between 4 and 17 years, the SDQ results from children younger than 4 were not included in the analysis of the data. Cronbach's alpha for the SDQ was .779.

2.8 Social Communication Questionnaire (SCQ; Rutter, Bailey & Lord, 2003)

The SCQ (Rutter, Bailey & Lord, 2003, See Appendix A-8) is a validated 40 item *yes* and *no* questionnaire derived from the Autism Diagnostic Interview-Revised (ADI-R) (Constantino et al., 2003; Le Couteur et al., 1989). The SCQ is completed by the caregiver and aims to explore the child's behaviour over the past 3 months. Each item of the SCQ can be scored with 0 or 1, with 1 being given when the parents' answers to the statements endorse autistic traits. Total scores of the SCQ can range from 0 to 39 (the first item is a language screening question that is not included in the total score).

This questionnaire can be used to evaluate children over the age of 4 years as long as their mental age exceeds 2 years (Rutter, Bailey & Lord, 2003). However, because we could not be sure that this was always the case for children with ASC, SCQ scores from children younger than 4 were not included in the final analysis of the data. The completion of this questionnaire takes less than 10 minutes and can be completed without supervision.

The SCQ consists of 4 subcategories focusing on *social interaction* (e.g. Does she/he have any particular friends or a best friend?), *communication* (e.g. When she/he was/is 4-5, did she/he nod her/his head to mean yes?), *abnormal language* (e.g. Has she/he ever got her/his pronouns mixed up e.g. saying you or she/he for I) and *stereotyped behaviour* (e.g. Has she/he ever seemed to be more interested in parts of a toy or an object (e.g. spinning the wheels of a car), rather than using the object as it was intended?).

Nineteen items rate current behaviour and twenty rate behaviour when the child was 4-5 years old. The points are summed and the cut-off is established as ≥22 for autism and ≥15 for other ASC (Charman, et al., 2007). A higher SCQ score indicates greater difficulty.

The SCQ is not a diagnostic tool, it aims to identify children at risk of ASC. Also, given the lack of evidence regarding the effectiveness of SCQ in children younger than 4 years old (Corsello et al., 2007; Oosterling et al., 2010), it was decided that SCQ results from children younger than 4 years would not be included in the final data analysis. As a result, in Chapter 4 the SCQ was not used to discriminate ASC from the control group, but solely as a tool to identify social and communicational difficulties in children with and without ASC. This allowed for an investigation into any association between social and communication problems and the existence of eating and sensory processing problems in Chapter 4. Internal consistency of sections within SCQ ranged between 0.28-0.91. Cronbach's alpha for the SCQ was 0.94.

2.9 Autism Spectrum Quotient (AQ, Baron-Cohen, Hoekstra, Knickmeyer, & Wheelwright, 2006)

The Autism Spectrum Quotient (AQ, See Appendix A-9) has been developed to measure autistic traits in adults with normal intelligence (Baron-Cohen et al. 2001). The Autism Spectrum Quotient (AQ) is a short self-report questionnaire measuring autistic traits, with five subscales, consisting of 10 questions. The subscales are: *social skills* (e.g. I find social situations easy), *attention switching* (e.g. I frequently get so strongly absorbed in one thing that I lose sight of other things), *attention to detail* (e.g. I usually notice car number plates or similar strings of information, *imagination* (e.g. If I try to imagine something, I find it very easy to create a picture in my mind) and *communication* (e.g. I enjoy social chit-chat). The response options range from *definitely agree* to *definitely disagree* on a 4-point Likert scale. Each of the 50 items scores 1 point if the respondent reports an autistic-like behaviour either mildly or strongly (*strongly agree/disagree, slightly agree/disagree*). A higher score in each subscale indicates respectively, poor social skills, poor communication skills, poor imagination, exceptional attention to detail, and poor attention-switching/strong focus of attention. A higher overall score would indicate a higher frequency of autistic traits. The AQ can be used to categorise individuals who have a low level of autistic traits (score ranging from 0-18), a medium level of autistic traits (19-31) and a high level of autistic traits (32-50). The AQ was used in study C (Chapter 6) in order to explore how the existence of any autistic traits might affect eating behaviour. The AQ has been identified as a valid measurement which can successfully predict which individuals are at risk of being diagnosed on the autistic spectrum in a clinical setting (Woodbury-Smith, Robinson & Baron-Cohen, 2005) and has strong test-retest reliability ($r = .92$, $p<.001$) (Baron-Cohen et al., 2006). The Cronbach's alpha for the AQ was .697 (Chapter 6).

2.10 Willingness to try food rating scales

For young adults participating in study C (Chapter 6) a 5 point Likert scale (see appendix A-10) was used to measure their level of interest in trying each vegetable option presented. Participants used the scale to answer the question

“How willing would you be to try this food option?” Answers varied from: *not at all* (1), *not really* (2), *undecided* (3), *somewhat* (4), and *very much* (5).

Similarly, in study B a 3-point rating scale was used for the pre-schoolers. Initially a 5-point Likert scale was decided upon to accord with study B. However, after a pilot testing with ten 3-4.5 year old pre-schoolers, it was concluded that a 3-point scale consisting of 3 black and white printed faces (smiling, neutral and frowning) would better serve the cognitive level of children in this age range. The 3-point rating scale (See Appendix A-10) has been used in previous studies (Birch & Sullivan, 1991; Guthrie, Rapoport & Wardle, 2000). Children were told that the ‘yummy face’ (smiling face) matches with foods that they like because when we like a food we have a ‘yummy face’. Similarly, the ‘yucky face’ (frowning face) matches to food that we don’t like, so when we eat a food we don’t like we have a “yucky face”. For the ‘okay face’ children were told that this is the face you might make when you eat something that doesn’t taste very yummy but doesn’t taste very yucky; “it tastes okay” (Guthrie, Rapoport & Wardle, 2000).

2.10.1 Introduction of the scale to pre-schoolers.

In each class children who were to take part in the study were selected and individually withdrawn from the classroom. In order to avoid interference with the selections made by other children, each child was tested separately in a quiet spot in the nursery away from the other children. During the introduction of the task the children were informed that ‘we are going to play a game with foods’. Initially there were some trials during which the children and the researcher practiced the faces with random food selections. Firstly the researcher would present some examples of non-vegetable food (e.g. fruits, chocolate/biscuits, dates, crackers, raisins, lemon etc.) and explain that those that they like are ‘yummy’ (and point to the smiling face), those that are neither ‘yummy/yucky’ are ‘Okay’ (and point to the neither smiling nor frowning face) and those they do not like are ‘yucky’ (point to the frowning face). Then the researcher would ask the child to try and do the same with some other non-vegetable foods. Testing of ‘willingness to try’ only started after making sure that the children comprehended the use of the scale.

Children were presented with foods in a random order. Food was offered in small plastic transparent containers without a lid so that the children were able to look at the food from all sides and at the same time be able to smell the food from above (See container in Appendix C-2). Children were not allowed to touch or consume the food. The children then ranked all food options based on the face they think they would make after trying each vegetable option. They were then asked to choose which they would try first and then which version they would try from the remaining options.

2.11 Vegetable preferences inventory

The vegetable preferences inventory (see Appendix A-11) was used in order to collect information regarding the parent’s and their child’s *liked, disliked* and *never tried* vegetables, from a list of 42 vegetables in study B (Chapter 5), and for the young adults in study C (Chapter 6). Before using the vegetable preferences inventory in any of the studies, it was piloted in a group of 20 young adults aged between 17 and 35 years. After piloting, more vegetables and methods of cooking preparation were added in order to accommodate culinary practices from a wider international range. The final version can be seen in Appendix A-11

2.11.1 Vegetable preferences recording and food preparation

Vegetable preferences, as collected from the vegetable preferences inventory, were recorded in detail in excel documents. From this, the most and least common way of preparation for each participant was individually calculated. This methodology was also followed for the selection of food offered in the observational part of study B and study C.

Before the study began there were some trials preparing each of the vegetable options and detailed notes were kept in terms of the portion size of each vegetable to be offered (measured in grams). The cooking temperatures and times for each vegetable were also reported to ensure consistency with how the food options were prepared. Cooking practices for the same vegetable option were followed for both study B and C. It was decided that the amount of food to be offered would cover the bottom of the container and would not be heaped, so that participants would not get overwhelmed by the amount of food. This also allowed them to observe the texture properties of each food.

2.12 Visual food exposure

Pre-schoolers in study B and young adults in study C were exposed to two arrays of vegetable options. Information collected in the vegetable preferences inventory was used in order to tailor each vegetable option according to the preferences of each participant.

The first array consisted of two vegetable options; a liked vegetable presented in an uncommon texture (prepared in an unfamiliar way of preparation) and was labelled as LVUT. This vegetable option was paired with a disliked vegetable presented in a familiar texture (offered in a familiar way of preparation), which was labelled as DVFT. For example, a disliked vegetable (celery) was offered in the most common way the participant had their vegetables e.g. boiled, while a liked vegetable (carrot) was offered in an uncommon way of preparation (e.g. mashed). See pictures in Appendix C-3.

The second array consisted of three vegetable options. A familiar vegetable commonly eaten raw (typically tomato or lettuce) was offered in the common raw form and was labelled as RV, the same vegetable was also presented in raw form with a blemish (labelled RBV) and in a different texture to the raw form, after being cooked (labelled VDT) (See pictures in Appendix C-4). It was not possible to use the same vegetable for all of the children as some parents had indicated that their child did not eat tomato, consequently lettuce was chosen as an alternative for these children. Vegetable options were offered in a random order in this task.

2.13 Demographic and additional background information (Appendix A-11)

2.13.1 Background information in Study A.

In study A, parents provided background information about themselves and their children. Parents self-reported their and their children's age, gender, height, weight and ethnicity, along with the highest level of education they had achieved. Parents reported on whether their child had typical development or had an ASC diagnosis. Background information on health conditions such as the existence of allergies, lactose intolerance or constipation was collected. Information was also collected on whether children presented with gastrointestinal reflux or other feeding problems.

2.13.2 Background information in Study B

Parents in this study provided information on age, gender and ethnicity for themselves and their children. Information about whether any of their children had been diagnosed with any conditions was also collected. Any children with a diagnosis of ASC or with a sibling with an ASC diagnosis, syndrome or learning/ speech/swallowing problems were excluded. Background information on the health conditions such as the existence of allergy, lactose intolerance or constipation was also collected.

2.13.3 Background information in Study C

In this study participants provided information on their age, gender, ethnicity and the highest level of education they had achieved. In addition, participants provided information about any specific diets they followed or any food allergies or other health conditions. Finally participants were asked to report the approximate amount they spend on vegetables every week and how many times they might try a food before they decide they do not like it.

2.14 General data analysis strategy

SPSS version 21, statistical software, was used to analyse the data. Histograms and Kolmogorov-Smirnov analysis showed that the majority of the data were not normally distributed. Descriptive statistics were run for the background information of the children and the parents in Chapter 3, Chapter 4 and Chapter 5, and for the adults in Chapter 6.

In Chapter 3 Chi-square analysis was used to explore the prevalence of early feeding problems in the two diagnostic groups (ASC-control group). Mann-

Whitney U analysis was used to compare the mean scores of food neophobia and the three FBC sub-scales between children with ASC and typically developing children. Also a Mann-Whitney U test was used to compare the food neophobia scores between children with and without early feeding problems in the overall sample, as well as within the ASC and control group. A Mann-Whitney U test was used to compare the FBC subcategories scores between children with and without problems in each feeding stage. Finally, in Chapter 3, a Mann-Whitney U test was used to compare the scores in terms of visual/auditory, tactile and taste-smell sensitivity between children with and without problems in each feeding stage.

A Kruskal Wallis test analysis was used in Chapter 4 to compare the sensory possessing scores of children with ASC and the control children in the *typical performance, probable difference and definite difference* classification groups. A Mann-Whitney U Test was used to compare the SSP and FBC subcategories scores in children with ASC and the control group. A Mann Whitney U test was used to compare differences in the three categories of the visual/ auditory, tactile, taste/smell (typical, probable, and definite difference performance), and scores of the FBC subcategories. A Mann-Whitney U test was also run in order to compare mean scores of the SDC and SCQ.

Spearman correlation analyses were run between the FBC overall and subcategories scores, and the SSP overall and the four sensory modalities scores in order to explore associations between sensory processing and eating problems in typically developing children and children diagnosed with ASC. Spearman correlation analyses were also used to examine associations between SCQ, SDQ, FBC and SSP scores in children with and without ASC in Chapter 4.

In Chapter 5 and Chapter 6 a two tailed Spearman's correlation analysis was run to explore the relationships between food neophobia, the SSP scores and vegetable preferences in study 2 (Chapter 5, Appendix B-4). A two tailed Spearman's correlation analysis was also used to explore associations between the FBC, AASP, AQ scores and vegetable preferences in study 3 (Chapter 6, Appendix B-5).

A two-sample paired Wilcoxon signed rank test analysis was carried out in order to compare the willingness to try the LVUT-DVFT, RBV-VDT, VDT-RV and RBV- RV in studies one and two (Chapter 5 and Chapter 6).

A two tailed Spearman's correlation analysis was run to explore the relationships between food neophobia, the SSP scores and range of vegetable preparation in study B (Chapter 5). Similarly, two tailed Spearman's correlation analyses were carried out to explore associations between the FBC, AQ, AASP scores and the total range of vegetable preparations, and also between the FBC, AQ, AASP scores and the number of *never tried* vegetables in study 3 (Chapter 6). Finally, a regression analysis was run in order to identify which of the variables included in this study were the most important predictors of the 'willingness to try' each of the vegetable options offered. Although the data were nonparametric, screening was carried out for violations (more details can be found in section 6.3.6 of Chapter 6).

CHAPTER 3

EARLY FEEDING PROBLEMS AND DIFFERENCES IN EATING BEHAVIOUR AND SENSORY SENSITIVITY OF CHILDREN WITH AND WITHOUT ASC

3.1 Abstract

Eating problems are commonly reported in children with autism spectrum conditions (ASC), however, little is known about the onset of these difficulties and the impact that early feeding stages can have on subsequent eating behaviour. The aim of the present study was to explore differences in terms of early feeding problems, food neophobia, sensory processing and eating behaviour in a sample of 254 children (151 typically developing and 103 children diagnosed with ASC) aged 2-14 years. An Early Eating Behaviour questionnaire was used as a retrospective parent-report tool in order to collect information on six feeding stages, starting from breast/bottle feeding until the toddler feeding period at around 18 months. The Feeding Behaviour Checklist (FBC) was also used to assess the following: eating selectivity (reasons for rejecting food and reaction to disliked food), rigid/perseverant eating behaviour (rigidness in terms of the mealtime environment, utensils or people who are present) and selectivity in terms of texture. The Short Sensory Profile (SSP) was used in order to identify differences in children's current visual-auditory, tactile and taste-smell sensitivity.

According to parents' reports, children with ASC showed significantly more problems during the transition from lumpy to family foods, and during the toddler feeding period in comparison to the control children. Additionally, children on the

autistic spectrum were found to have significantly higher levels of food neophobia, presented significantly more eating selectivity, had higher levels of rigid /perseverant eating behaviour and were also more selective in terms of texture in comparison to the control children. Results revealed that children from both the ASC and control group with early feeding problems were more likely to be more food neophobic, eating and texture selective and present more rigid eating behaviour. Higher visual-auditory, tactile and taste-smell sensitivity was also noticed among children who presented early feeding problems in both diagnostic groups.

3.2 Introduction

3.2.1 Early feeding behaviour

Early feeding stages, from birth to 2 years, are fundamental to the development of eating behaviour. This period is a crucial time for infants to be exposed to a variety of flavours, to identify different foods and to learn more about the sensory properties of the food they are eating, such as texture, taste, temperature and smell (Blossfeld, Collins, Kiely & Delahunty, 2007; Harris,1993; Mennella & Beauchamp, 1991).

Previous research has suggested a link between early feeding problems and eating behaviour later in childhood, with research mainly focusing on typically developing children (Mennella & Beauchamp, 1991; 1999). However this research field is still at a very early stage for the ASC population. Among the very few studies which have paid attention to early feeding behaviour in children with ASC is the Avon Longitudinal Study of Parents and Children (ALSPAC- Emond, Emmett, Steer & Golding, 2010). In this study parents of children with a subsequent ASC diagnosis described their infants as “slow feeders” at 6 months of age and as having a difficult and slow transition to solid foods. At 15 to 54 months, parents reported that their toddlers with autism were “difficult to feed” and “very choosy” eaters (Emond, Emmett, Steer & Golding, 2010).

It is commonly accepted that the transition from pureed to lumpy food, as well as the transition from lumpy to family food, is important for the child’s eating development. During these feeding stages infants build their experiences with new textures and develop the sensory and oral motor skills necessary for the successful transition from a less textured food (pureed), to a food with bits (lumpy), in order to then move on to the food that the rest of the family eats (Blossfeld, Collins, Kiely & Delahunty, 2007; Gisel, 1991; Illingworth & Lister, 1964).

Research mainly focusing on clinical populations (such as children with congenital disorders and tube fed infants) has previously suggested that there is a link between sensory motor problems in infancy and feeding problems later in childhood (Babbitt, Hoch & Coe, 1994; Dobbelsteyn, Marche, Blake & Rashid, 2005). In addition, recent evidence from a research study in a typically developing population suggests that infants who were tactile sensitive were less likely to try a new complementary food if this was offered late in the usual introduction period (4-6 months) (Coulthard, Harris & Fogel, 2016).

Longitudinal studies looking at eating behaviour also support the idea that infant feeding practices contribute to the development of later childhood eating behaviour (Coulthard & Harris, 2003; Coulthard, Harris & Emmett, 2009; Harris, 2008; Lioret, et al.,2015). However, there has been little research on how problems in the early feeding stages may link with eating difficulties and sensory sensitivity in childhood, not only in children with ASC but also in typically developing children.

One might expect that in developmental disorders such as ASC, early feeding problems may be the consequence of a disruption in the development of eating. However, given that an ASC diagnosis usually comes no earlier than the second year of life, this poses a question as to whether the higher prevalence of problems in the transition from puree to family foods in the children with ASC of the sample was indeed a result of developmental delay or due to autistic symptomatology that also becomes more obvious around this age.

3.2.2 Food neophobia

When toddlers become more mobile they are more likely to consume non edibles that might be a health risk and it is believed that food neophobia develops around this time as a protective mechanism (Birch, Gunder & Grimm-Thomas, 1998). This personality trait describes children's unwillingness to try novel or unfamiliar foods, peaks at two years of age and typically lasts until 4 to 6 years (Cashdan, 1994; Cooke, Wardle & Gibson, 2003; Pliner & Hobden, 1992), although occasionally it can be present into adulthood (Knaapila et al., 2015). In line with this, food neophobia in typically developing children aged 2-6 years has been linked with greater eating selectivity and lower consumption of fruits and vegetables (Cooke, Wardle & Gibson, 2003).

Insistence on sameness is a commonly reported symptom of autism (DSM-V, 2013) and this characteristic has been found to also affect the eating behaviour of individuals with ASC (Nadon, Feldman & Gisel, 2011). Although unwillingness to try novel foods has been commonly observed in studies exploring the eating behaviour of children with ASC (Whiteley, Rodgers & Shattock, 2000; Schreck & Williams, 2006; Lockner, Crowe & Skipper, 2008; Nadon, Feldman, Dunn & Gisel 2011) very few studies mention food neophobia as a cause for unwillingness to try novel foods (Rastam, 2008; Kral, Eriksen, Souders & Pinto-Martin, 2013). Martins, Young and Robson (2008) ran the only known study that has compared food neophobia in an ASC and typical population. The sample used in this study consisted of 41 children with ASC, 12 typically developing siblings of the children with ASC, and 41 typically developing children, aged between 2 and 12 years old. The data showed that children with ASC presented with greater food neophobia and food avoidance significantly more frequently than did the other two groups. However, the sample size was small, and the mean differences noticed across the groups, even if they reached significance, were small (0.5 and 1.5 on a 7 point-scale). The research team suggested that children with ASC were only marginally more likely to present with problematic eating. Nevertheless, this study did not provide any information regarding the onset of these eating difficulties, or examine any individual differences in early feeding stages between the children with ASC and typically developing children. As early feeding plays a crucial role in the development of the eating behaviour in childhood, there is a need for further research exploring early feeding differences, and the impact that a problematic feeding history has on the food neophobia levels in children with and without ASC.

3.2.3 Eating selectivity

Eating behaviours such as extreme selectivity and food refusal are widely reported in children with ASC (Schreck, Williams & Smith, 2004). Although these eating behaviours are also common in typically developing children, in the ASC population they are more frequent and persistent (Kozlowski, Matson, Fodstad & Moree, 2011) and it has been observed that these difficulties may follow individuals into adulthood (Buckley & Newchok, 2005).

There are various factors affecting food selectivity in children with autism. Ahearn (2003) reported that the 'type' of food was among the most common factors affecting selectivity in children with ASC, with vegetables and fruits being the least preferred type of food. Other studies have identified colour as another possible cause for food refusal in children with ASC (Johnson, Handen, Mayer-Costa & Sacco, 2008), while Rastam (2008) reported children with autism as only eating white food (rice, pasta, milk). According to parents' reports, children on the autistic spectrum are often sensitive to any apparent difference in the appearance of the food (Williams, Dalrymple & Neal, 2000), which suggests that "any food that looked slightly different from what they were used to, would be refused" (Huxham, 2012). Therefore, colour as well as subtle differences in the appearance of the food could lead to food refusal (Whiteley, Rodgers & Shattock, 2000). Food might also be refused if different ingredients are used, or a different method of preparation leads to an alteration in the appearance of the meal (Raiten & Massaro, 1986; Cornish, 1998; Nadon et al., 2011; Provost et al., 2010; Rogers, Magill-Evans & Rempel, 2012; Schreck et al., 2004; Williams et al., 2000; Williams, Gibbons & Schreck, 2005). It therefore remains to be investigated how selectivity in children with ASC compares with that shown by typically developing children.

3.2.4 Rigideating behaviour

Obsessions, rigid routines and repetitive behaviour are commonly reported in children on the autistic spectrum (Honey, Rodgers & McConachie, 2012). Similar behaviour during mealtimes has also been identified, for instance children on the autistic spectrum may follow rigid routines such as following a certain routine preparing for dinner, using the same utensils or only eating from a specific bowl (Marquenie, Rodger, Mangohig & Cronin, 2011; Schreck & Williams, 2006). Previous studies have noticed that these behaviours were significantly more prevalent in children with ASC than in the control group (Schreck, Smith & Williams, 2004; Williams, Gibbons & Schreck, 2005). These idiosyncrasies not only make the life difficult for individuals with ASC and their family, but in some cases can lead to a very rigid diet (Kerwin, Eicher & Gelsinger, 2005; Marquenie et al., 2011; Rogers, et al., 2012; Schmitt, Campbell & Heiss, 2008); Schreck & Williams, 2006; Williams et al., 2000). Studies comparing the variety of different food options that children with ASC and age matched control children would eat commonly report a restricted dietary variety in the children on the autistic spectrum (Bandini, et al., 2010; Nadon et al., 2011; Zimmer, Hart, Manning- Courtney, Murray, Bing & Summer, 2012).

Nevertheless, although rituals and repetitive behaviour are common in children with ASC, very few studies have specifically measured the prevalence of ritualistic behaviour during mealtimes in children with and without ASC. Schreck, Williams and Smith (2004), observed, in a set of descriptive data, that behaviours such as refusing food, requiring specific utensils and insistence on particular food presentations were significantly more frequent in children with ASC than in children in the control group. However Martins, Young and Robson (2008), when questioning parents about whether their children presented any ritualistic mealtime behaviour (e.g. requiring specific utensils, wanting certain people to be present when they eat), found no statistically significant differences between the control group and children with ASC.

Therefore, although rigid eating behaviour is commonly observed in children with ASC, it remains unclear whether these difficulties are significantly more prevalent in children with ASC, or whether these behaviours differ from those experienced by typically developing children. In addition, it is of interest to explore whether the existence of early feeding problems may have an impact on the development of rigid eating behaviour in later childhood.

3.2.5 Selectivity in terms of texture

Texture related food selectivity is commonly mentioned in many research studies looking into problematic eating in children with ASC (Cornish, 1998; Schmitt et al., 2008; Heiss, Moody, Crosley & Campbell, 2005; Ahearn et al., 2001; Kerwin et al., 2005; Collins and Eaton-Evans, 2001; Field et al., 2003; Schreck et al., 2004).

Lockner, Crowe and Skipper (2008) in a sample of 19 children aged 3-5 years found that children on the autistic spectrum were significantly more likely to have a preference for certain textures. According to parents' reports, children with ASC have a higher preference for dry, crunchy and crispy foods such as crisps, cereals or even softer foods with a degree of moisture, such as mashed potatoes or rice pudding (Whiteley, Rodgers and Shattock, 2000). However, it is not clear whether all children with ASC conform to one specific texture preference, as it may well be that texture selectivity differs according to early experience and sensory reactivity, and is therefore unique to the child.

3.3 Aims and hypotheses

This study aimed to investigate differences in early feeding behaviour between children with ASC and typically developing children. Despite the significant lack of research looking at early feeding behaviour in children with ASC, it was hypothesised, based on the results of ALSPAC (Emond, Emmett, Steer & Golding, 2010), that children with ASC would present with a more problematic early feeding background, especially around the age of 2 years when they would normally receive their ASC diagnosis (Hagberg & Jick, 2010; Howlin & Moore, 1997).

This study also aimed to investigate any associations between early feeding stages and current eating behaviour (eating selectivity, rigid/perseverant eating behaviour and selectivity in terms of texture). Based on the findings of Martins, Young and Robson (2008), it was hypothesised that children with ASC would show higher food neophobia levels in comparison to the control group.

Previous literature has demonstrated a link between sensory sensitivity in infancy and food acceptance (Coulthard, Harris & Fogel (2016); this study aimed to extend these findings and to examine whether there is an association between early feeding problems and higher sensory sensitivity in later childhood. The present study also aimed to compare differences in terms of food neophobia between children with and without early feeding problems across the two groups (ASC and control children). It was expected that children with early feeding problems would present with higher food neophobia scores in comparison to the children who did not have a problematic early feeding background.

Given that eating selectivity, rigid/perseverant eating behaviour and selectivity in terms of texture are commonly mentioned in literature examining eating behaviour in children with ASC, it was expected that children with ASC would present with a significantly higher score in these behaviours in comparison to the control children. Furthermore, it was expected that difficulties in early feeding stages would be linked with greater problems in eating selectivity, rigid/perseverant eating behaviour and selectivity in terms of texture in both groups.

3.4 Method

Parents/carers were recruited through internet based parent groups and networks (for more information on the recruitment process see Chapter 2) and an extended electronic questionnaire was completed (see Chapter 2 and Appendix).The use of an electronic questionnaire was chosen as a means to increase the range of socio-economic and ethnic backgrounds of participating families. Online recruitment for this study took place between March 2013 and January 2015.

3.4.1 Participants

Carers of two hundred and fifty four 2-14 year old children with and without ASC participated in this study. Children who had been diagnosed with serious neurological impairment that may be related to poor growth (e.g. cerebral palsy or Rett syndrome) were deleted from the original number of the participants' sample. Children suffering from severe chronic medical conditions such as cardiac problems, respiratory disease, metabolic disease of any kind or heart, kidney or liver disease, coeliac disease, cystic fibrosis and trachea-oesophageal fistula were also excluded as these conditions might lead to poor appetite or impaired food consumption (Williams & Foxx, 2007). The study also excluded children diagnosed with severe speech or swallowing problems, poor oral co-ordination or dysphagia given that feeding is a complicated procedure requiring adequate oral motor skills and intact neuromuscular coordination (Sullivan, 2009). Finally, children with an additional diagnosis of mental disorder such as Schizophrenia or a diagnosis of a syndrome (e.g. Ehler-Danlos syndrome) were excluded as behaviour and mental health problems due to a mental disorder may be confused with ASC symptomatology. Overall, 262 parents initially participated in this study but due to these criteria 8 participants were excluded. Children of the sample were predominantly from a White British/Caucasian background and their parents had mostly been educated to University degree level (see Table 3.1).

3.4.2 Measures and procedure

The questionnaires were completed by the children's parents or carers. The measures included in the questionnaire can be found below. (More detailed information can be found in Chapter 2).

Demographic information (Appendix A-11-Study A)

Carers reported on their children's diagnosis, age, gender, weight, height, and ethnicity in addition to their own gender, age, weight, height and education. Table 3.1 shows carers' BMIs and child BMI z-scores, adjusted for age and gender. Table 3.2 shows the frequency of an ASC diagnosis in the sample. Information on the prevalence of any co-existing health condition (e.g. allergies, constipation, pathological gastro-oesophageal reflux) in both ASC children and the control group was also collected.

Early eating behaviour questionnaire (See Appendix A-1, Study A)

Carers provided information on whether their children presented any problems during breast/bottle feeding, their transition to complementary food (weaning), when progressing from pureed to lumpy solid foods, from lumpy solid food to family food, during the finger food stage and in the toddler period when children were 18 months old. Carers were given the option to provide further information about the transitional stages or the type of feeding difficulty their children had (See Table 3.5).

Short Sensory Profile (SSP, McIntosh, Miller & Shyu,1999; Dunn, 1999, Appendix A-5)

Behavioural sensory processing was measured by the SSP. The SSP is a 38-item questionnaire to be completed by parents and caregivers with the use of a 1-5 point scale. A lower score represents a less desirable (more pathological) performance, while higher scores are closer to the normative performance. In this study the sensory processing modalities of visual/auditory, tactile and olfactory were considered as more likely to have an effect on eating behaviour.

Child Food Neophobia Scale, (CFNS, Pliner, 1994, Appendix A-2)

Food neophobia was measured by the Child Food Neophobia Scale, (CFNS, Pliner, 1994) The CFNS questions were extracted from the FBC. For this study, based on the factor analysis loadings only 4 questions were used from the original CFNS (See Chapter 2).

Feeding behaviour checklist (FBC, Appendix A-4)

The FBC is a measure of eating behaviour in children. The FBC is divided into three subcategories to explore eating pickiness, rigid/perseverant eating, and selectivity based on the texture of the food (See Chapter 2 for a description of these subcategories and further information on the factor analysis procedure followed to shape the three subcategories can be found in Appendix B-1).

3.4.3 Data analysis

SPSS version 21 statistical software was used to analyse the data collected in this research study. Histograms and Kolmogorov-Smirnov analysis showed that the majority of the data were not normally distributed. Descriptive statistics for demographic characteristics were used. Differences in terms of diagnosis, gender, age and whether the children of the sample presented early feeding problems were explored using Mann-Whitney U and Chi-square statistical analyses.

3.5 Results

Demographic characteristics regarding the gender, age, Body Mass Index (BMI) of parents and children in addition to the educational level of parents and ethnicity of the children can be found in Table 3.1.

Table 3.1 Demographic characteristics of the sample divided by diagnosis

Variables	ASC Diagnosis (n=103)	No ASC Diagnosis (n=151)
Child age range	2.2-13.9	3.5-13.9
Mean Age (SD)	7.95 (2.6)	6.90 (2.45)
Child BMI (SD)	-1.93-4.16 (1.09)*	-1.83-3.24 (1.08)*
Child gender	23 female, 80 male	77 female, 74 male
Parent age range	20-57	27-54
Mean Age (SD)	38.76 (7.36)	38.71 (5.82)
Parent BMI (SD)	17-41, 27.07, (5.10)	17-40, 24.77 (4.22)
Parent gender	97 female, 6 male	140 female, 11 male
Education level	23.3% Post-Graduate Qualification (n=24)	29.8% Post-Graduate Qualification (n=45)
	36.9% University graduate (n=38)	41.7% University graduate (n=63)
	20.4% A-Levels (n=21)	10.6% A-Levels (n=16)
	8.7% GCSEs (n=9)	8.6% GCSEs (n=13)
	6.8% No qualification (n=7)	6% No qualification (n=9)
	3.9% Other (n=4)	3.3% Other (n=5)
Ethnicity	93.2% White British/Caucasian/ Other white background (n=96)	89.4 % White British/Caucasian/ Other white background (n=135)
	0% Arab (n=0)	2% Arab (n=3)
	1% Black/ Black British (n=1)	1.3% Black/ Black British (n=2)
	1.9% Asian/Asian British (n=2)	0 % Asian/Asian British (n=0)
	2.9 % Mixed (n=3)	4.6% Mixed (n=7)
	1% Other (n=1)	2.6% Other (n=4)

* Children BMIs (mean and *SD*) are adjusted according to their age and gender (BMI z-scores).

3.5.1 Demographic differences between ASC and control group

Age: Mann-Whitney U analysis indicated a significant difference between the mean age of children with ASC (M=7.95) and the control children (M=6.90), U=5797, p≤.001, Z= -3.443. However, no statistically significant correlations were noticed between age and the FBC overall score (r_s=.026, p=.681) or the food neophobia score (r_s=-.021, p=.738) in the sample as a whole. Mann-Whitney U analyses showed that there were no differences between the age of parents of the control group (M= 38.71, SD=5.82) and the parents of the ASC group (M=38.76, SD=7.36) U=7341.5, Z= -.057, p=954.

Gender: Chi square analysis indicated that overall in the sample there were significantly more boys (n=154) than girls (n=100) $\chi^2(1)$ =11.480, p≤.001. This is due to the higher number of boys (n=80) in comparison to girls (n=23) in the ASC group which is typical, as the approximate ratio of boys to girls with ASC is 4.3:1 (Fombonne, 2003, 2005, 2007) and affects the overall ratio of boys and girls of the overall sample. However, no statistically significant gender differences were found in the FBC scores between boys and girls of the sample both in the control group (U=2371.5, Z=-1.778, p=.075) and the ASC group (U=826.5, 11138.5, Z=-.455, p=.649).

Table 3.2 Gender distribution according to diagnosis of the sample

	Female		Male		Total	
	N	%	N	%	N	%
Autism	12	12%	51	33.1%	63	25%
Asperger's	7	7%	20	13%	27	10.6%
Other ASC	4	4%	9	5.8%	13	5%
None	77	77%	74	48.1%	151	59.4%
Total	100	100%	154	100%	254	100%

Weight: 193 (76%) parents provided the weight and the height of their children, and 226 (89%) parents gave information regarding their own weight and height. The BMI of the children were calculated and classified according to the national WHO BMI guidelines for children (See Table 3.3).

Table 3.3 Sample distribution according to diagnosis and BMI classification*

	ASC		Controls		
	N	%	N	%	
Underweight	13	12.6%	21	13.9%	p=.170
Ideal	41	39.8%	66	43.7%	p=.016
At risk	11	10.7%	13	8.6%	p=.683
Overweight	14	13.6%	14	9.3%	p=1.00
Missing data	24	23.3%	37	24.5%	

*BMI classification is according to the national WHO BMI guidelines for children, percentages are calculated within each diagnostic group.

Chi-square test showed that control group of children, based on their BMI, were significantly more likely to belong in the ideal BMI group category $\chi^2(1)= 5{,}841$, p=.016.

3.5.2 Early feeding behaviour

Chi square analysis was carried out to test the hypothesis that children with ASC would present with a more problematic early feeding background, especially in the toddler feeding period.

Table 3.4 Diagnosis of the sample and differences in reported problems in early feeding stages

	ASC (N,%)	Controls (N,%)	
Breast\Bottle feeding problems	42 (40.8%)	48 (31.8%)	U=6681, Z=-1.468 p=.141
Difficulties in the transition to complementary food (weaning)	20 (19.4%)	27 (17.9%)	U=4708, Z=-.3467 p=.729
Difficult transition from pureed to lumpy food	25 (24.3%)	25 (16.6%)	U=4500, Z=-1.515 p=.129
Difficult transition from lumpy solids to family food	31 (30.1%)	23 (15.2%)	U=4244, Z=-2.837 p=.004
Difficulties with eating during the finger food stage	18 (17.5%)	20 (13.2%)	U=3775, Z=-.926 p=.353
Difficulties with eating during the toddler feeding period (around 18 months)	33 (32%)	17 (11.3%	U=3484, Z=-4.082 p≤.001

There were no statistically significant differences between reported problems in the breast/ bottle feeding period, the transition to complementary food and in the transition from pureed to lumpy baby food between children with and without ASC. However, children with ASC presented significantly more problems than did the control group in the transition from lumpy food to family food, (N=23, (15.2%). There was no significant difference between the two groups regarding difficulties with finger food (U=3775, Z=-.926 p=.353). However, children with ASC appeared to be significantly more likely to have difficulties with eating during the toddler period (around 18 months) than the control group children U=3484, Z=-4.082, p≤.001.

3.5.3 Food neophobia and early feeding behaviour in children with and without ASC

A Mann-Whitney U analysis was run in order to test the hypothesis that children with ASC would present with significantly higher food neophobia levels than the children in the control group. The results supported the hypothesis; children with ASC scored significantly higher (Mean=19.94, SD=5.13) than children in the control group (Mean=15.31, SD=6.71) in terms of food neophobia (U=4805.5, Z=5.186, p≤.001).

A Mann-Whitney U test was run to explore any differences in terms of food neophobia between children with and without early feeding problems (in both groups, ASC and control) (See Figures 3.1 and 3.2).

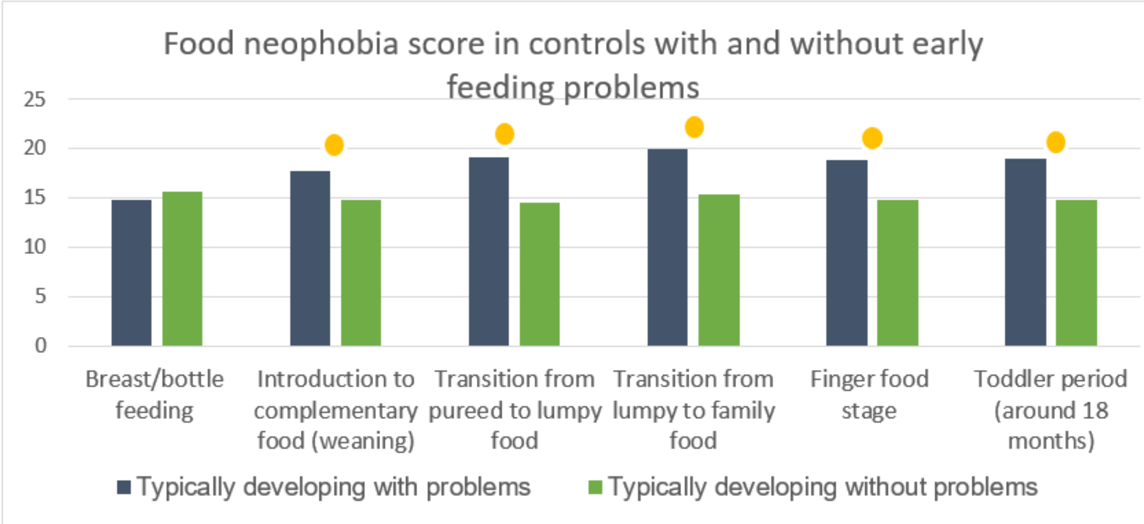


Figure 3.1 Difference in food neophobia score in control children according to their early feeding behaviour

Typically developing children with problems during the introduction to complementary food (U=1246, Z= -2.084, p=.037), the transition from pureed to lumpy food (U=964. 5,Z=-3,065p=.002) the transition from lumpy to family food (U=782, Z= -3.583,p≤.001), during the finger food stage (U=871, Z=-2.417, p=.016) and the toddler period (around 18 months) (U=741, Z=-2.350, p=.019) presented with significantly higher current food neophobia scores than did the typically developing children without problems in these feeding stages (See Figure 3.1).

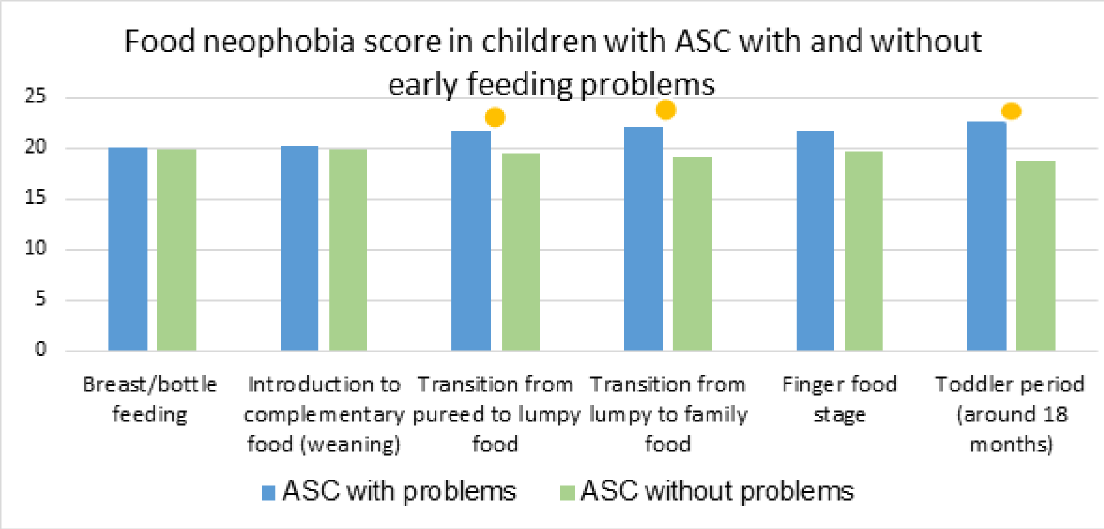


Figure 3.2 Difference in food neophobia score in children with ASC according to their early feeding behaviour

Children with ASC who presented with problems during the transition from pureed to lumpy food (U=718, Z= -1.992, p=.046), in the transition from lumpy to family food (U=720, Z=-2.869, p=.004) as well as feeding problems in the toddler period (around 18 months) (U=597.5, Z=-3.971, p≤.001) had significantly higher current food neophobia scores than did the children with ASC without problems in these feeding stages (See Figure 3.2).

3.5.4 Feeding behaviour checklist (FBC) and subcategories scores

The FBC was divided into three subcategories in terms of eating selectivity, rigid/perseverant eating behaviour and selectivity regarding texture. Mann-Whitney U analyses were run to compare the performance of children with ASC and the children in the control group in these subcategories.

Table 3.5 Differences in the scores of children with ASC and controls in the three FBC subscales

	ASC	Controls	Sig
Eating selectivity mean score (SD)	52.42 (13.10)	39.61 (16.00)	p=≤.001
Rigid/ perseverant eating behaviour mean score (SD)	33.46 (11.06)	22.10 (8.19)	p=≤.001
Selectivity in terms of texture mean score (SD)	11.67 (4.10)	8.38 (3.66)	p=≤.001
Feeding behaviour checklist (FBC) mean score (SD)	97.54 (25.73)	69.93 (25.49)	p=≤.001

Children in the ASC group showed significantly more eating selectivity than the control group U=4294, Z=-6059, p=≤.001. Similarly, children with ASC scored significantly higher in the rigid/perseverant eating behaviour subcategory U=3067.5, Z=-8.151, p=≤.001. Children with ASC were also found to be significantly more selective in terms of the texture of the food U=4410.5, Z=-5.889, p=≤.001 and children with ASC had a significantly higher overall score in the FBC U=3479.5, Z=-7.425, p=≤.001.

3.5.5 Early feeding behaviour and Food Behaviour Checklist subcategories score

A Mann Whitney U test was run to explore whether the later eating behaviour of children with and without ASC differed according to problems in the breast/bottle feeding stage (see Table 3.6).

Table 3.6 FBC subcategories scores of children with and without breast/bottle feeding problems

Breast/bottle feeding stage	**Eating selectivity**		Sig	**Rigid/perseverant eating behaviour**		Sig	**Selectivity in terms of texture**		Sig
	Mean score (SD)			Mean score (SD)			Mean score (SD)		
	With problems	Without problems		With problems	Without problems		With problems	Without problems	
ASC	75.38 (16.15)	72.77 (21.28)	p=.658	22.24 (5.34)	21.03 (7.01)	p=.414	12.45 (3.90)	12.16 (4.14)	p=.816
Controls	54.21 (24.47)	52.23 (18.64)	p=.903	15.42 (6.21)	15.35 (5.87)	p=.911	9.15 (4.03)	8.83 (3.21)	p=.904

No statistically significant differences were noticed in the three FBC subcategories between the children with and without breast/bottle feeding problems, both in the control group and the children with ASC.

A Mann Whitney U test was run to explore whether the later eating behaviour of children with and without ASC differed according to problems in the introduction to complementary feeding stage (see table 3.7).

Table 3.7 FBC subcategories scores of children with and without problems in the introduction to complementary food

Introduction of complementary food	**Eating selectivity** Mean score (SD)		Sig	**Rigid /perseverant eating behaviour** Mean score (SD)		Sig	**Selectivity in terms of texture** Mean score (SD)		Sig
	With problems	Without problems		With problems	Without problems		With problems	Without problems	
ASC	75.65 (18.22)	73.16 (19.65)	p=.625	22.80 (5.77)	21.11 (6.49)	p=.276	13.40 (4.50)	11.93 (3.83)	p=.172
Controls	63.48 (21.72)	50.55 (19.70)	p=.004	17.85 (6.69)	14.83 (5.68)	p=.028	11.41 (3.82)	8.40 (3.17)	p≤.001

Among the ASC group, children with and without problems in the introduction to complementary food showed no significant differences in terms of current eating selectivity rigid/perseverant eating behaviour and selectivity regarding texture. However the control group children with problems during the introduction of complementary food presented with higher current eating selectivity, had a significantly more rigid eating behaviour and were more selective in terms of texture than the children from the control group who did not have problems during this feeding stage.

A Mann Whitney U test was run to investigate whether the later eating behaviour of children with and without ASC differed according to problems in the transition from pureed foods to lumpy solids (See Table 3.8).

Table 3.8 FBC subcategories scores of children with and without problems in the transition from pureed foods to lumpy solids

Transition from pureed foods to lumpy solids	**Eating selectivity** Mean score (SD)		Sig	**Rigid/perseverant eating behaviour** Mean score (SD)		Sig	**Selectivity in terms of texture** Mean score (SD)		Sig
	With problems	Without problems		With problems	Without problems		With problems	Without problems	
ASC	81.32 (19.51)	71.44 (18.75)	p=.016	23.84 (6.48)	20.78 (6.21)	p=.062	13.72 (3.92)	11.82 (3.97)	p=.043
Controls	65.64 (20.63)	50.33 (19.72)	p≤.001	18.20 (6.04)	14.81 (5.81)	p=.009	11.60 (3.99)	8.40 (3.13)	p≤.001

In the ASC group, children with a difficult transition from pureed to lumpy solids were significantly more eating selective and selective in terms of texture in comparison to the children with ASC without problems in this feeding stage. The control group children with problems in this feeding stage were significantly more eating selective, showed more rigid/perseverant eating behaviour and were more selective in terms of texture.

A Mann Whitney U test was carried out to investigate whether the later eating behaviour of children with and without ASC differed between those with and without problems in the transition from lumpy solids to family foods (See table 3.9).

Table 3.9 FBC subcategories scores of children with and without problems in the transition from lumpy solids to family foods

Transition from lumpy solids to family foods	**Eating selectivity** Mean score (SD)		Sig	**Rigid /perseverant eating behaviour** Mean score (SD)		Sig	**Selectivity in terms of texture** Mean score (SD)		Sig
	With problems	Without problems		With problems	Without problems		With problems	Without problems	
ASC	81.23 (18.01)	70.65 (19.09)	p=.007	24.23 (15.78)	20.36 (6.32)	p=.006	13.90 (3.94)	11.58 (43.88)	p=.006
Controls	71.52 (24.57)	49.51 (17.96)	p≤.001	19.65 (6.64)	14.60 (5.51)	p≤.001	11.39 (3.85)	8.49 (3.23)	p≤.001

A problematic transition from lumpy solids to the family food was linked to higher eating selectivity, a more rigid eating behaviour and to a higher selectivity in terms of texture in both ASC and control group children.

A Mann Whitney U test was run to explore whether the later eating behaviour of children with and without ASC differed according to problems in the finger food stage (See table 3.10).

Table 3.10 FBC subcategories scores of children with and without problems in the finger food feeding stage

Finger food feeding stage	**Eating selectivity**		Sig	**Rigid/perseverant eating behaviour**		Sig	**Selectivity in terms of texture**		Sig
	Mean score (SD)			Mean score (SD)			Mean score (SD)		
	With problems	Without problems		With problems	Without problems		With problems	Without problems	
ASC	86.28 (14.79)	71.20 (19.19)	p=.002	25.28 (5.33)	20.73 (6.33)	p=.007	13.83 (4.12)	11.95 (3.95)	p=.157
Controls	65.35 (23.23)	50.95 (19.58)	p=.008	18.80 (6.62)	14.85 (5.70)	p=.012	11.10 (4.29)	8.60 (3.24)	p=.023

Children with ASC who presented with problems during the finger food stage were significantly more selective and rigid in terms of eating than their peers without problems in this feeding stage. Control group children with problems in this feeding stage showed significantly more problematic eating behaviour across all three FBC subcategories.

A Mann Whitney U test was run to investigate whether the later eating behaviour of children with and without ASC differed according to problems in the toddler period feeding stage (See Table 3.11).

Table 3.11 FBC subcategories scores of children with and without problems during the toddler period feeding stage

Toddler period (around 18 months) feeding stage	**Eating selectivity** Mean score (SD)		Sig	**Rigid/perseverant eating behaviour** Mean score (SD)		Sig	**Selectivity in terms of texture** Mean score (SD)		Sig
	With problems	Without problems		With problems	Without problems		With problems	Without problems	
ASC	85.15 (15.46)	68.50 (18.72)	p≤.001	25.52 (5.32)	19.64 (6.00)	p≤.001	14.09 (3.73)	11.43 (3.89)	p=.004
Controls	71.94 (25.60)	50.44 (18.65)	p≤.001	19.24 (6.63)	14.88 (5.71)	p=.010	10.88 (3.95)	8.69 (3.35)	p=.024

Children from both groups (ASC and control group), who presented with eating problems during the toddler period (around 18 months), were significantly more eating selective, presented a more rigid eating behaviour and were significantly more selective in terms of the texture of the food in comparison to those from the sample with no problems in this feeding stage (see table 3.11).

Mann Whitney U tests were carried out to look at differences in early feeding problems according to reported sensory sensitivity in later childhood (See Table 3.12- Table 3.17).

Table 3.12 SSP subcategories scores of children with and without breast/bottle feeding problems

Breast/bottle feeding stage	**Visual auditory processing score** Mean score (SD)		Sig	**Tactile processing score** Mean score (SD)		Sig	**Taste-smell processing score** Mean score (SD)		Sig
	With problems	Without problems		With problems	Without problems		With problems	Without problems	
ASC	14.50 (4.59)	15.42 (4.88)	p=.321	22.44 (7.58)	23.73 (6.40)	p=.424	10.98 (4.74)	10.82 (5.41)	p=.739
Controls	20.26 (3.06)	20.45 (3.80)	p=.423	31.00 (4.52)	31.95 (3.61)	p=.151	15.85 (5.19)	16.70 (4.08)	p=.712

There were no statistically significant differences in sensory processing modalities between children with and without breast/bottle feeding problems both in the control group and in children with ASC, suggesting that breast/bottle feeding problems were not related to the sensory processing behaviour of the sample later in childhood.

Table 3.13 SSP subcategories scores of children with and without problems in the introduction to complementary food stage

Introduction to complementary food	**Visual auditory processing score** Mean score (SD)		Sig	**Tactile processing score** Mean score (SD)		Sig	**Taste-smell processing score** Mean score (SD)		Sig
	With problems	Without problems		With problems	Without problems		With problems	Without problems	
ASC	14.00 (4.03)	15.37 (4.89)	p=.257	22.00 (6.75)	23.64 (6.89)	p=.319	10.40 (4.63)	11.08 (5.24)	p=.707
Controls	19.67 (3.48)	20.54 (3.59)	p=.178	30.63 (3.83)	31.88 (3.93)	p=.024	13.85 (5.46)	17.00 (4.02)	p=.005

Children with ASC who presented with problems in the introduction to complementary food showed no significant differences in terms of their sensory sensitivity scores (in all three of the studied sensory modalities) in comparison to their peers without problems in this feeding stage. However, control group children with problems in this feeding stage were significantly more tactile and taste-smell sensitive in comparison to control children with no problems at this feeding stage (See table 3.13)

Table 3.14 SSP subcategories scores of children with and without problems in the transition from pureed to lumpy solids

Transition from pureed foods to lumpy solids	**Visual auditory processing score** Mean score (SD)		Sig	**Tactile processing score** Mean score (SD)		Sig	**Taste-smell processing score** Mean score (SD)		Sig
	With problems	Without problems		With problems	Without problems		With problems	Without problems	
ASC	14.00 (4.04)	15.38 (4.95)	p=.256	22.25 (7.68)	23.51 (6.66)	p=.510	8.83 (4.52)	11.52 (5.16)	p=.030
Controls	19.80 (3.74)	20.50 (3.55)	p=.357	31.48 (3.86)	31.69 (3.95)	p=.629	12.60 (5.49)	17.20 (3.81)	p≤.001

Children with ASC who had a difficult transition from pureed to lumpy solids were found to be significantly more taste-smell sensitive than the children with ASC who presented no problems at this feeding stage. Similarly, children of the control group with a problematic transition at this feeding stage were also significantly more taste-smell sensitive in comparison to their control peers with no problems at this feeding stage (See Table 3.14).

Table 3.15 SSP subcategories scores of children with and without problems in the transition from lumpy solids to family food

Transition from lumpy solids to family foods	**Visual auditory processing score** Mean score (SD)		Sig	**Tactile processing score** Mean score (SD)		Sig	**Taste-smell processing score** Mean score (SD)		Sig
	With problems	Without problems		With problems	Without problems		With problems	Without problems	
ASC	13.55 (3.87)	15.99 (4.99)	p=.034	21.26 (6.44)	24.07 (6.96)	p=.065	9.23 (4.46)	11.61 (5.25)	p=.036
Controls	18.65 (3.85)	20.70 (3.45)	p=.015	30.04 (5.34)	31.94 (3.56)	p=.049	12.30 (5.62)	17.80 (3.78)	p≤.001

Among the children with ASC, those who had a difficult transition from lumpy solids to family food were found to be significantly more visual-auditory sensitive in comparison to those without problems in this feeding stage. In the control group, children with a problematic transition from lumpy solids to family foods were found to be significantly more sensitive across all three sensory processing modalities (See Table 3.15).

Table 3.16 SSP subcategories scores of children with and without problems in the finger food feeding stage

Finger food feeding stage	**Visual auditory processing score** Mean score (SD)		Sig	**Tactile processing score** Mean score (SD)		Sig	**Taste-smell processing score** Mean score (SD)		Sig
	With problems	Without problems		With problems	Without problems		With problems	Without problems	
ASC	12.56 (3.86)	15.57 (4.78)	p=.014	17.17 (5.76)	24.52 (6.44)	p≤.001	8.44 (4.00)	11.41 (5.20)	p=.033
Controls	18.80 (3.53)	20.63 (3.53)	p=.026	30.85 (5.49)	31.78 (3.64)	p=.562	13.05 (5.95)	16.95 (3.96)	p=.004

Children with ASC who had a difficult finger food feeding stage were found to be significantly more sensory sensitive in all three sensory processing modalities, in comparison to those without problems in this feeding stage. Children from the control group with finger food problems were significantly more visual-auditory and taste-smell sensitive in comparison to control children with no problem at this feeding stage (See Table 3.16).

Table 3.17 SSP subcategories scores of children with and without problems during the toddler period feeding stage

Toddler period (around 18 months) feeding stage	**Visual auditory processing score** Mean score (SD)		Sig	**Tactile processing score** Mean score (SD)		Sig	**Taste-smell processing score** Mean score (SD)		Sig
	With problems	Without problems		With problems	Without problems		With problems	Without problems	
ASC	13.88 (4.02)	15.59 (5.01)	p=.07	20.94 (6.49)	24.31 (6.65)	p=.025	8.18 (4.04)	12.19 (5.10)	p≤.001
Controls	19.82 (2.92)	20.46 (3.65)	p=.28	30.71 (3.72)	31.77 (3.95)	p=.082	12.76 (5.19)	16.90 (4.15)	p=.002

Children with ASC who had feeding difficulties during the toddler period were found to be significantly more tactile and taste- smell sensitive in comparison to the children with ASC without feeding problems at this stage. Children from the control group with difficulties during the toddler period were significantly more taste-smell sensitive in comparison to the control children who presented no problems at this feeding stage (See Table 3.17)

3.6 Discussion

This study looked at the differences in early feeding behaviour between children with and without ASC. It also explored whether the existence of early feeding problems signal differences in the current eating behaviour and sensory processing skills of the sample.

It was expected that children with ASC would present with a higher prevalence of early feeding problems, especially closer to the age of 2 years. Moreover, based on previous research, it was hypothesised that food neophobia, eating selectivity, rigid/perseverant eating behaviour and texture selectivity would be significantly more prevalent and more severe in children with ASC. It was also expected that children with early feeding problems (in both groups) would present with higher levels of food neophobia, eating selectivity, rigid/perseverant eating behaviour, selectivity in terms of texture, as well as higher sensory sensitivity.

The data moderately supported the hypotheses of the study. In children with ASC, early feeding problems were significantly more prevalent than in control group children at around the age of 15-18 months. More specifically, the transition from lumpy to family food and the toddler feeding period were significantly more problematic in this group. Findings also revealed, as expected, that children with ASC were currently reported to be more eating selective, showed greater rigid/perseverant eating behaviour and were more texture selective than the children of the control group. Although a higher prevalence of early feeding problems was found in children with more problematic eating behaviour and higher sensory sensitivity in both the control group and children with ASC, differences in early eating behaviour and sensory processing were not consistent across the children with and without problems in the two diagnostic groups.

3.6.1 Early feeding problems and differences in the current eating behaviour of the sample

Although there is a serious lack of research comparing the early feeding skills of children with and without ASC, there is some research suggesting that feeding problems in infancy could be an indicator of a subsequent diagnosis of autism (Keen, 2008; Laud, Girolami, Boscoe & Gulotta, 2009; Twachtman-Reilly et al. 2008). In the present study it was hypothesised that children with ASC would present with a higher frequency of early feeding problems, which would become more prevalent closer to the onset of autism symptomatology (12-18 months old) (Ozonoff et al., 2010). The results revealed a higher prevalence of reported early feeding problems during the transition from lumpy to family food and during the toddler period in children with ASC. A potential explanation for these findings could be that the transition to these feedings stages occurs during the time when the autism symptomatology becomes more prominent and/or the time that food neophobia peaks. Consequently, during the transition to family food children with ASC may not yet be developmentally ready to manage the food that the rest of the family eats (e.g. the deglutition skills of this feeding stage may not have been effectively developed yet). It could also be that children with ASC symptomatology may have had significantly greater difficulty in adapting to the feeding expectations of the family and their environment (e.g. nursery) at this age. At this point the child is expected to learn the ‘mealtime rules’ by modeling parents and siblings’ eating behaviours (Birch, McPhee, Sullivan & Johnson, 1989; Hendy, 2002; Hendy &

Raudenbush, 2000), therefore ASC symptomatology and/or the presence of food neophobia (Harris, 2000) can inhibit modeling.

Early feeding problems, except during breastfeeding, signalled a more negative prediction for the eating behaviour in both groups (ASC and control groups), however the way in which current eating behaviour differed according to the existence of early feeding problems was not always consistent across the two groups. For instance, problems in the early feeding stages for the controls, signalled a worse prediction in terms of their scores in all three FBC subcategories in later childhood. While in the ASC group, the existence of problems in the introduction to complementary food signalled no significant differences in reported current eating behaviour. However, a problematic transition from pureed to lumpy solids presented a higher current eating selectivity and selectivity in terms of texture. Additionally, in children with ASC problems in the transition from lumpy solids to family food, as well as difficulties with eating in the toddler period were linked with a generally more problematic eating behaviour (including eating selectivity, rigid eating and texture selectivity) and higher food neophobia (See Figure 3.4).

3.6.2 Early feeding problems and differences in children’s current sensory processing behaviour

In the control group higher current visual-auditory sensitivity was significantly more prevalent in children with a problematic transition from lumpy to family foods, and in children who presented difficulties in the finger food feeding stage. Tactile sensitivity in childhood was significantly more prevalent in the children from the control group with a problematic introduction to complimentary food and a difficult transition from lumpy to family foods. Higher taste-smell sensitivity in the control group was more frequent among those with problems in all early feeding stages except breast/bottle feeding (See Figure 3.5).

It is an interesting finding that, similar to the control group, higher visual-auditory sensitivity was found among the children with ASC who presented with a problematic transition from lumpy to family foods and difficulties in the finger food feeding stage. The transition from lumpy to family food and the finger food feeding stage are the child's first attempts with 'real looking' food, when the visually perceived qualities of the food become more obvious. This may suggest that visual sensitivity in infancy could be the reason that these children would not easily accept family and finger foods, which have more heterogeneous visual characteristics.

Higher tactile sensitivity was found in children with ASC who presented with early problems in the finger food feeding stage and difficulties in the toddler period. During these feeding stages children were expected to touch food when feeding themselves, therefore children with a higher tactile sensitivity may have found these feeding stages more challenging. Furthermore, taste-smell sensitivity was noted in the ASC children with early feeding problems beginning from the transition from pureed to lumpy food until the toddler feeding period (See Figure 3.6). Likewise, higher taste-smell sensitivity was present in children from the control group with problems in the same feeding stages, in addition to those with a problematic introduction to complementary food. These findings initially highlight the importance of early feeding stages in the shaping of the eating behaviour in later childhood, in both children with and without ASC, however they may also indicate that these problems become evident early and follow infants throughout childhood.

These findings lead us to question whether taste-smell sensitivity may also follow children from infancy to childhood, or could be the result of early negative experiences with food. However, as this was the first study to investigate differences in early feeding problems and later eating behaviour and sensory sensitivity in children with and without ASC, further research is needed in order to provide a clearer answer to this question.

3.6.3 Strengths and limitations of the present study and directions for future research

Although children in the ASC group were significantly older than the control group, age did not have any significant effect on the FBC and food neophobia scores of the sample. A possible explanation for the older mean age in the ASC group could be that, although the presence of autism symptomatology may become more obvious between 12 and 18 months, it is not until school age that children with ASC commonly receive an official diagnosis (Mandell, Listerud, Levy & Pinto-Martin, 2002; Howlin, 1997; Levy, Mandell, Merhar, Ittenbach & Pinto-Martin, 2003; Yeargin-Allsopp, Rice, Karapurkar, Doernberg, Boyle & Murphy, 2003).

Given the lack of literature exploring early feeding in children with ASC, the present study offers a good base for future research. Among the strengths of the present study is that provides evidence that eating selectivity, rigid perseverant behaviour and texture selectivity are significantly more prevalent in children with

ASC. This study found that problematic eating in this population may have its roots early in life (around 12-18 months) when children are expected to progress from lumpy (baby food) to the food that the family eats. Although early problems in the same feeding stages were common in the control sample, more research is needed to explain why these eating behaviours become significantly more prevalent and severe in the ASC population. Future research could specifically try to identify whether the autistic symptomatology (including higher sensory sensitivity) becoming more obvious, food neophobia reaching its peak, a combination of both or another presently unforeseen factor could be responsible.

Another strength of this study is that, as opposed to previous research which has used the umbrella term of ‘picky’/selective eating to describe a wide variety of eating behaviours, this study, with the use of FBC, manages to set a clearer picture of the type of eating difficulties experienced, in an appropriate sized sample, with a good representation of both typically developing children and children with ASC.

Nevertheless, this study was not without limitations. Parents’ participation was voluntary. Therefore there is a possibility that the results of this study may be influenced by a self-selection bias, as perhaps parents who were more concerned about their child’s eating problems may have been more willing to participate in this study. However, as can be seen in Chapter 4, the data from both the ASC and the control group showed an appropriate diversity in terms of their overall FBC score (Figure 4.1).

The minor overlap in the questions of the SSP (e.g. Limits self to particular food textures/temperatures) and the FBC (e.g. Prefers foods which have certain textures, e.g. Smooth) could be considered as another limitation of this study. However, the FBC, with the use of questions such as “Does not like lumpy foods”, “Does not like mashed foods (e.g. mashed vegetables, potatoes)”, “Does not like puree smooth foods (e.g. vegetable/fruit smoothies, yoghurt)”, in addition to the question “Prefers foods which have certain textures, e.g. Smooth)” aims to identify whether children of the two groups (ASC, neurotypicals) have any particular texture preferences.

Another possible limitation is that parents who believe their child has eating problems may over report or recall more problematic eating behaviour. However it is believed that these issues would have influenced both control children and children with ASC (Martins, Young & Robson, 2008). The present study was a retrospective study and parents were asked to report their children’s feeding skills from before they were diagnosed with an ASC. It is therefore possible that these parents may have been influenced by their child’s subsequent ASC diagnosis and more negatively report regarding their child’s feeding skills during infancy. Therefore, a suggestion for better practice in future research aiming to focus on the development of early feeding skills in children with ASC would be to run a prospective longitudinal study in a sample consisting of both low and high risk infant populations before they receive their ASC diagnosis.

3.7 Conclusion

The findings of the present study suggest that typically developing children with early feeding problems generally showed more problematic eating behaviour in later childhood in comparison to their control peers without early feeding problems. Children with ASC generally presented with more problematic eating behaviour (including eating selectivity, rigid/perseverant eating, texture selectivity and food neophobia) across the sample, regardless of whether they presented with early feeding problems or not. Additionally, apart from minor differentiations in terms of tactile sensitivity, early feeding problems signalled similar differences in terms of the visual-auditory and taste-smell sensitivity in later childhood, both in the control group and children with ASC (See Figures 3.5 and 3.6). Finally, further research is needed to better understand why early feeding problems around the age at 18 months were more prevalent in children with ASC.

Figure 3.3 Early feeding problems and current eating behaviour in typically developing children

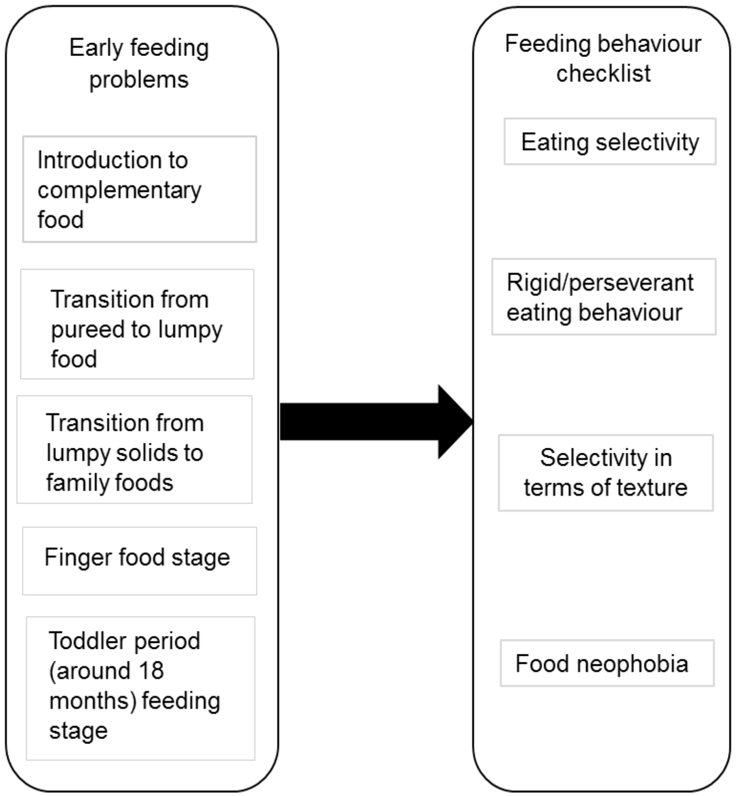


Figure 3.4 Early feeding problems and current eating behaviour in children with ASC

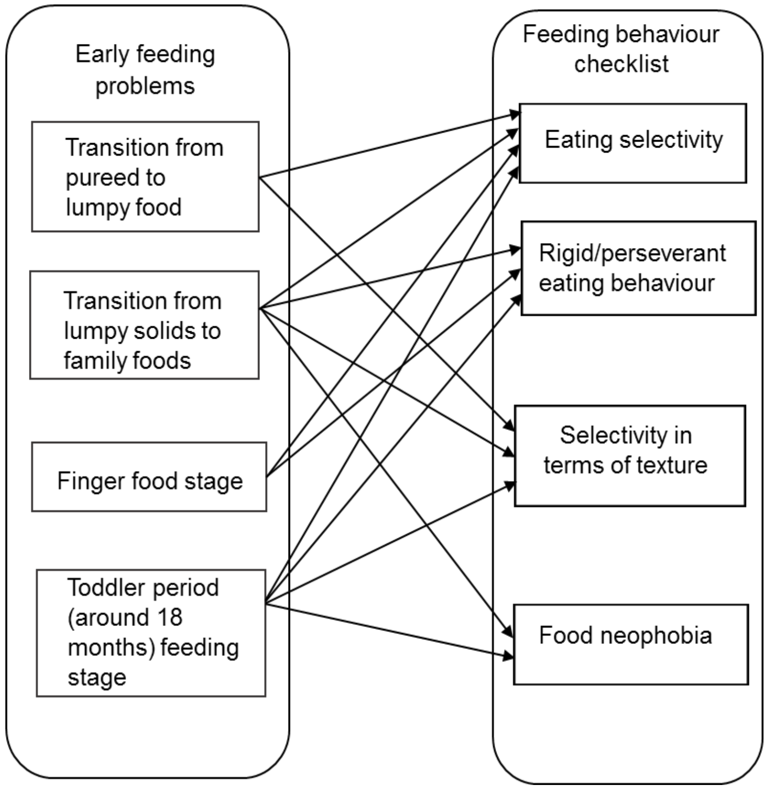


Figure 3.3 and Figure 3.4 show the early feeding problems and current eating behaviour in typically developing children (left) and children with ASC (right).
Arrows in Figures 3.3-3.6 are used to indicate time of appearance and not causality; reported early feeding problems precede the report of problematic eating behaviour and sensory sensitivity in later childhood but do not necessarily cause them.

Figure 3.5 Early feeding problems and sensory sensitivity in typically developing children

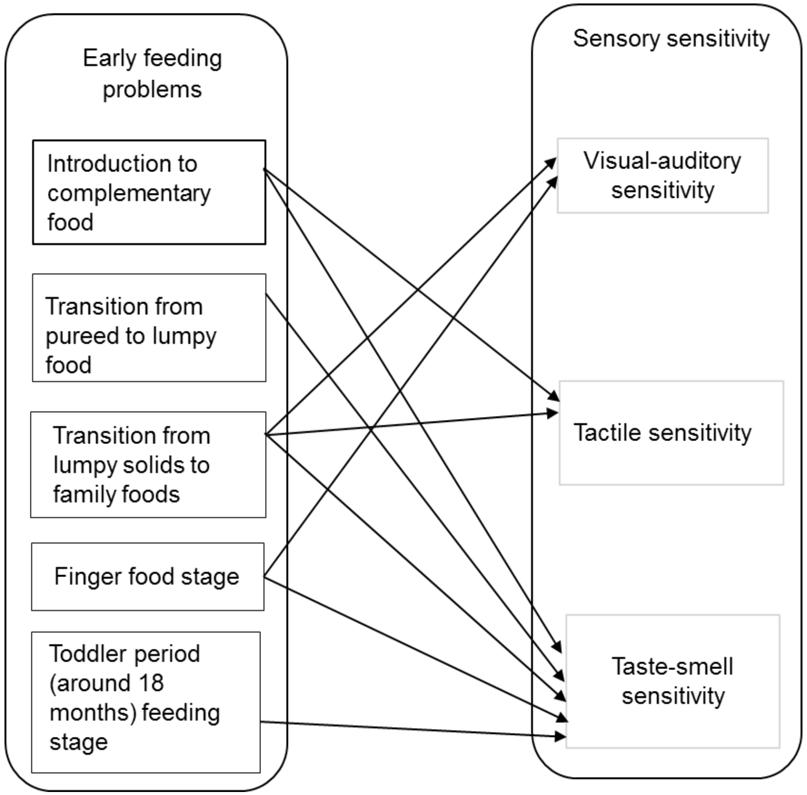


Figure 3.6 Early feeding problems and sensory sensitivity in children with ASC

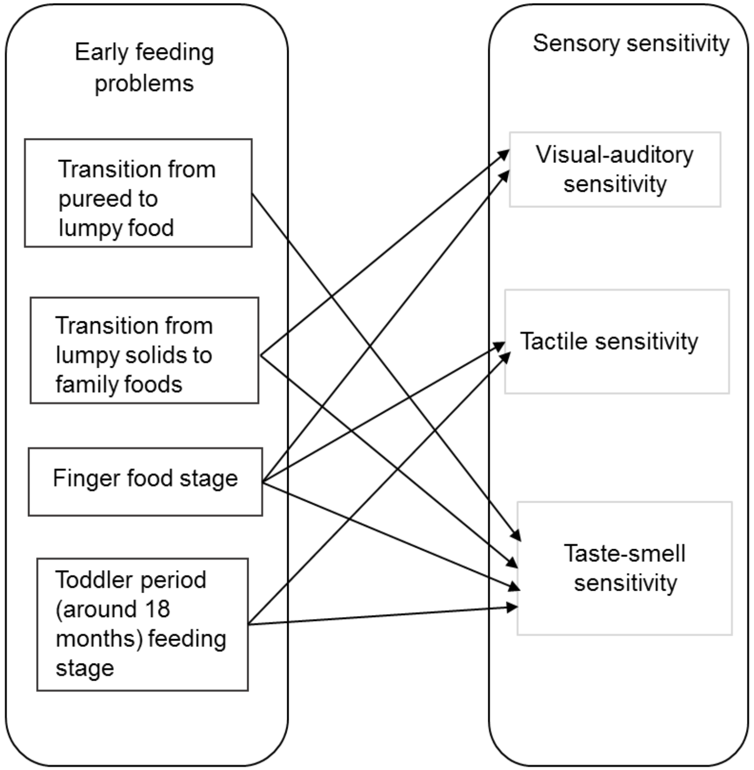


Figure 3.5 and Figure 3:6 show the early feeding problems and sensory sensitivity in typically developing children (left) and children with ASC (right).

CHAPTER 4

ASSOCIATIONS BETWEEN SENSORY PROCESSING, SOCIAL-COMMUNICATION AND BEHAVIOURAL PERFORMANCE AND EATING BEHAVIOUR IN CHILDREN WITH AND WITHOUT ASC

4.1 Abstract

Different reasons have been suggested as causes for the high number of eating problems, especially food refusal and dietary restriction, seen in children with autism spectrum conditions (ASC). Sensory processing difficulties are among the most frequently suggested reasons for the high prevalence of eating problems in the ASC population. The purpose of this study was to investigate the relationship between sensory processing and eating problems in 254 children (151 typically developing children and 103 children with ASC) aged between 2 and 14 years. Sensory processing behaviour was measured using the Short Sensory Profile (SSP), and eating selectivity, rigid/perseverant behaviour and texture selectivity was assessed using the Feeding Behaviour Checklist (FBC). The social, communication and behavioural profile of the children was assessed using the Social Communication Questionnaire (SCQ) and the Strengths and Difficulties Questionnaire (SDQ). The data showed that the majority of children with a *definite difference* in their sensory processing performance were from the ASC group, however, and more importantly, it was found that sensory processing problems were related to selective eating in both the ASC and the control group. Eating and sensory problems were observed to co-exist with a more problematic social, communication and behavioural profile

in both groups. However these difficulties were generally more severe in children with ASC.

4.2 Introduction

4.2.1 Eating behaviour and sensory sensitivity

Autism Spectrum Conditions (ASC) are widely linked with the existence of communication deficits, difficulties in social interaction, insistence on sameness and adherence to routines. Hyper-or hypo-reactivity to sensory input, or unusual interest in sensory aspects of the environment; has also been added to the criteria for ASC in the most recent version of DSM (DSM-V, APA, 2013).

Eating difficulties such as extreme selectivity, rigid eating behaviour and reluctance to try new foods are commonly reported in children with ASC (Nadon, Feldman & Gisel, 2013), and although similar eating difficulties are common in children of typical development, it is suggested that in the ASC population these eating behaviours appear more often and are more persistent (Kozlowski, Matson, Fodstad & Moree, 2011).

Sensory processing difficulties are another commonly reported problem in children with ASC (Cermak, Curtin, & Bandini 2010; Dunn, Myles & Orr, 2002; Tomchek, Little & Dunn, 2015). Much of the existing evidence on the sensory processing of children with ASC comes from parents' reports (Kientz & Dunn, 1997), clinical observations (Gillberg et al., 1990; Ermer & Dunn, 1998) or self-reports of individuals with ASC describing their sensory difficulties (Cesaroni & Garber, 1991; Grandin, 1995). Beyond the anecdotal evidence, other studies have used sensory processing questionnaires in order to measure the severity of these problems, with the standardised Sensory Profile (Dunn,

1999) and its reviewed version, the Short Sensory Profile (SSP, McIntosh, Miller, & Shyu & Dunn,1999); being the most commonly used.

Individuals with ASC show variability in terms of the type and the severity of their sensory symptoms (Baranek, David, Poe, Stone & Watson, 2006; Rogers, Hepburn & Wehner, 2003). Tomchek and Dunn (2007), compared the sensory processing skills of 281 children with ASC with aged matched control children aged between 3 and 6 years. The data showed that 95 % of the ASC population showed some sensory processing dysfunction based on their overall SSP score, with the greatest difference appearing in the sections regarding under-responsive/seeks sensation (*definite difference*: 86.1% ASC, 6% controls), auditory processing (*definite difference*: 77.6% ASC, 3.1% controls), tactile sensitivity (*definite difference*: 60.9% ASC, 8.9% controls), and taste/smell sensitivity (*definite difference*: 54.1% ASC 6.8% controls). This study confirmed the observations of previous literature (Cermak, Curtin & Bandini, 2010) that sensory processing problems are more prevalent in the ASC population.

Since sensory processing problems are common in children with ASC (Case-Smith, Weaver & Fristad, 2015), one would expect these problems to also affect other aspects of everyday life, such as eating (Schaaf et al., 2011). Although it is widely accepted that sensory processing problems and eating difficulties (Chapter 3) are common in the ASC population, very little research has examined the relationship between sensory processing and eating problems in children with ASC as well as in typically developing children.

One of the very few studies exploring the role of sensory processing in the eating behaviour of typically developing children was run by Smith, Roux, Naidoo and Venter (2005). In this study tactile defensiveness was measured with the use of the SSP in typically developing children aged between 3 and 10 years. The results suggested that tactile sensitive children had a poorer appetite, would refuse food based on smell or temperature, and were more reluctant to eat unfamiliar food or eat in other people's houses. In line with this, Coulthard and Blissett (2009) in a study exploring eating selectivity and sensory sensitivity in typically developing children aged 2-5 years, found a strong link between taste/smell and tactile sensitivity and more selective eating in terms of fruits and vegetables and higher levels of food neophobia. While a linke was also reported between tactile, visual and taste/smell sensitivity and higher levels of food neophobia.

Another study by Nadon, Feldman, Dunn and Gisel (2011), using the SSP (McIntosh, Miller & Shyu & Dunn, 1999) and the Eating Profile (a questionnaire on eating behaviour created by Nadon in 2007) attempted to examine any links between sensory processing problems and the number of eating problems in an autistic population. The data showed that children with definite sensory problems in tactile sensitivity, taste-smell and visual/auditory sensitivity had a higher number of eating problems than did the children with typical sensory performance. Moreover, this study revealed that difficulties in certain sensory modalities were linked to different eating behaviours. For example, children with ASC who presented a '*definite difference'* in terms of tactile sensitivity also presented with problems in the social aspects of mealtime, or presented with rigidness in terms of brands, the way of cooking, colour, texture, or the temperature of the food. Although this study has provided valuable input into this body of research, it was only based on an ASC population; there was no neurotypical control group.

Among the limited but growing number of research studies exploring the link between eating problems and sensory processing in samples consisting of children with ASC and typically developing, age matched peers, is the study produced by Zobel-Lachiusa, Andrianopoulos, Mailloux and Cermak (2015). The findings of this research team suggested that children with ASC had a more pathological performance in all of the measures used in the study, both at mealtimes (BAMBI, Lukens & Linscheid, 2008); and in terms of sensory processing (SSP; Dunn, 1999; SEC; Yack, Sutton & Aquilla, 2003; TIE; Royeen & Fortune, 1990). Moreover, a positive correlation was found between the existence of mealtime problems and sensory sensitivity. It needs to be noted that the sample consisted of only 34 children in each group(ASC and control) respectively.

One of the targets of the present study is to explore the sensory and eating difficulties in children with ASC in comparison with typically developing children in a larger and geographically broader sample. In line with the research of Nadon, Feldman, Dunn and Gisel (2011) it is of interest to explore further whether certain sensory modalities are linked to different eating behaviours, not only in the ASC population but also in the typically developing population. Furthermore, it remains to be investigated whether eating behaviour such as eating selectivity, rigid eating behaviour and selectivity in terms of texture differs in children within the control group and children with ASC who present similar sensory processing behaviour.

Twachtman-Reilly, Amaral and Zebrowski (2008) explored the factors affecting mealtime behaviour in children with ASC, and one of the ideas that they put forward was that multisensory experiences may be problematic for children with difficulties in their sensory processing. For example, a school cafeteria is a place where the levels of noise, smell and visual stimuli can be high. As a result, children (with ASC or not) who have difficulty in tolerating certain sensory inputs may develop unusual social responses, such as becoming upset, aggressive or having temper tantrums. They may escape this eating environment as soon as possible, or socially withdraw from the experience. It is difficult to specify whether observed problematic behaviour may appear due to 'fussiness' in terms of eating, or as a coping technique in response to an overwhelming sensory input. In addition, the social demands of eating in a crowded environment may increase stress levels and therefore decrease appetite. Given that language and speech is often compromised in children with ASC, these children are also at a disadvantage in terms of expressing what they do not like about their food or the mealtime environment, as well as expressing any discomfort due to the sensory experience, abdominal pain or feelings of disgust due to something they have eaten.

So far there has been little published research on the role that social and communication skills play in cases where mealtime problems are present in children with or without ASC. Consequently, it was decided that for the present study the Social Communication Questionnaire (SCQ) would be used to explore the social and communication capacity of the sample and the relationship between these skills and the existence of eating and sensory problems. Furthermore, the Strengths and Difficulties Questionnaire (SDQ) was used to investigate the relationship between eating problems and antisocial behaviour (e.g. conduct, peer or emotional problems, poor attention span or difficulties in pro-social behaviour (e.g. sharing). This measure was included because recent research has identified a positive correlation between behavioural problems (measured by the SDQ) and the existence of eating selectivity and emotional under-eating (Blissett, Meyer & Haycraft, 2011). It is therefore an intention of this study to try to discover whether there is a link between a problematic sensory profile and the existence of eating and/or behavioural problems. It is also of interest to explore which of the SDQ subcategories of difficulty are more likely to play an important role in the presence of eating and sensory problems in the sample. Finally, the use of the SCQ and SDQ will contribute to shaping a more concrete idea about the behavioural, social and communication profile of children with eating and sensory problems.

4.3 Aims and hypotheses

One of the main objectives of the study was to explore the relationship between sensory processing and eating problems in typically developing children and children diagnosed with ASC. It was hypothesised that children with ASC would present with a more problematic performance in all of the measures used to look at eating behaviours and sensory processing. Additionally, this study aimed to identify any differences in eating behaviour between children who were divided by their sensory processing performance (*typical performance, probable, definite difference*), using the cut off points suggested by the Short Sensory Profile (SSP). It was expected that children with definite sensory problems will show overall greater difficulties (scoring higher) in terms of eating selectivity, rigidness and selectivity in terms of texture. Differences in the eating behaviour (as measured by the FBC) between the control group and children with ASC when matched in terms of sensory performance (*typical performance, probable and definite difference*) were explored. In addition, this study intended to investigate the behavioural, social and communication characteristics of the sample and to investigate further any associations between these characteristics, eating, and sensory processing problems. It was hypothesised that children with ASC would have a more pathological performance in the SCQ and SDQ and a positive correlation was expected to be found between the existence of eating problems and behavioural problems.

4.4 Method

4.4.1 Participants

Carers of two hundred and fifty four children aged between 2 and 14 years (151 controls and 103 with ASC) participated in this study. Details on study procedure and participants are summarised in Chapter 3. The mean age of the children in the sample was 7.32 years (SD= 2.58). Participants' exclusion criteria for this study are stated in Chapter 2.

4.4.2 Measures

Feeding behaviour checklist (FBC, Appendix A-4)

The FBC is a measure of eating behaviour in children (Harris, in preparation) which consists of three subcategories and aims to explore eating selectivity, rigid/perseverant eating and selectivity based on the texture of the food. More information on the factor analysis procedure followed in order to shape the three subcategories can be found in Chapter 2 and Appendix B-1.

Short Sensory Profile (SSP, McIntosh, Miller & Shyu & Dunn 1999; Dunn,1999, Appendix A5)

Behavioural sensory processing was measured by the SSP, a 38-item questionnaire to be completed by parents and caregivers with the use of a 1 to 5-point scale. A lower score represents a less desirable (more pathological) performance, while higher scores are closer to the normative performance. In this study only three sensory processing sections were included (visual/auditory, tactile and smell-taste) as these sections were considered as more likely to have an effect on eating behaviour. In each sensory modality the classification system suggested in the SSP was used to divide the sample into *typical performance, probable difference* and *definite difference* groups in terms of their sensory processing performance.

Typical performance describes scores at, or above, 1 Standard Deviation below the mean for children without disabilities; *probable difference* refers to scores at, or above, 2 Standard Deviations below the mean, but lower than 1 Standard Deviation below the mean; and *definite difference* describes scores that lie below 2 Standard Deviations of the mean (Dunn, 1999).

Parents failed to complete the SSP for two children, while data in terms of tactile and taste/smell sensitivity were missing for one child.

The Strengths and Difficulties Questionnaire (SDQ, Appendix A-7*)*

The SDQ was considered the most appropriate measure of behavioural functioning for children in the control group and children with ASC, as it has previously been used in both community and clinical populations. The SDQ consists of 4 behavioural subscales which assess conduct problems, hyperactivity, emotional symptoms, and peer problems in addition to pro-social behaviour. Higher scores in the four subscales of the SDQ represent more difficulties in these areas. The total SDQ difficulties score can be calculated by combining the scores from all scales except pro-social behaviour. Higher scores on the pro-social behaviour scale indicate a less problematic performance.

This measurement has previously been used in populations ranging in age from 4 to 17 years, and therefore data from children younger than 4 in this study were not included in the final analysis. (For more information see Chapter 2).

Social Communication Questionnaire (SCQ, Appendix A-8)

The SCQ is a validated 40 item questionnaire which aims to assess the social and communication skills of individuals aged 4-40 years, as long as their mental age exceeds 2 years. It consists of 4 subcategories which focus on social interaction, communication, abnormal language and stereotyped behaviour. Higher scores on the SCQ indicate greater social and communication difficulties. The SCQ was used as a tool to identify social and communicational difficulties in children with and without ASC (See Chapter 2). This allowed us to investigate any associations between these problems and the existence of eating and sensory processing problems.

4.4.3 Procedure

Data were collected from carers of children, with and without ASC, from a wide range of ethnic backgrounds with the use of an electronic survey. Detailed information about the research design and the procedure followed can be found in Chapter 2.

4.4.4 Statistical analysis

SPSS version 21, statistical software, was used to analyse the data. Histograms and Kolmogorov-Smirnov analysis showed that the majority of the data were not normally distributed. Descriptive statistics for demographic characteristics were used and differences in terms of diagnosis and gender were explored using a Mann-Whitney U test, and any potential correlations in terms of age and weight and the eating behaviour were explored with the use of Spearman correlation analysis.

Spearman correlation analysis was also used to explore the relationship between sensory processing and eating behaviour with social and communication difficulties and behavioural problems (e.g. conduct, peer, emotional problems). Finally, cluster analysis was used in order to classify the data into three groups based on the children's performance in terms of sensory processing and eating behaviour.

4.5 Results

4.5.1 Descriptive statistics

For more detailed information on the demographic characteristics of the sample see Chapter 3. In the overall sample, there were no significant relationships between the overall sensory processing score and age (r_s =-.044, p=.487). No significant differences were found in terms of gender and the overall sensory processing score in children with ASC (U=877, Z=-.162, p.871) or in the control group (U=2348.5, Z=-1.738, p=.082). Also, no significant correlation was found between weight and the overall sensory processing score of the sample (r_s =-.078, p=.260).

4.5.2 Demographic variables and sensory processing performance of the sample

Based on their scores in each of the sensory modalities, the sample was divided into three groups of *typical performance, probable difference* and *definite difference,* with the cut off points suggested by the SSP (Dunn 1999; McIntosh, Miller & Shyu & Dunn, 1999) (See Table 4.1).

Table 4.1 Performance classification on the SSP sections and the diagnosis group

Section	Typical performance		Probable Difference		Definite Difference		
	ASC	Controls	ASC	Controls	ASC	Controls	
Visual/ Auditory Sensitivity	N=30 29.4%	N=110 73.3%	N=17 16.7%	N=23 15.3%	N=55 53.9%	N=17 11.3%	$\chi^2(2)=59.69$ $p \leq .001$
Tactile Sensitivity	N=25 24.8%	N=121 80.7%	N=7 6.9%	N=17 11.3%	N=69 68.3%	N=12 8%	$\chi^2(2)=101.7$ $p \leq .001$
Taste/smell Sensitivity	N=27 26.7%	N=111 74%	N=12 11.9%	N=10 6.7%	N=62 61.4%	N=29 19.3%	$\chi^2(2)=55.84$ $p \leq .001$

Percentage of study participants showing *typical, probable or definite* differences in SSP in Visual/Auditory sensitivity, Tactile sensitivity and Taste/Smell sensitivity.

The findings revealed that children with ASC were more likely than the control group to be assigned to the *definite difference* classification in all of the studied sensory modalities. The highest percentage of children with ASC with a *definite difference* in terms of their sensory performance was noticed in the modality of tactile sensitivity. The highest percentage of control children with a *definite difference* in their sensory performance was found in the taste/smell modality.

As was expected, the majority of the control group's scores indicated a typical sensory processing performance. A Chi-square test analysis showed that the difference between the number of children with ASC presenting with a *definite difference* in terms of sensory problems was significant when compared with the number of control children who showed *typical performance* (See Table 4.1).

A Mann-Whitney U Test was carried out to explore whether children with ASC present a more pathological performance in all the measures used in this study for both mealtime and sensory processing (see Table 4.2).

Table 4.2 Sensory processing and FBC scores in children with and without ASC

	ASC Mean (SD)	Controls Mean (SD)	
Visual/ Auditory Sensitivity	15.04 (4.76)	20.39 (3.58)	U=2899.5, p≤.001
Tactile Sensitivity	23.21 (6.90)	31.65 (3.93)	U=2230.5, p≤.001
Taste/smell Sensitivity	10.88 (5.12)	16.43 (4.46)	U=3134, p≤.001
Eating selectivity	52.42 (13.40)	39.61(16.00)	U=3499, p≤.001
Rigid/ perseverant eating behaviour	33.46 (11.06)	22.10 (8.19)	U=3754.5, p≤.001
Selectivity in terms of texture	11.67 (4.10)	8.38 (3.66)	U=3989.5, p≤.001

Children with ASC scored significantly lower than the control group in the SSP subcategories, suggesting greater sensory sensitivity in processing the visual-auditory, tactile and taste-smell information from their environment. In accordance with the hypothesis children with ASC scored significantly higher in the FBC subcategories, suggesting that this diagnostic group generally presented with greater problems in their eating behaviour in comparison to the control group.

A Mann Whitney U test was used to compare differences in the three categories of the visual/auditory, tactile, taste/smell (*typical, probable, and definite problem*), and eating behaviour measured by the FBC (See Tables 4.3.1 and 4.3.2)

Table 4.3.1 Differences in FBC subscales scores according to the sensory processing classification of the sample

Sections of the SSP and children's classifications	Mean score eating selectivity (SD)			Mean score rigid/ perseverant eating behaviour score (SD)			Mean score selectivity in terms of texture (SD)		
Visual/ Auditory Sensitivity	ASC	Controls		ASC	Controls		ASC	Controls	
Typical performance ASC (N=30) Controls (N=110)	63.37 (19.9)	48.44 (18.93)	p≤.001	18.63 (5.59)	14.09 (5.58)	p≤.001	10.97 (3.74)	8.56 (3.58)	p≤.001
Probable Difference ASC (N=17) Controls (N=23)	73.00 (17.04)	64.35 (21.83)	p=.101	20.29 (6.00)	18.39 (5.15)	p=.277	12.65 (4.28)	9.87 (2.86)	p=.048
Probable Difference ASC (N=17) Controls (N=23)	78.56 (18.48)	67.00 (18.10)	p=.024	23.49 (6.35)	19.76 (6.21)	p=.020	12.91 (4.02)	10.35 (3.06)	p=.016

Table 4.3.2 Differences in FBC subscales according to the sensory processing classification of the sample

Sections of the SSP and children's classifications	Mean score eating selectivity (SD)			Mean score rigid/ perseverant eating behaviour score (SD)			Mean score selectivity in terms of texture (SD)		
Tactile Sensitivity	ASC	Controls		ASC	Controls		ASC	Controls	
Typical performance ASC (N=25) Controls (N=121)	59.52 (18.43)	50.28 (19.44)	p=.010	17.44 (5.26)	14.60 (5.64)	p=.013	10.24 (3.75)	8.57 (3.29)	p=.026
Probable Difference ASC (N=7) Controls (N=17)	65.71 (19.72)	61.12 (18.16)	p=.534	18.43(6.10)	18.82 (4.92)	p=.901	10.57 (4.82)	10.94 (3.01)	p=.576
Definite Difference ASC (N=69) Controls (N=12)	79.33 (17.09)	68.67 (26.58)	p=.297	23.23 (6.12)	18.58 (8.09)	p=.067	13.23 (3.80)	10.17 (4.76)	p=.017
Taste/smell Sensitivity	ASC	Controls		ASC	Controls		ASC	Controls	
Typical performance ASC (N=27) Controls (N=111)	59.96 (18.43)	50.28 (19.44)	p=.011	14.81 (4.79)	13.06 (4.52)	p=.079	8.41 (2.76)	7.76 (2.55)	p=.289
Probable Difference ASC (N=12), Controls (N=10)	68.00 (11.72)	68.80 (11.00)	p=.923	19.08 (3.70)	21.20 (5.71)	p=.381	11.83 (2.98)	10.40 (2.54)	p=.254
Definite Difference ASC (N=62) Controls (N=29)	84.73 (12.28)	81.72 (16.28)	p=.355	24.82 (4.81)	22.31 (4.00)	p=.022	14.10 (3.49)	13.10 (3.50)	p=.186

4.4.2.1 Eating selectivity

Children with ASC in the *typical* performance and *definite difference* in visual/auditory processing categories were significantly more eating selective in comparison to the control children in these categories (See tables 4.3.1 and 4.3.2). In addition, children with ASC who obtained a *typical processing* performance score in tactile and taste/smell processing were significantly more eating selective than the control children from the same performance group in these two sensory modalities.

4.4.2.2 Rigid/perseverant eating behaviour

Children with ASC in the *typical* performance and *definite difference* in terms of visual/auditory processing groups showed significantly more rigid/ perseverant eating behaviour than did the control children (See tables 4.3.1 and 4.3.2). Children with ASC in the *typical* tactile performance group were found to be significantly more rigid/perseverant in terms of eating than the control children of this group. Children from the ASC group who presented with a *definite difference* in terms of taste/smell sensory performance showed significantly higher rigid/perseverant eating behaviour in comparison to the control children with a *definite difference* in the same sensory modality.

4.4.2.3 Selectivity in terms of texture

Children with ASC were significantly more texture selective than the control group, no matter which category they were classified to in terms of their visual/auditory processing performance. In addition, children with ASC from the *typical performance* and *definite difference* groups were significantly more likely to show higher texture selectivity. No significant differences were noticed in terms of texture selectivity between children with ASC and control children in every group of taste/smell performance (*typical, probable, and definite problem*).

4.5.3 Correlations between FBC and SSP

Spearman correlation analyses were run between the FBC overall score and the SSP overall score in order to explore associations between sensory processing and eating problems in typically developing children and children diagnosed with ASC.

A scatterplot was created to graphically represent the relationship between the overall scores of the two variables (sensory processing difficulties and eating problems) (See Figure 4.1).

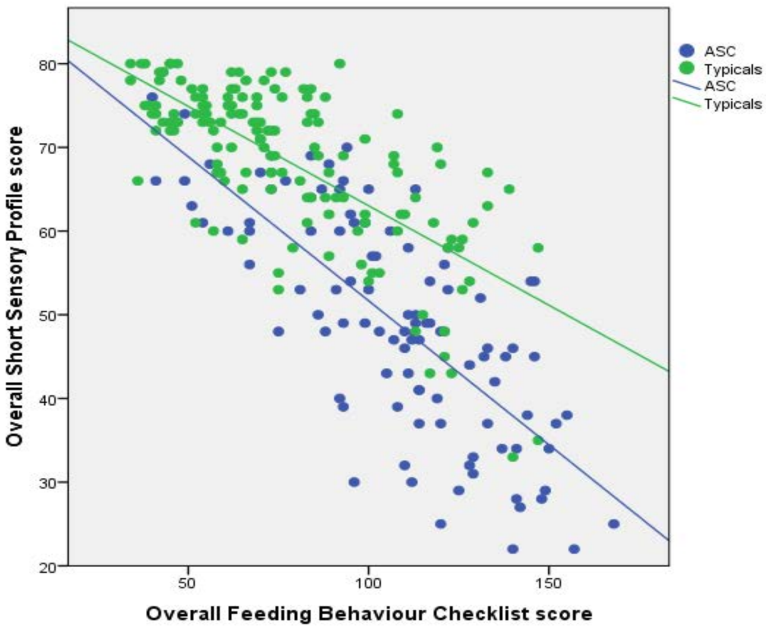


Figure 4.1 Scatterplot depicting overall FBC and SSP scores in children with ASC and control children

From the scatter plot (Figure 4.1) and Table 4.4 a negative correlation can be observed between the SSP score and FBC score in both diagnostic groups. These findings confirm the hypothesis that there is a relationship between eating problems (higher score) and sensory processing difficulties (lower score).

Notably, Figure 4.1 also shows a wide range of sensory processing scores in the ASC group, whilst the scores of the control group cluster within the typical performance range. This reflects the fact that ASC is a spectrum of difficulties, widely varying in terms of the prevalence and severity of the difficulty.

Table 4.4 Correlations between subcategories of FBC and Sensory sensitivity for ASC and control group.

Controls	Overall SSP score	Visual/ Auditory Sensitivity	Tactile Sensitivity	Taste/smell Sensitivity
Overall FBC score	-.674**	-.308**	-.377**	-.840**
Eating selectivity	-.673**	-.265**	-.322**	-.824**
Rigid /perseverant eating behaviour	-.653**	-.303**	-.460**	-.716**
Selectivity in terms of texture	-.505**	-.124	-242**	-645**
ASC				
Overall FBC score	-.737**	-.339**	-.525**	-.861**
Eating selectivity	-.738**	-.301**	-.388**	-.834**
Rigid /perseverant eating behaviour	-.694**	-.415**	-.606**	-.713**
Selectivity in terms of texture	-.518**	-.172	-.363**	-.673**

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

Spearman correlation analyses showed that greater sensitivity in all three sensory modalities was linked with higher eating selectivity scores in both control group and children with ASC. Similarly, greater sensory sensitivity in the three modalities was linked with a higher level of rigid/perseverant eating behaviour in both diagnostic groups. However, although there was a relationship between tactile, taste/smell sensitivity and greater selectivity in terms of texture in both children with ASC and control group, there was no significant relationship between visual/auditory sensitivity and texture selectivity in either group.

4.5.4 Strengths and Difficulties Questionnaire and Social Communication Questionnaire scores in children with ASC and controls

Another aim of this study was to investigate the behavioural, social and communication characteristics of the sample and explore the extent to which these characteristics may be linked with eating and sensory problems. A Mann-Whitney U Test was run in order to identify differences between the ASC and control group in terms of their scores in the SDQ and SCQ and the subcategories (See tables 4.5-4.6).

Table 4.5 Scores of SDQ and subcategories across diagnostic groups

	ASC Mean (SD)	Controls Mean (SD)	
SDQ (Total difficulties score)*	21.61(6.46)	8.71(5.99)	p≤.001
Emotional Symptoms	4.68 (2.77)	2.14 (2.16)	p≤.001
Conduct problems	3.62 (2.37)	1.60 (1.76)	p≤.001
Hyperactivity/inattention	7.40 (2.16)	3.48 (2.68)	p≤.001
Peer problems	5.85 (2.06)	1.52 (1.75)	p≤.001
Prosocial behaviour	4.15 (2.61)	8.03 (1.95)	p≤.001

SDQ (Total difficulties score): This is generated by combining scores from all of the scales except the prosocial behaviour scale. Higher scores in the prosocial behaviour scale indicate less problematic performance

Table 4.6 Scores of SCQ and subcategories across diagnostic groups

	ASC Mean (SD)	Controls Mean (SD)	
Overall SCQ score	22.07 (7.38)	5.21 (4.75)	p≤.001
Social Interaction	9.68 (4.94)	1.83 (2.33)	p≤.001
Communication	2.63 (1.71)	0.56 (0.93)	p≤.001
Abnormal Language	3.45 (1.45)	1.33 (1.44)	p≤.001
Stereotyped behaviour	5.40 (1.87)	1.50(1.75)	p≤.001
Overall SCQ score	22.07 (7.38)	5.21 (4.75)	p≤.001

As was expected the SDQ, SCQ, overall and subcategory scores of children with ASC indicated a significantly more pathological performance than that of the control group.

4.5.5 Correlations between FBC, SSP, SCQ and SDQ

Spearman correlation analyses were run in order to investigate the association between the SDQ and SCQ scores and the eating behaviour (FBC) and sensory profile (SSP) scores of the sample (See table 4.7 and table 4.8).

4.5.5.1 Correlations of FBC, SSP, SCQ and SDQ scores in typically developing children

Table 4.7 Correlations observed in the eating behaviour, sensory processing, SCQ and SDQ scores in typically developing children

Typically developing children	**SCQ**	Social Interaction	Communication	Abnormal Language	Stereotyped behaviour	**SDQ**
Overall FBC score	.398**	.223**	.111	.291**	.371**	.544**
Eating selectivity	.404**	.229**	.107	.303**	.371**	.539**
Rigid /perseverant eating behaviour	.374**	.218**	.073	.272**	.369**	.519**
Selectivity in terms of texture	.312**	.168*	.202*	.207*	.265**	.500**
Overall SSP score	-471**	-.240**	-.132	-.418**	-.494**	-.671**
Visual/ Auditory Sensitivity	-.303**	-.114	.075	-.358**	-.348**	-.423**
Tactile Sensitivity	-.419**	-.175*	-.102	-.411**	-.428**	-.456**
Taste/smell Sensitivity	-.354**	-.276**	-.183*	-.189*	-.318**	-.470**

*Correlation between FBC, SSP and the subcategories of SDQ can be found in the Appendix B-3 * p < .05 ** p < .01*

Positive correlations were observed between the existence of eating problems (FBC) and the existence of problems in social interaction and communication. More specifically, in the control group positive relationships were noticed between greater difficulty in terms of social interaction, language and the existence of stereotypical behaviour and greater eating selectivity, and rigid/perseverant eating behaviour. Higher texture selectivity was found to positively associate with higher scores on the SCQ, and in all of the subcategories of this measurement, suggesting that greater social and communication problems relate to greater selectivity in terms of texture.

Significant negative correlations were also noticed between the overall SSP score and higher SCQ score as well as between overall SSP score and the SDQ overall score, revealing an association between the existence of greater sensory problems with higher levels of social and communication difficulties (r_s=-.471, $p \leq .001$) and behavioural and emotional problems (r_s=-.671, $p \leq .001$). A strong correlation was also noticed between higher texture selectivity and greater communication difficulties (e.g. communication cues, such as turn taking, perceiving facial expressions or contacting someone with the intention to be friendly, r_s=.202, p=.013). In addition to this, a strong correlation was found between greater communication difficulties and greater taste/smell sensitivity (r_s=-.183, p=.013) (See Table 4.7).

4.5.5.2 Correlations of FBC, SSP, SCQ and SDQ scores in children with ASC

Table 4.8 Correlations observed in the eating behaviour, sensory processing, SCQ and SDQ scores in children with ASC

ASC	**SCQ**	Social Interaction	Communication	Abnormal Language	Stereotyped behaviour	**SDQ**
Overall FBC score	.468**	.391**	.297**	.135	.336**	.292**
Eating selectivity	.447**	.371**	.292**	.153	.339**	.289**
Rigid /perseverant eating behaviour	.460**	.384**	.280**	.144	.356**	.340**
Selectivity in terms of texture	.278**	.251*	.228*	.081	.189	.133
Overall SSP score	-.497**	-.355**	-.339**	-.235*	-.480**	-.593**
Visual/ Auditory Sensitivity	-.314**	-.169	-.204*	-.352**	-.415**	-.507**
Tactile Sensitivity	-.430**	-.312**	-.269**	-.251*	-.398**	-.517**
Taste/smell Sensitivity	-.388**	-.331**	-.273**	-.014	-.255*	-.291**

*Correlations between FBC, SSP and the subcategories of SDQ can be found in the Appendix B-3, * p < .05, ** p < .001*

Positive correlations were observed between the existence of eating problems (FBC) and the existence of problems in social interaction and communication. More specifically, in children with ASC, positive relationships were noticed between greater difficulty in terms of social interaction, communication and the existence of higher levels of stereotypical behaviour and of problematic eating behaviour in every one of the FBC subcategories (selective eating, rigid/perseverant eating behaviour and selectivity in terms of texture). No significant correlations were found between abnormal language and pathological eating behaviour in children with ASC. Correlation analysis also revealed an association between higher levels of sensory processing problems and greater behavioural, emotional, social and communication problems in children with ASC (See Table 4.8

4.5.6 Results of cluster analysis

A two Step Cluster analysis was used in order to divide the sample (including children with ASC and control children) into three clusters (1) high sensory processing problems-high/greater problematic eating behaviour (2) moderate sensory processing problems-moderate problematic eating behaviour, and (3) low sensory problems-low problematic eating behaviour. Cluster analysis was used to identify homogenous groups of cases. In this way, the social-communication and behavioural performance of children with high, moderate and low severity difficulties in sensory processing and eating could be further explored.

Grouping children in this way allowed an insight into the distribution of children with high/moderate/low sensory sensitivity and problematic eating according to their behavioural, social and communicational profile. The distribution of the sample based on their behavioural, social and communicational skills can be observed in table 4.9.

Table 4.9 Scores in FBC, SSP, SDQ and SCQ across the three performance clusters

	Cluster 1 High N=37	Cluster 2 Moderate N=97	Cluster 3 Low N=117
Mean overall FBC score	133.08 (15.92)	106.51 (16.45)	61.09 (14.58)
Mean overall SSP score	34.81 (6.72)	56.67 (7.83)	72.21 (5.50)
	Cluster 1 High N=37*	Cluster 2 Moderate N=92*	Cluster 3 Low N=114*
Mean overall SDQ score	24.84 (5.76)	16.29 (7.35)	8.30 (6.36)
Mean overall SCQ score	24.88 (7.34)	13.92 (9.13)	5.61 (5.83)

**Missing data and data collected from children younger than 4 years were not included in the final analysis of SDQ and SCQ*

From the cluster analysis it can be observed that the most pathological FBC and SSP scores (Cluster 1) were linked with more problematic scores in terms of behavioural and emotional performance (SDQ) and with greater difficulty in terms of social and communication skills (SCQ). A scatterplot was drawn in order to better observe how the children in the three clusters were distributed in terms of their scores in SDQ and SCQ (See Figure 4.2).

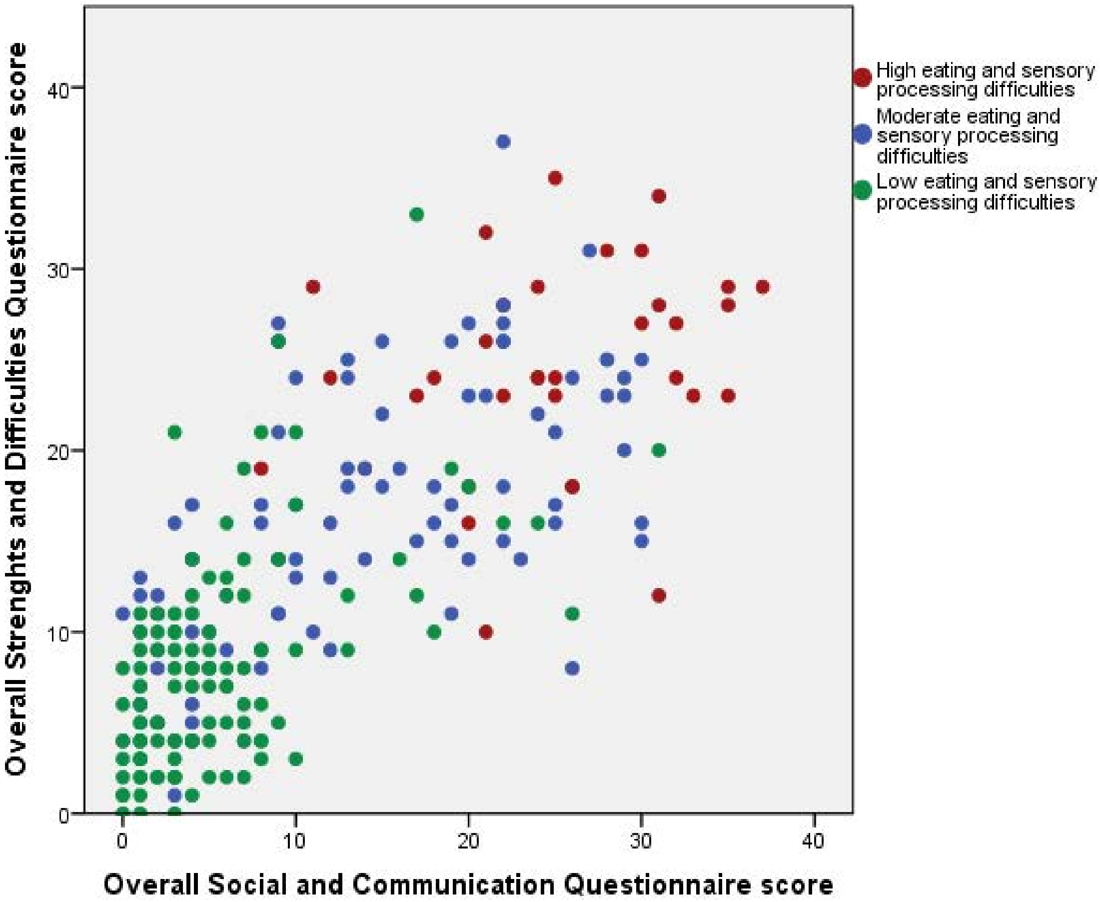


Figure 4.2 Scatterplot depicting the performance of the three sample clusters in terms of their behavioural, social and communicational skills

In the scatterplot it can be observed that children from cluster 3 are mainly gathered in the area of low SDQ and SCQ scores, children from cluster 1 mostly occupy the area of highest scores in both SDQ and SCQ, whereas children from cluster 2 are sparsely distributed among higher and lower SDC and SDQ scores.

4.6 Discussion

The present study aimed to explore the associations between sensory processing, social-communication and behavioural performance with eating behaviour in children with and without ASC. It was expected that children with ASC would present with a more problematic profile in terms of their eating behaviour and would present with higher sensory sensitivity. Given the nature of the ASC symptomatology, intrinsically connected problems such as social-communicational and behavioural problems were expected to be significantly more prevalent in children with ASC. It was also hypothesised that children with ASC would be more likely to be in the groups of *definite difference* in terms of visual/auditory, tactile and taste/smell sensitivity performance. Furthermore, it was expected that children from the *definite difference* sensory performance groups across the sample would present with greater problems in terms of their eating behaviour. Moreover, a positive correlation was expected to be found between behavioural and eating problems. The study also aimed to explore whether higher sensory sensitivity may correlate with greater problems in terms of social, communication and behaviour.

The findings of this study strongly supported these hypotheses. Children with ASC were found to be significantly more eating selective, rigid/perseverant in terms of eating and also showed greater selectivity in terms of texture than the control children of the sample. As expected, possibly due to ASC symptomatology, children with ASC presented with significantly more problematic social-communication and behavioural profile than did the control group. The hypothesis that children with ASC would be significantly more likely to present with a *definite difference* in terms of their performance in the three sensory modalities was confirmed, as more than half of the children of the ASC group belonged to the *definite difference* performance groups in all three of the sensory modalities. Additionally, the hypothesis that there would be a strong correlation between behavioural and eating problems was proven, as higher SDQ scores were significantly correlated with more problematic eating behaviour (FBC overall and subcategories score) in both groups. Similarly, a strong association was found between greater sensory sensitivity (SSP overall and subcategories score) and greater social and communication problems (higher overall SCQ score).

4.6.1 Sensory processing and eating behaviour in children with ASC and controls

The sample was divided into sensory performance groups in order to explore any differences in the three FBC categories between children with and without ASC in the three sensory performance groups (*typical, probable and definite difference*). When control group children and children with ASC were categorised into groups of similar sensory processing performance, it was observed that children with ASC still presented with a more problematic eating profile, suggesting that there were some other factors (which will be discussed later) contributing to a more problematic eating performance.

4.6.2 Eating selectivity

From the children from the *typical performance* and the *definite difference* group for visual/auditory sensitivity, children with ASC were significantly more selective in terms of eating. These findings suggest that even when children with and without ASC were categorised in terms of their visually/ auditory performance, the children with ASC with the most and least visual/ auditory processing problems will present with significantly more eating selectivity.

The most tactile sensitive (*probable, definite difference*) children (from ASC and control group) showed no significant differences in terms of their eating selectivity. However, in the *typical* tactile performance category, children with ASC significantly stood out in terms of their eating selectivity behaviour. The data were very similar in terms of taste/smell sensitivity in this group, as children with ASC with *typical* tactile and taste-smell processing were still significantly more selective than the control children with *typical* tactile and taste-smell processing. These findings suggest that even when tactile or taste/smell processing is not a problem there may be other reasons causing children with ASC to be more selective in terms of eating.

4.6.3 Rigid perseverant eating

Children with ASC in the *typical* and *definite difference* visual/auditory groups were found to be significantly more rigid and perseverant in terms of their eating in comparison to the control group who fell into these categories. However, only children with ASC with *typical* performance in tactile processing were significantly more rigid/perseverant in their eating than the control children. In the *definite difference* taste and smell category, children with ASC presented as significantly more rigid in terms of their eating in comparison to the control group. If the sensory processing performance was the only factor contributing to rigid and perseverant eating, there would be no statistically significant differences between the two diagnostic groups across the different performance categories. It can therefore be suggested that when visual/auditory or tactile performance was typical there were other reasons linked to ASC, which were causing children with ASC to be more rigid in terms of their eating behaviour. Additionally, the findings suggest that a more problematic performance (*probable, definite difference*) in visual/auditory and taste/smell processing, had a significantly more negative impact on the existence of rigid perseverant eating behaviour in children with ASC than in the control group

4.6.4 Selectivity in terms of texture

Children with ASC were significantly more texture selective than typically developing children, no matter their visual/auditory sensory performance group. Children with ASC in the *definite* (68.3%) and *typical* (24.8%) tactile performance groups were still more texture selective than the control group with these classifications. Given that only 6.9% of the children with ASC were in the probable performance group it may explain why no significant differences were noticed in texture selectivity between the control group and children with ASC in this performance group. Or it could be that sensory difficulties in visual/auditory, taste/smell sensitivity had a more negative impact on the existence of texture selectivity in children with ASC in comparison to the control group.

4.6.5 Correlations between FBC scores and sensory sensitivity

As was expected, a negative correlation was observed between the overall scores of SSP and FBC in both the control group and children with ASC. In line with this, strong negative correlations were noticed between each of the FBC subcategories and the SSP subcategories in both groups (See Figures 4.3 and 4.4), suggesting that more highly sensory sensitive children presented with more problematic eating behaviour no matter which diagnostic group they belonged to. However, as observed in the relevant scatterplot (See Figure 4.1), less problematic scores in terms of FBC and SSP in the ASC group were still more problematic that the counterpart scores of the control group.

4.6.6 Social-communication and behavioural problems and eating behaviour in children with and without ASC

Although there have been some indications that eating problems may co-exist with difficulties in behaviour and/or social and communication skills (Twachtman-Reilly, Amaral & Zebrowski, 2008),there has been very little research examining the behavioural, social and communication characteristics of children with eating and sensory problems;.

This current study was among the first to present a link between social and communication difficulties and a more problematic eating profile in both children with and without ASC. In the control group greater problems in social interaction, language and stereotyped behaviour were linked with greater problems in all three FBC sub-categories, while greater communication problems were correlated with greater texture selectivity (See Figure 4.3 below). These findings suggest that social and communication problems may also co-exist with eating problems even in typically developing children.

In children with ASC greater problems in social interaction and communication were linked to greater problems in all the three FBC sub-categories, suggesting that children with ASC with greater social-communication problems also present with greater eating problems. Additionally, it was found that more stereotyped behaviour linked to higher eating selectivity and greater rigid/perseverant eating behaviour, also suggesting that greater stereotypic behaviour co-exists with a more rigid and selective eating profile. These findings could possibly shape the hypotheses of future research looking into both social-communicational problems and eating behaviour in the ASC population.

Few differences were noticed between the diagnostic groups. Therefore more research is needed to specifically explore social and communication skills and eating behaviour in children with ASC and in typically developing children. Future research could provide explanations for why communication problems were only linked with greater texture selectivity in the control group, and why stereotyped behaviour was only significantly linked with greater eating selectivity and rigidness in terms of eating and not with texture selectivity in the ASC group.

4.6.7 Social-communication problems and sensory sensitivity in children with and without ASC

Previous research has suggested that sensory sensitivity may co-exist with difficulties in social behaviour both in children with and without ASC (Hilton et al. 2010). The present study sheds more light on the nature of the social and communication problems that are correlated with visual/auditory, tactile and smell/taste sensitivity. The findings revealed a strong positive correlation between greater problematic social interaction, as well as stereotyped behaviour, and higher tactile and taste/smell sensitivity in both children with and without ASC (See Figures 4.5 and 4.6). Although greater communicational problems were linked with higher sensitivity across the three sensory processing modalities in children with ASC, in control group children, higher taste/smell sensitivity was only linked with greater communicational problems (See Figure 4.5 below).

Previous research had suggested a possible link between behavioural problems and a more problematic eating profile (Blissett, Meyer & Haycraft, 2011). The results of this study took the findings of this research further by suggesting a connection between behavioural/emotional problems (as measured by SDQ) and a more problematic eating and sensory profile in both diagnostic groups.

However, it is believed that the relationship between problematic eating behaviour and social-communicational difficulties, as well as behavioural/ emotional problems, is just a correlation, not a causation. It is possible that the existence of eating problems is related to one or more variables, e.g. sensory processing difficulties, which would also account for the communication difficulties and/or neurodevelopmental disorder especially in the case of children with ASC. Finally, it could be that in children from both groups who present with greater eating and sensory processing problems, an overall more problematic profile in terms of social and communication skills is also more prevalent.

4.6.8 Strengths and limitations

An electronic questionnaire was used as a recruitment method to ensure that data from a wide ethnic and cultural background were collected. Consequently, a formal screening (e.g. ADOS-II, Lord, Rutter, DiLavore, Risi, Gotham, & Bishop, 2012), that would demand the physical presence of the children could not be included. This could be considered as one of the limitations of this study, as the data base had to rely upon the parents reporting their child's diagnosis. Another limitation of the study is that the SSP could perhaps have been used in addition to another sensory processing measure e.g. the Sensory Eating Checklist (SEC; modified from the Eating Checklist Yack, Sutton & Aquilla, 2003) as this would provide a better insight into sensory responses mainly during mealtimes. The use of a three point Likert scale was another limitation, as the limited range of answers may have prevented the observation of subtle differences and could possibly explain the results of non-statistical significance (e.g. in terms of willingness to try the vegetable options in task1).

Nonetheless, this study is a valuable addition to the small number of studies investigating sensory processing differences and eating behaviour. It advances the research in this field some steps further by comparing how differences in sensory processing affect mealtime behaviour in a large sample (N=254) of a wide age range (2-14 years) of children. Secondly, this study offers an innovative perspective as it describes the social-communication and behavioural profile of children with sensory and eating problems.

4.7 Conclusion

Overall, the findings of this study suggest that eating problems co-exist with sensory problems both in children with and without ASC. It was observed that although factors contributing to problematic eating behaviour show similar patterns in relation to the studied variables (SSP and SCQ) in both groups, children with ASC still present with a more problematic profile in terms of eating and sensory sensitivity. Finally, in the children from the sample with a more problematic eating and sensory profile, greater social-communication and behavioural problems also co-exist.

Figure 4.3 Associations in the eating behaviour of typically developing children

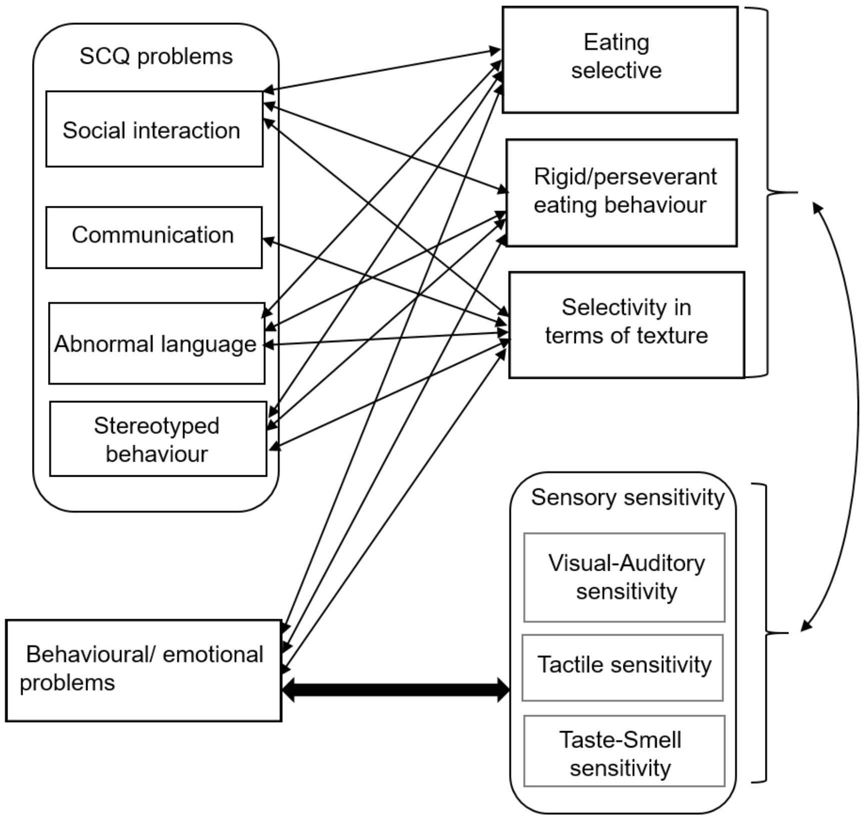


Figure 4.4 Associations in the eating behaviour of children with ASC

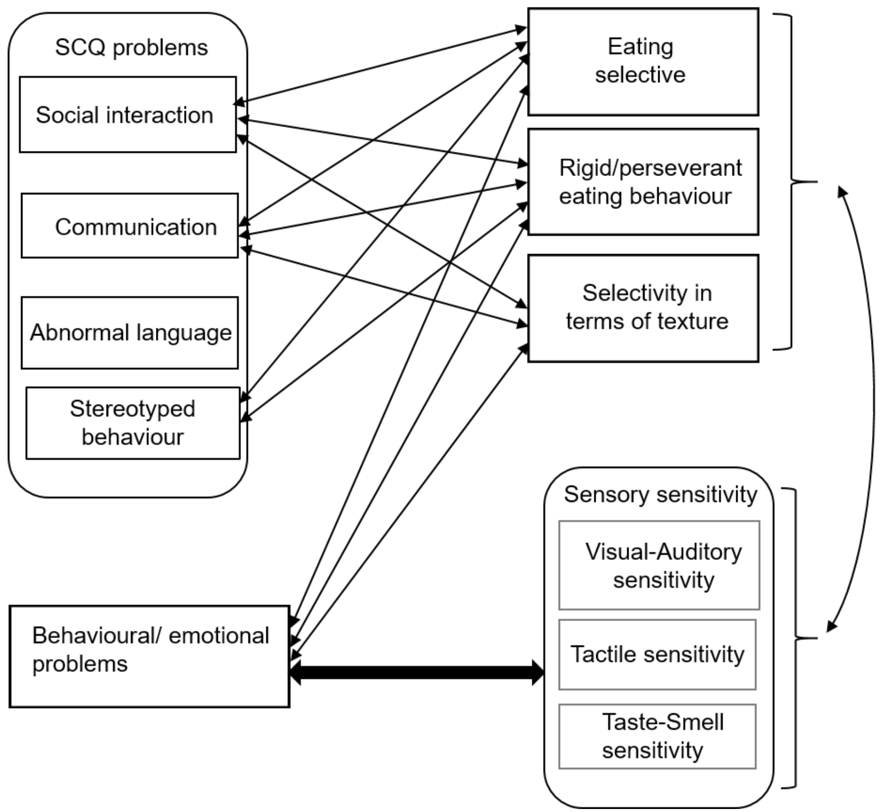


Figure 4.3 and Figure 4.4 illustrate the associations between the studied types of eating behaviour with the performance score SCQ and subcategories, SSP and subcategories and the overall SDQ score (Behavioural/emotional problems) for children from the control group (left) and for children with ASC (right).

Figure 4.5 SCQ problems and sensory sensitivity in typically developing children

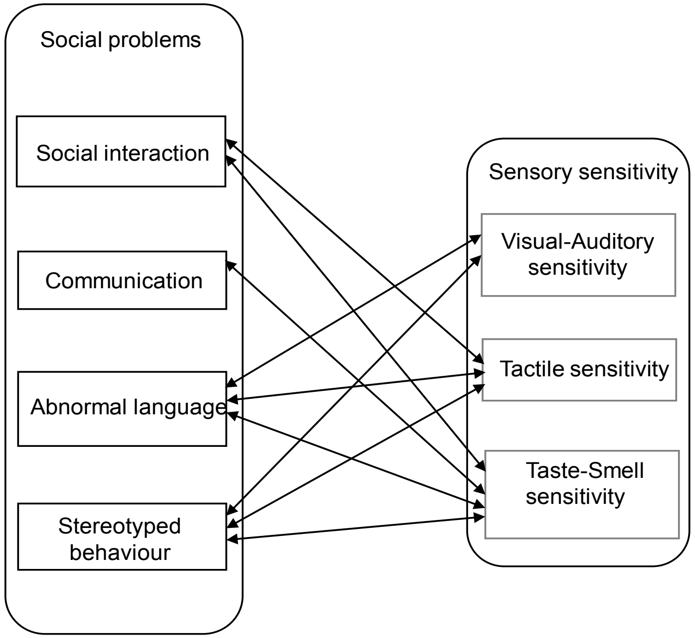


Figure 4.6 SCQ problems and sensory sensitivity in children with ASC

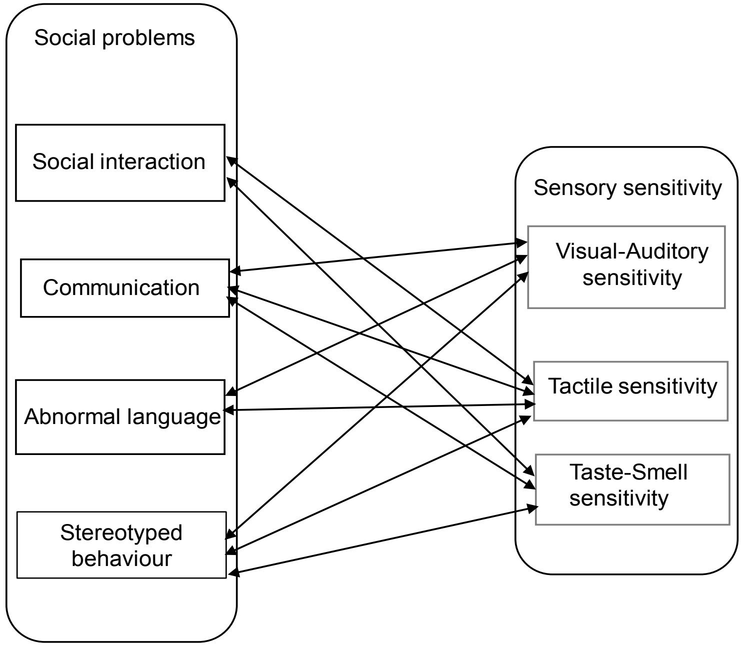


Figure 4.5 and Figure 4.6 illustrate the associations between the studied types of eating behaviour with the performance score SCQ and subcategories, SSP and subcategories and the overall SDQ score (Behavioural/emotional problems) for children from the control group (left) and for children with ASC (right).

CHAPTER 5

THE EFFECT OF FOOD NEOPHOBIA AND SENSORY PROCESSING ON THE WILLINGNESS TO TRY VEGETABLES IN PRE-SCHOOLERS

5.1 Abstract

Vegetables regularly feature among children's least preferred foods. Food neophobia has been identified among the factors negatively affecting vegetable consumption. However, there is a gap in research on how factors such as food neophobia, sensory sensitivity, liking in terms of taste, or familiarity in terms of texture affect willingness to try vegetables. The present study looked into children's willingness to try two sets of vegetable options. The first set included a familiar vegetable of a liked taste offered in an unfamiliar texture and a disliked vegetable presented in a familiar texture. The second set consisted of three options of the same commonly eaten raw vegetable (raw, an alternative method of preparation, and blemished). The vegetable options offered were carefully chosen and tailored to the children's vegetable preferences. Parents of 53 children aged 3-4.5 years were asked to complete a series of questionnaires regarding their child's vegetable preferences, food neophobia, and sensory processing. The results of this study highlighted liking of taste among the most important factors positively affecting children's willingness to try vegetables. This study also showed that a blemish in appearance, in comparison to an uncommon texture, can more negatively affect willingness to try vegetables. Finally this study revealed a strong association

between the existence of food neophobia and sensory sensitivity in the children of the sample.

5.2 Introduction

Although the recommendations for fruit and vegetable intake in preschool children are not as explicit as those made for adults (five per day). A 1995 COMA report on the nutritional aspects of cardiovascular disease suggested that children should begin to eat more fruit and vegetables from the age of 2 years, so that by the time they are 5 years old they meet the target of ‘at least five a day’ (Hunty, 1995). The health benefits of a higher fruit and vegetable intake have been described in a large number of previous research studies (Graf, Reidy & Kaskel, 2016; Wengreen, Madden, Aguilar, Smits & Jones, 2013). Promoting healthy eating at an early age is therefore especially important as eating behaviour in toddlerhood shapes the eating habits in childhood, and can follow the individuals into adulthood (Kelder, Perry, Klepp & Lytle, 1994).

During the second year of life toddlers’ diets become more varied as many new solid foods are introduced to the child. At the same time young toddlers also become more mobile, which increases the risk of them consuming inedible objects or dangerous elements in their environment when they are without parental guidance (Raudenbush & Frank, 1999). Food neophobia, described as a specific distrust of unfamiliar food or fear of trying new foods, appears around this age (Harris, Blissett & Johnson, 2000; Marcontel, Laster & Johnson, 2003). The food neophobic response mainly works to prevent the ingestion of potentially toxic chemicals in toddlerhood (Birch, Gunder, Grimm-

Thomas & Laing 1998; Cashdan, 1998); it peaks at 2 years of age and may be strongly present until 4 to 6 years (Cooke, Wardle & Gibson, 2003). In some individuals it can manifest, in a milder form, into adulthood (Knaapila et al., 2015).

Children with high food neophobia levels become comfortable with eating only a limited number of foods and develop a cognitive aversion, as well as behavioural avoidance, of new or unfamiliar looking foods (Singer, Ambuel, Wade & Jaffe, 1992). As a result these children trust foods that look similar to their known food types and often follow a narrow diet mainly consisting of foods high in sugar, and a very limited variety of fruits and vegetables (Birch & Fisher 1998; Drewnowski et al., 1989; Galloway, Lee & Birch, 2003). In line with this, Cooke, Carnell and Wardle (2006), found that highly neophobic pre-schoolers have a fruit and vegetable intake 35% lower than low neophobic children.

There is growing evidence that children who present with sensory sensitivity in terms of smell, taste, colour or texture are more likely to reject fruit and vegetables with strong smells, intense colours and/or complicated textures (Dunn, 1999; Martins & Pliner, 2005). Coulthard and Blissett (2009) were among the first to explore the associations between sensory sensitivity, food neophobia and fruit and vegetable consumption. The results from this study suggest that children with lower fruit and vegetable consumption were more taste/smell sensitive and more food neophobic. Additionally, strong links were identified between tactile sensitivity, lower fruit and vegetable consumption and food neophobia. It was also found that children with higher tactile, visual and taste/smell sensitivity were also more food neophobic.

Over time children become more aware of what they like and don't like, and as a result the introduction of new foods can become more difficult (Cooke et al. 2004; Coulthard, Harris & Emmett, 2009; Harris, 2000). Observational studies have shown that during the child’s neophobic phase, the rejection of unfamiliar food typically happens before the food has been tasted, suggesting that food rejection may happen solely based on visual judgement consequently, foods that do not ‘look exactly right’ according to the child’s standards are rejected (Harris, 1993). The period between 2 and 4 years, when food neophobia is present, is a challenging time for parents to introduce new foods to their children. Therefore more research in children in this age range is needed in order to shed light on the factors affecting children's food preferences, and to inform caregivers of successful ways of introducing vegetables to this age group.

At present very little is known about how different methods of preparation can influence children’s willingness to try vegetables. Among the few studies exploring the method of preparation as a potential factor affecting the willingness to try vegetables is a study by Donadini, Fumi and Porreta, (2012). This study measured pre-schoolers’ liking for six pre-decided vegetables (tomato, carrot, spinach, fennel, zucchini and chicory) when offered raw, boiled and oven-baked. The results revealed that liking was mainly dependant on children’s personal vegetable preferences, and the way they prefer for them to be prepared.

Another study by Colas, Vaccaro, Zarini and Huffman, (2013), again with the use of a list of pre-chosen vegetables (cauliflower, bell peppers, carrots, green beans, and celery), found that cooked vegetables were preferred to raw among first grade children, with boiled being a more popular way of preparation than oven-baked. In contrast, an earlier British study revealed that children preferred raw vegetables over a softer cooked vegetable option (Stead & Goodlad, 1996).

In the present study the method of preparation was used as a tool to create a contrast between texture familiarity/unfamiliarity and perceived liked/ disliked taste. The aim was to identify whether liking of taste or familiarity in terms of texture is the strongest factor positively affecting willingness to try vegetables. Furthermore, texture variation and the presence of an artificial blemish was used in order to explore whether blemishes in the appearance or an unfamiliar way of preparation (different texture) could more negatively affect the willingness to try vegetables.

There is evidence that caregivers' eating practices can have an effect on children's eating behaviour (Branen & Flecher, 1999; Cullen et al., 2001). Research has also shown that repeated exposure to a particular food can positively influence food liking (Birch & Marlin, 1982; Sullivan & Birch, 1994) as well the willingness to try, not only this food, but also similar looking food. Based on this evidence one would expect that the vegetables children choose to eat, and the way that vegetables are prepared and offered to them vary dramatically due to factors such as culture (Dindyal & Dindyal, 2003), the eating environment (e.g. school cafeteria, home restaurant) (Dazeley, & Houston-Price, 2015) or the socio-economic status of the family (Hendrie, Coveney & Cox, 2008). Consequently, in order to explore effectively the willingness to try the vegetable options offered, previous eating preferences of the sample were collected and considered. This was in order to shape the observational part of this study, as the food offered was tailored to the vegetable preferences and eating habits of each child within the sample.

5.2.1 Aims and hypotheses

There were 3 main aims in this study. Firstly, this study aimed to examine any relationships between the existence of food neophobia and sensory sensitivity and children's vegetable preferences (the number of 'never tried', disliked vegetables and the range of vegetable preparation). It was expected that higher levels of food neophobia and sensory sensitivity would be linked with a greater number of 'never tried' and disliked vegetables, and with a more limited range of vegetable preparation. This study also intended to explore whether there is a relationship between food neophobia and sensory sensitivity. It was expected that children with higher levels of food neophobia would present with higher levels of sensory sensitivity.

The second aim was to explore which vegetable options (raw, cooked, blemished) are the most and least popular (overall and within the tasks), based on the willingness to try scores from participants. Given the controversy in previous research, it was difficult to shape a hypothesis regarding the most popular vegetable option. However, since negative aspects of appearance are perceived to link to unappealing taste or inappropriate texture (Hill, Casswell, Maskill, Jones & Wyllie, 1998; Ross, 1995), it was expected that a blemished vegetable would elicit low willingness to try.

The third aim of this study was to investigate any correlations between food neophobia and sensory sensitivity and willingness to try the vegetable options offered in this study. It was anticipated that willingness to try would be inversely related to food neophobia scores. More specifically, given that food neophobia initially develops as a protective mechanism against the consumption of unsafe food, one would expect that the more food neophobic children would be less willing to try the blemished vegetable option. In addition, higher levels of sensory sensitivity (lower SSP scores) were expected to correlate with lower willingness to try.

In summary, this study aimed to identify the visual properties of foods that can positively or negatively affect pre-schoolers' visual judgment and therefore enhance or reduce food desirability. More specifically, this study aimed to examine whether perceived liking of taste or familiar texture preferences have a greater effect on willingness to try vegetables in children aged 3-4.5 years. Finally, this study aimed to investigate whether a blemish in the appearance or an unfamiliar texture is more likely to have a negative effect on the willingness to try vegetables.

5.3 Method

5.3.1 Participants

Children aged 3-4.5 (Mean age= 3.86, SD=.46) years were recruited from local nurseries in the Birmingham area. Parents of 53 children returned consent forms and completed questionnaires to the school in a sealed envelope. The sample consisted of 25 girls and 28 boys.

5.3.2 Design

This was a cross-sectional study consisting of two research phases. During the first research phase an extended questionnaire was completed by the parents of the children.

The second phase was tailored to each of the children's vegetable preferences using the information obtained from their parents during the first phase. During the second phase children were visually exposed to a total of 5 different vegetable options in two arrays (see below). These were real food options that the children could see and smell but were not allowed to touch or consume.

The first array of vegetable options consisted of two choices. A liked vegetable prepared in an uncommon way was paired with a disliked vegetable presented in a familiar way (See Appendix C-3). This combination of vegetable choices was chosen to test whether texture or taste preferences are more likely to affect willingness to try. The second array of choices consisted of three different versions of the same vegetable (See Appendix C-4), this was to create a contrast between texture unfamiliarity and an uncommon visual appearance, and to explore which of these conditions could have a more negative effect on the willingness to try. Children were asked to rate their willingness to try each vegetable option when presented separately and then choose the vegetable option they were more likely to try from each of the two arrays of vegetables.

5.3.3 Measures

Vegetable preferences inventory (See Appendix A-11)

The vegetable preferences inventory provided detailed information regarding the parent's and their child's liked, disliked and never tried vegetables, from a list of 42 vegetables. Parents also gave information on the method of preparation in which they and their children individually ate their vegetables. Information regarding any food allergies in children was collected. If children were allergic to any vegetables, then these vegetables were excluded from the observational part of the study. Parents also filled in the same vegetable preferences inventory for themselves, in order to control for the availability of vegetables (See Appendix A-11). However, since these data were not directly related to the main aims of this study they are not included in this chapter.

The adapted Child Food Neophobia Scale (CFNS, Appendix A-2)

The questionnaire included the six-item version of the Child Food Neophobia Scale (CFNS; Pliner, 1994). This version of the CFNS has been used in previous research (Cooke et al., 2004; Cooke, Wardle & Gibson, 2003). For this study, reliability of the CFNS score as measured by Cronbach's α was 0.89.

The Short Sensory Profile (SSP, Appendix A-5)

Parents filled in the SSP (McIntosh, Miller, Shyu & Dunn, 1999) providing information regarding their child's everyday sensory experiences. The Short Sensory Profile has 7 domains but for this study only the domains of visual/auditory, tactile and smell/taste sensitivity were analysed as they are more closely related to eating experiences (Coulthard & Blissett, 2009; Smith, Roux, Naidoo & Venter, 2005).

Willingness to try food scale (Appendix A-10)

A simplified 3-point Likert scale with faces (smiling, frowning and neutral) was used in order to match with the cognitive abilities of the children and has been used in previous research studies (Birch & Sullivan, 1991; Guthrie, Rapoport & Wardle, 2000). The Likert scale was offered to the children every time a vegetable option was presented to them. Children were not given any explanation or further details of what each vegetable option was. During the introduction of the tasks the children were informed that “we are going to play a game with foods”. The children were shown the 3-point scale and were told that the “yummy” (happy) face matches with foods that they like because when we like a food we have a “yummy face”. Similarly, “the ‘yucky” (unhappy) face matches with food that we don’t like, so when we eat a food we don’t like we have a “yucky face”. For the “okay” face children were told that this is the face you might make when you eat something that doesn’t taste very “yummy” but doesn’t taste very “yucky”, “it tastes okay”. There were some trials with samples of real food during which the children and the researchers practiced allocating foods to the faces and these foods were different from the vegetable options used during their trial. “Yummy” answers were scored with 3, “okay” answers were scored with 2, and “yucky” answers were scored with 1.

5.3.4 Food stimuli

The food stimuli offered to pre-schoolers was divided into two arrays of vegetable options. The first array of vegetable options consisted of two choices; a liked vegetable presented with an unfamiliar texture preparation (LVUT). This vegetable option was paired with a disliked vegetable presented with a familiar texture preparation (DVFT) (See Appendix C-3).These vegetable options were chosen in order to investigate whether perceived taste or texture is the most determinate factor affecting the willingness to try vegetables in pre-schoolers.

The second array consisted of three vegetable options. A familiar vegetable commonly eaten raw was chosen (typically tomato or lettuce) and offered in the common raw form (RV), the same vegetable was also presented in raw form with a blemish, RBV, and in a different texture to the raw form after being cooked, (VDT) (See Appendix C-4). Vegetables were offered to the pre-schoolers in a random order.

5.3.5 Procedure

Data collection was conducted in two phases:

Phase one:

Parents provided detailed information on demographic information (e.g. age, gender allergies), and completed the CFNS, the SSP, and the vegetable preference inventory. The information collected from the vegetable preference inventory was used to form the second observational part of this study.

Phase two:

This part of the study included exposure to food and visual judgement of a willingness to try each of the five vegetable options. This phase was tailored using answers received from parents in phase one about the eating habits and vegetable preferences of their children. The two tasks of visual food exposure were:

Task 1: Disliked vegetable offered in familiar texture (DVFT) and Liked vegetable offered in unfamiliar texture (LVUT) (see Appendix C-3).

Task 2: Raw blemished vegetable (RBV), Vegetable offered in different texture (VDT), and Raw vegetable (RV) (see Appendix C-4).

Each vegetable option was presented separately and children were asked to rate their willingness to try each of them. Finally, children were asked to indicate which vegetable option looked the most appealing to them from Task 1 and Task 2 respectively.

5.3.6 Statistical analysis

SPSS version 21 statistical software was used to analyse the data. Kolmorgorov Smirnov tests and histograms indicated that the data of this study were not normally distributed ($p \leq .001$), and as a result non parametric tests were used for the analysis of the data.

Gender differences within the child sample were explored using Mann Whitney U analysis.

A two-sample paired Wilcoxon signed rank test analysis was carried out in order to explore differences in the willingness to try a liked vegetable offered in an unfamiliar texture (LVUT) and a disliked vegetable in a familiar texture (DVFT) in Task 1. A two-sample paired Wilcoxon signed rank test analysis was also carried out in order to explore differences in the willingness to try a raw vegetable (RV), raw blemished vegetable (RBV) and a vegetable of a different texture (VDT) in Task 2.

A Spearman's rank correlation analysis was run to explore the relationship between food neophobia, the Short Sensory Profile score (SSP) (including sub categories) and the overall willingness to try vegetables in Task 1 and Task 2.

5.4 Results

5.4.1 Descriptive statistics

Table 5.1 Demographic characteristics of the overall sample (N = 53)

Variables	Parent Characteristics	Child Characteristics
Gender	49 females, 4 males	25 females, 28 males
Mean age (*SD*)	36.20 (4.97) years	45.6 (5.52) years
Age range	25-44 years	38-54 years
Educational level	13.2 % Professional/Doctorate (*n*=7)	
	13.2 % Master's degree (*n=7)*	
	15.1 % Post-Graduate Qualification (*n*=8)	
	30.2% University graduate (*n*=16)	
	7.5% A-Levels (*n*=4)	
	11.3 % GCSEs (n=6)	
	3.8 % Some secondary education (*n*=2)	
	1.9 % Other (*n*=1)	
	3.8% did not mention (n=2)	
Ethnicity	50.9 % White British (*n*=27)	39.6% White British (*n*= 21)
	7.5 % Black British (*n*=4)	7.5% Black British (*n=4)*
	26.4 % Asian British (*n*=14)	26.4 % Asian British (*n=14*)
	9.8 % Mixed (*n*=2)	22.7% Mixed (*n=12*)
	7.5 % Other (*n*=4)	3.8% Other (*n=2)*

The sample consisted of 53 children (28 boys and 25 girls). The mean age (SD) of the sample was 3.8 (0.46) years and there was no significant difference in terms of the age between the boys and girls of the sample (U=245.5, p=.062). No significant gender differences were found in terms of the Child Food Neophobia Scale scores (U=332.5, Z=-.064, p=.949) or the Short Sensory Profile score of the sample (U=249.5, Z=-.156, p=.876).

Furthermore, no gender differences were noticed in terms of the vegetable preferences of the children, the boys and girls of the sample did not significantly differ in terms of ‘never tried’ vegetables (U=233.5, Z=-.673, p=.201), number of disliked vegetables (U=248.5, Z=-.353, p=.724) or the range of preparations in which they have their vegetables (U=135.5, Z=-1.210, p=.229). Therefore, gender was not further considered in the analysis.

5.4.2 Correlations between food neophobia, sensory profile and children’s previous vegetable eating experiences

A two tailed Spearman correlation analysis was run to explore the relationships between food neophobia, sensory profile score and the number of never tried vegetables, disliked vegetables and the range of preparation of vegetables (Table 5.2).

Table 5.2 Spearman correlation analysis between food neophobia, sensory profile and previous vegetable eating experiences

	Food neophobia score	Number of never tried vegetables	Number of disliked vegetables	Range of preparation of vegetables
SSP Score	-.538**	.183	-.388*	.348*
Smell-taste processing	-.598**	-.164	-.434**	.560**
Visual processing	-.053	.300*	-.065	-.135
Tactile processing	-.312*	.316*	-.199	.201
Number of never tried vegetables	307*	_	.056	-.407*
Number of disliked vegetables	.649**	.056	_	-.493**
Range of preparation of vegetables	-.704**	-.407*	-.493**	_

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

As hypothesised, food neophobia was negatively correlated with the number of different ways (range) children would have their vegetables prepared (r_s=-.704, p≤.001), and positively correlated with the number of never tried vegetables (r_s=307, p=040), as well as the number of disliked vegetables (r_s=649, p≤.001). These findings revealed that the more food neophobic children had not only tried fewer vegetables and had a larger number of vegetables they would not eat, but they also had experienced a more limited range of vegetable preparations. As hypothesised, sensory sensitivity was significantly correlated with a higher number of disliked vegetables (r_s=-.388, p=.012) and with a more limited range of preparation (r_s=.384, p=.041). Smell-taste sensitivity was significantly correlated with a higher number of disliked vegetables (r_s=-.434, p=.005) and a more limited range of vegetable preparation (r_s=.560, p≤.001). It was noted that visual/auditory (r_s=.300, p=.043) and tactile sensitivity (r_s=.316, p=.032) was significantly correlated with a lower number of ‘never tried’ vegetables.

The hypothesis suggesting a significant correlation between food neophobia and sensory sensitivity was confirmed. It was found that food neophobic children were more sensory sensitive (lower sensory profile scores indicate higher sensory sensitivity, r_s=-.538, p≤.001) and a negative correlation was also found between food neophobia scores and tactile sensitivity (r_s=-.312, p=.024) and taste/smell sensitivity (r_s=-.598, p≤.001) showing that children with higher food neophobic response were also more sensitive in these subcategories.

The ratings children gave for each vegetable option during the observation phase were compared in order to identify the most and least popular vegetable options from those offered (see Figure 5.1).

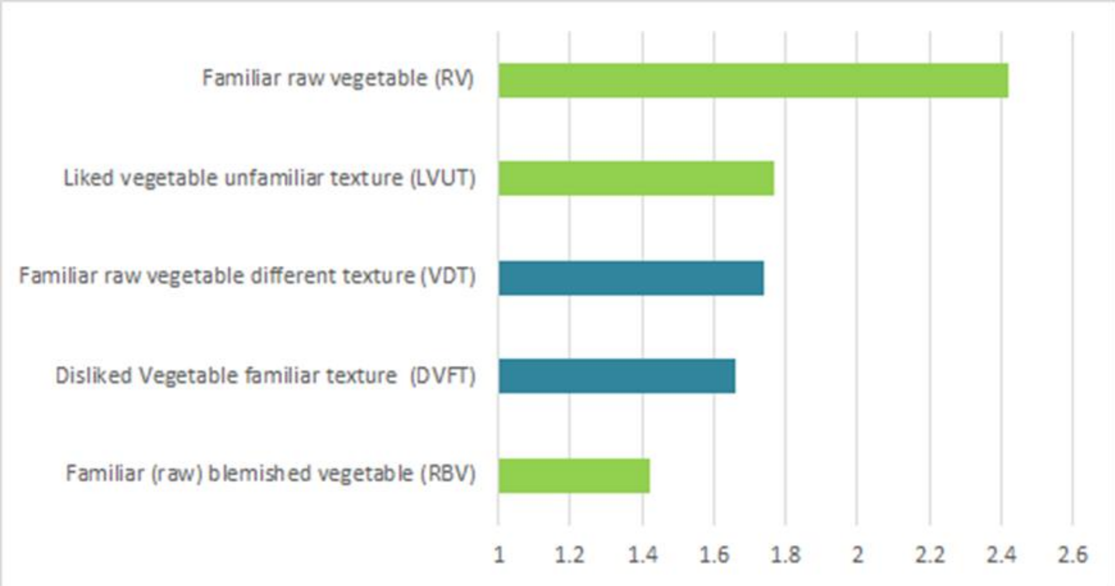


Figure 5.1 shows the ranking of all vegetable options offered in this study according to the children's mean willingness to try score.
Task 1 Task 2

As hypothesised, the raw blemished vegetable option was very low in children's preferences (mean score= 1.42, SD=0.891) and was the least preferred vegetable (see Figure 5.1).

The raw vegetable option was listed as the most popular in terms of the children's willingness to try (mean score =2.42, SD= 0.842). Second in terms of willingness to try was the liked vegetable offered in an unfamiliar texture (mean score=1.77, SD=0.891). Third in the children's willingness to try was the commonly eaten raw vegetable when offered in another texture (mean score=1.74, SD=0.902). The disliked vegetable when offered in familiar texture (mean score= 1.66, SD=0.919) was fourth in the children's willingness to try.

5.4.3 Results of the observational research phase

5.4.3.1 Results for the first array of vegetable options offered

A two related samples Wilcoxon analysis was carried out on children's willingness to try each vegetable option. The results showed that the willingness to try the LVUT (1.77, SD=.891) was significantly higher than the willingness to try the DVFT (mean score =1.66, SD=.919). When children were asked to indicate which of the two vegetable options they would try, 29 of the children (54.7%) were more willing to try the LVUT in contrast to the 24 (45.3%) children who were more willing to try the DVFT. However, a Wilcoxon two related samples analysis showed that these findings were not of statistical significance (Z=-.793, p=.428, See Appendix B-4).

5.4.3.2 Willingness to try DVFT, LVUT and CFNS & SSP scores

Two tailed Spearman correlation analyses showed no significant correlations between the willingness to try the vegetable options DVFT, LVUT and the scores on the CFNS and SSP and with most sensory sub scales. However, a significant correlation was found between higher taste/smell sensitivity and a greater willingness to try the LVUT (r_s=-.299, p=.044).

5.4.3.3 Results for the second array of vegetable options offered

In this array of vegetables a commonly eaten raw vegetable (RV) was also presented in an unfamiliar way of preparation (vegetable in different texture, VDT) and the raw vegetable was offered raw and blemished (RBV). A Wilcoxon two related samples analysis was run to compare children's willingness to try the vegetable options paired in groups, namely RBV and VDT, VDT and RV and finally RBV and RV. Willingness to try scores for each condition can be seen in Table 5.3.

Table 5.3 Children's mean score of willingness to try the vegetable options offered in Task 2

Willingness to try vegetable options in Task 2	**Raw blemished vegetable (RBV)**	**Vegetable offered in different texture (VDT)**	**Vegetable offered raw (RV)**
	Mean (SD)	Mean (SD)	Mean (SD)
	1.42 (0.77)	1.74 (0.90)	2.42 (0.84)

As hypothesised, Wilcoxon analyses showed that children's willingness to try the RV was higher than their willingness to try the RBV ($Z=-3.987$, $p \leq .001$). Children's willingness to try the VDT vegetable option was significantly higher than their willingness to try the RBV vegetable option ($Z= -2.322$, $p=.020$). Children were significantly less willing to try the VDT option than the RV ($Z= -3.987$, $p \leq .001$).

When children were asked to choose which of the three vegetable options they would try, 37 (69.8%) children chose the RV option, while 12 (22.6%) children found the VDT option more appealing and only 4 (7.5%) children chose the RBV option. Non parametric Chi-square analysis showed that this finding was statistically significant ($\chi^2(2)= 33.547$, $p \leq .001$).

5.4.3.4 Correlations between the willingness to try vegetable options RBV, VDT, RV and CFNS, SSP and total range of preparation

No significant correlation was found between the willingness to try any of the second array of vegetable options with the CFNS, SSP scores and the total range of vegetable preparation reported by parents (See Table 5.4).

Table 5.4 Correlations between willingness to try the vegetable options offered in Task 2 with CFNS, SSP and the total range of vegetable preparation

Willingness to try	Child Food neophobia score (CFNS)	Short Sensory Profile Score(SSP)	Range of preparation of vegetables
Raw blemished vegetable (RBV)	.100	.198	-.023
Vegetable offered in different texture (VDT)	.125	.199	-.128
Raw vegetable (RV)	-.121	.222	.161

Finally, there was no significant correlation between the willingness to try any of the second array of vegetable options and the subcategories of the SSP (See Table 5.5).

Table 5.5 Correlations of willingness to try vegetable options RBV, VDT, RV and three Sensory Profile subcategories

Willingness to try	Smell/ taste	Visual processing	Touch processing
Raw blemished vegetable (RBV)	.065	.193	.084
Vegetable offered in different texture (VDT)	.108	.108	.204
Raw vegetable (RV)	.124	.208	.256

5.5 Discussion

The present study aimed to collect information on various factors affecting the willingness to try vegetables in pre-school children. It was hypothesised that higher levels of food neophobia and sensory sensitivity would be linked with a higher number of 'never tried' vegetables and disliked vegetables, as well as a narrower range of vegetable preparation. Based on previous evidence (Coulthard & Blissett, 2009), it was also hypothesised that food neophobia would be significantly correlated with the presence of high sensory sensitivity ratings. The present study aimed to identify the most popular vegetable options offered and explored any associations between food neophobia, sensory sensitivity and the willingness to try the vegetable options. Finally, this study explored whether perceived taste or appearance was the most determinate factor affecting the willingness to try vegetables (Task 1) and whether a blemish in the appearance or an unfamiliar texture would more negatively affect pre-schoolers' willingness to try vegetables (Task 2).

As expected food neophobia and sensory sensitivity were linked with a higher number of 'never tried' and disliked vegetables, as well as with a more restricted range of vegetable preparation. Similarly, and in agreement with the hypothesis, it was found that the existence of higher levels of food neophobia were strongly associated with the existence of greater sensory sensitivity. Although the data regarding children's willingness to try the vegetable options revealed some very interesting findings, no associations were found between food neophobia or sensory sensitivity and children's ratings of how willing they were to try the options offered.

5.5.1 Links between food neophobia, sensory sensitivity and vegetable preferences

In line with the hypothesis, a strong correlation was found between food neophobia and the number of 'never tried' and disliked vegetables. This finding revealed that the more food neophobic children had tried fewer vegetables overall, while the number of vegetables they disliked was also higher. Another interesting finding of this study was that higher levels of food neophobia were linked with a narrower variety of ways that children would have their vegetables prepared. This strong correlation indicates that food neophobia is associated with a more rigid eating behaviour that may include an insistence on having food prepared only in certain ways. However, it could be that parents of more food neophobic children offer food to the children in a more limited range of preparation and this contributes to their conservatism.

This study also provided a unique insight into how sensory sensitivity interacts with vegetable eating preferences. In the present study a strong link was observed between higher sensory sensitivity and a higher number of disliked vegetables, along with a more restricted range of vegetable preparation. These findings suggest that children who were more sensory sensitive, and more specifically, as further analysis showed, children with higher taste and smell sensitivity were more selective in terms of their vegetable choices and also followed a more restricted diet in terms of vegetable preparation. However, contrary to expectations, this study found a strong correlation between less problematic visual and tactile processing and a higher number of never tried vegetables. As this is the first study to investigate the joint impact of sensory sensitivity (including the SSP categories) and the number of never tried vegetables, more research is needed to provide an explanation for these findings.

This study is among the first to suggest that smell/taste sensitivity and food neophobia are factors which not only compromise the types of foods accepted but also the variability in the ways individuals prefer their food to be prepared. Additionally, as it was expected, this study replicated the findings of previous research (Coulthard & Blissett, 2009)), which suggested that a higher food neophobic response often co-exists with greater sensory sensitivity. More specifically it was found that greater food neophobia levels in the sample were linked with higher levels of tactile and taste/smell sensitivity.

5.5.2 Most popular vegetable options, food neophobia and sensory sensitivity

The main aim of the present study was to investigate whether perceived taste or appearance is the most determinate factor affecting the willingness to try vegetables. Additionally, this study explored whether a blemish in the appearance or an unfamiliar texture can more negatively affect pre-schoolers' willingness to try vegetables.

Regarding the most popular vegetable options, the results from Task 1 suggested that children were more willing to try a vegetable of a liked taste even if offered in an unfamiliar texture. While in Task 2, a blemish in the appearance was a significantly more negative factor affecting willingness to try than an unfamiliar texture.

Although it was hypothesised that food neophobia would negatively affect the willingness to try all of the vegetable options, the results of the study did not support this hypothesis. A possible explanation for this could be that children in the age range of the sample are still developing their knowledge and experiences with food, including where a food comes from or whether they have tried it before. Consequently, it is possible that categorisation of foods as familiar or unfamiliar, or recognition of specific food items, is less sophisticated at this age.

The results also did not confirm the hypothesis that higher sensory sensitivity would be associated with lower willingness to try the vegetable options offered. However, a significant correlation was found between higher taste/smell sensitivity and a greater willingness to try the LVUT (p=.044). This finding indicates that children with a greater taste/ smell sensitivity would be more likely to try a vegetable with a liked taste, even if the texture it is presented in is not commonly encountered, and suggests that the rejection of food on sight by sensory sensitive children could be texture related.

Given that in its development, food neophobia functions as a protective mechanism against the consumption of unsafe food (Raudenbush & Frank, 1999), one would expect that children with higher food neophobia levels would perceive the RBV as a less safe vegetable option. However, the current findings did not reveal any significant negative correlation between food neophobia and the willingness to try the RBV. A possible explanation is that the way food neophobia affects food choices may alter with age. Perhaps food neophobia at the age range of our sample has stoped functioning as a protective mechanism against negative aspects of appearance such as spots and blemishes. Also given that children's options to rate willingness to try only ranged from 1 to 3, with the mean score being 1.42 (SD=0.891), this limited scale possibly did not permit more results of statistical significance.

For Task 2 it was difficult to shape a hypothesis regarding which vegetable option would be the most popular among children due to the controversy in previous research (Colas, Vaccaro, Zarini & Huffman, 2013; Stead & Goodlad, 1996). However, it was expected that the 'blemished' version would score lower in children's willingness to try. The findings confirmed this hypothesis, as the RBV was the lowest in terms of the children's willingness to try. The data also showed that the raw vegetable was significantly more preferable, scoring higher in comparison to the other two vegetables, including the cooked (RBV) vegetable option. A possible explanation for this is that the RV was actually the most commonly encountered, and therefore most trusted of the vegetable options.

One aim of this study was to identify which factors affect vegetable preferences in pre-schoolers. The data showed that the liking of the taste of a vegetable is the most important factor, and secondly that the preparation familiarity of a trusted vegetable option can positively affect willingness to try. Combining the findings of the present study with previously suggested viewpoints (Maier, Chabanet, Schaal, Issanchou & Leathwood, 2007), we could say that early exposure to a wider range of vegetables is crucial, as this will increase the chances that children will like, or at least accept more vegetables. Carers should try to ensure that the child has had plenty of experiences with a variety of foods before pre-school age. If carers then want to increase the variety of vegetables in their children's diet they can start by introducing already liked vegetables in uncommon ways of preparation. This may lead children to become more adventurous with their food and to adopt a more positive approach to vegetables of an unfamiliar look or texture, or even novel vegetables.

On the other hand, disliked (or less preferred) vegetables should be offered in a familiar way of preparation as this will limit the new sensory characteristics of the food and in the long term children, after continued exposure (Birch, 1999), may get used to the look of this vegetable option and possibly start feeling that it is safe to start consuming it (sensory desensitization). In addition to this, the finding that there were no statistically significant differences between the willingness to try the LVUT and the DVFT possibly suggests that children in this early age may not have a clear idea of where each vegetable options comes from (e.g. carrot mashed is comprised of the same vegetable they are used to eating boiled) or whether they had tried this food option before. Therefore the chances of children accepting a DVFT might be higher at this age than perhaps later in life.

Finally, the finding that RBV was the least preferred highlights the common observation that bruised fruits and vegetables, or those that look different from the 'uniform' look (e.g. has spots) usually get rejected (Ross, 1995; Hill, Casswell, Maskill, Jones & Wyllie, 1998). In addition, this proves that blemishes, even in the appearance of liked food options, get readily noticed by children of 3-4.5 years and can negatively affect their willingness to try.

5.5.3 Summary and limitations

The vast majority of previous research studies looking at vegetable preferences has mainly been based on questionnaires or interviews completed by parents, while the food stimuli used were either photographs of food or a limited variety of food (e.g. pre-chosen list of vegetables), without taking into consideration the children's already existing individual eating preferences. One of the biggest advantages of the current research study was that the observational part was tailored using the eating information provided by parents in advance. In this way, previous eating experiences and vegetable preferences were considered for each child.

Nevertheless, there were some shortcomings in the design of this study. As every task had been tailored to each participant, this may have created more ‘noise’ in the data and might be one of the reasons why no statistically discernible differences were noticed between the willingness to try DVFT and LVUT.

Given that the results suggested no significant correlation between food neophobia and the willingness to try the vegetable options offered in this study, future research could benefit from using a sample of an older age, as this will ensure better understanding of the testing procedure. Moreover, as the sample did not try the food, the willingness to try ratings may only demonstrate eating intention and may not necessary translate into eating behaviour in practice.

An older sample will also permit the use of a broader rating scale (a Likert scale of more than three points) that will match their cognitive development and may possibly lead to more subtle differences in the results. Furthermore, given that there was no significant correlation between sensory sensitivity and willingness to try the vegetable options offered in this study, it may well be worth replacing this tool with another, e.g. the Sensory Eating Checklist (SEC; Yack, Sutton & Aquilla 2003) which may describe sensory behaviour from a more eating focused perspective.

Given that both cooked and raw food was used, a future study following a similar research design should control for the olfactory characteristics of the food.

In this way children will not have information regarding the smell of the food and their choice would be solely based on visual judgement.

Despite these limitations, overall, this study provides valuable observational evidence for the factors affecting willingness to try vegetables in children aged 3-4.5 years. The results of this study highlight how important the liking of a known taste is for children in this age group. It also shows that a blemish in the appearance of a food is a stronger factor negatively affecting willingness to try than the same vegetable presented in an uncommon texture. Finally, this study identifies the importance of previous eating experiences as a predictor of current eating behaviour.

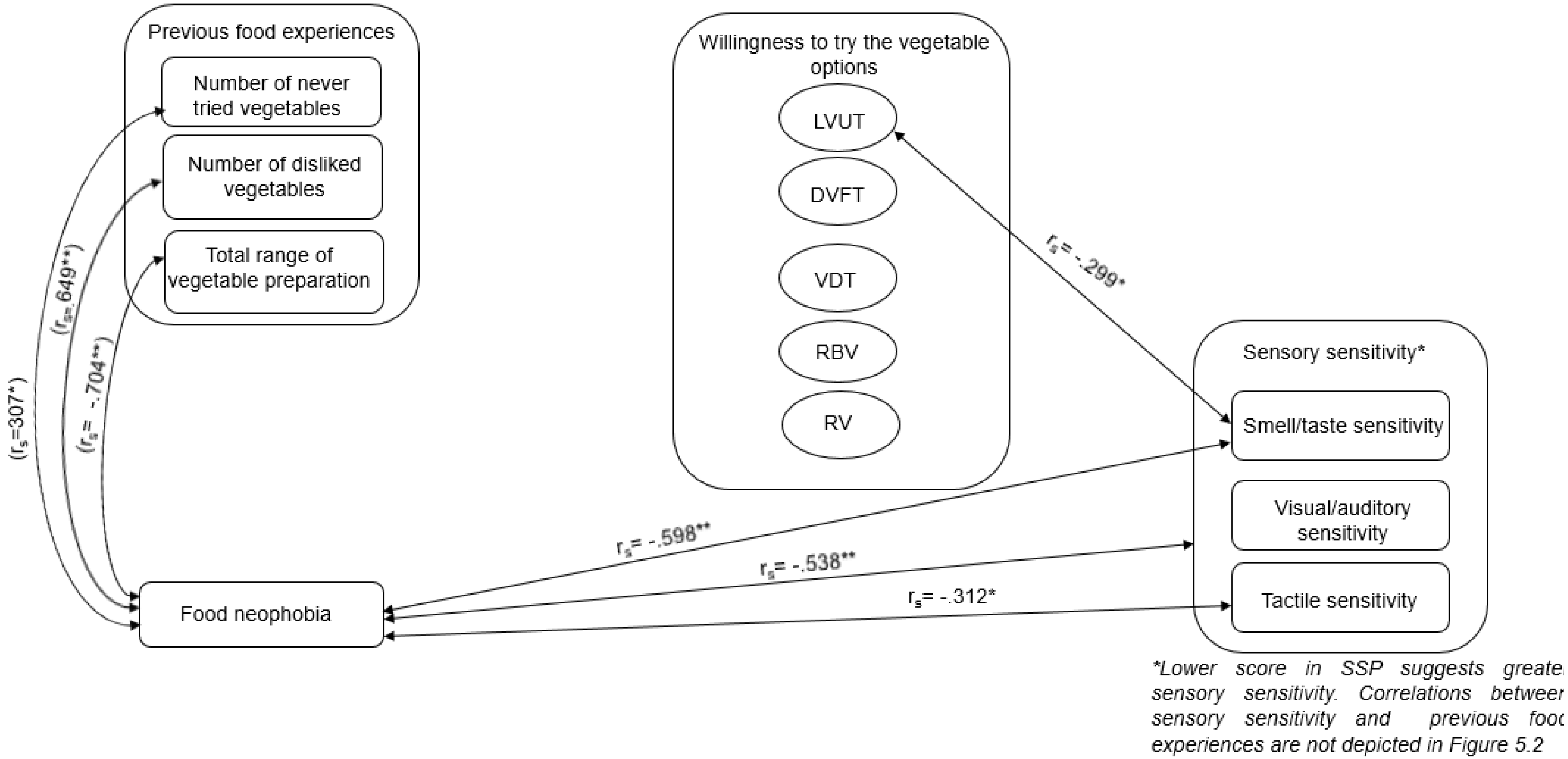


Figure 5.2 The proposed model of the associations affecting willingness to try the food stimuli

CHAPTER 6

THE EFFECT OF FOOD NEOPHOBIA, SENSORY PROCESSING AND AUTISTIC TRAITS ON THE WILLINGNESS TO TRY VEGETABLES IN YOUNG ADULTS

6.1 Abstract

Individuals with higher food neophobia scores tend to present with a lower fruit and vegetable intake. However, very little is known about how sensory processing, and the presence of autistic traits interact with food neophobia and the role these factors play in adults' vegetable preferences. The present study aimed to explore how these factors affect willingness to try vegetables in seventy seven adults aged 17-35 years. Participants were exposed to two arrays of vegetable options. The vegetable options offered were carefully chosen and tailored to each participant's vegetable preferences. One of the aims of this study was to identify whether liking in terms of known or perceived taste, or familiarity in terms texture, is the stronger factor positively affecting adult's willingness to try vegetables. It also examined whether a blemish in appearance or an unfamiliar method of preparation can more negatively affect adult's willingness to try. A strong correlation was found between higher food neophobia and taste-smell sensitivity. Food neophobia was also identified as a negative correlate for trying a commonly eaten raw vegetable when offered in another texture. Higher taste-smell sensitivity was seen to negatively interfere with the willingness to try a liked vegetable when offered in an unfamiliar texture. Autistic traits were identified as an important

correlate of vegetable choices even in a highly functioning adult sample. Finally, results from this study suggest that previous experience of eating a wide range of vegetables facilitates willingness to try other vegetable options which vary both in terms of appearance and texture.

6.2 Introduction

Food neophobia is believed to start as a protective mechanism which emerges when toddlers become more mobile, preventing them from eating dangerous food or inedible objects (Pelchat & Pliner, 1986; Schulze & Watson, 1995). This personality trait appears around the age of 20 months and peaks between two and five years (Cashdan, 1994; Cashdan, 1998; Pliner, 1994). However, recent evidence suggests that if food neophobia has not been resolved during childhood it might persist into adulthood (Knaapila et al., 2015). Food neophobic children often follow a restricted diet consisting solely of familiar, and those identified as “safe”, foods. Typically these are ‘unhealthy’ foods and this diet is highly likely to be sustained into adulthood (Kelder, Perry, Klepp & Lytle, 1994). As a result, adults who have been food neophobic as children may have developed a particular mistrust of new types of food and may continue to avoid foods that they have not been introduced to before (Stein, Nagai, Nakagawa, Beauchamp, 2003).

There is some controversy in the literature regarding whether gender can have an effect on the levels of food neophobia in adult individuals. Two Scandinavian studies looking into gender differences in food neophobia reported that male participants were more food neophobic than females (Hursti and Sjoden, 1997; Koivisto, Sjoden, 1996; Tuorila, Lähteenmäki, Pohjalainen & Lotti, 2001). However, two other studies did not find any significant differences in neophobia levels between adult males and females (Knaapila, et al., 2015; Pliner & Hobden, 1992).

Texture has been identified as one of the most dominant factors affecting food choices (Smith, Roux, Naidoo & Venter, 2005). In addition, it has been suggested that refusal based on texture may be linked with oral sensory sensitivity (Dunn, 1999; Smith, Roux, Naidoo & Venter, 2005). What has not been investigated is whether similarity to a familiar food in terms of texture is a more important factor than known taste in determining whether a new food will be accepted (Werthman et al., 2015).

Adults and children can make assumptions about the texture of a food without tasting it and therefore individuals who are more sensitive or reactive to the appearance of a food may be less willing to taste a food that differs in appearance from a known safe food. This sensitivity could be due to the visual or perceived textural (tactile) differences between known and novel foods. Coulthard and Blissett (2009) found that higher tactile, visual and taste/smell sensitivity scored by the Dunn Short Sensory Profile (SSP, Dunn, 1999) was positively associated with food neophobia in children aged 2-5 years .However there has been very little relevant research in an adult population exploring any associations between sensory processing and the willingness to try foods that look different, or have a different texture to that which is usually accepted. It is therefore important to investigate whether variation in presentation, or in texture, more strongly affects adults' willingness to try a food. It is also of interest to explore whether adults who score higher on measures of sensory sensitivity differ in their willingness to try vegetables of a different presentation and texture, in comparison to their less sensory sensitive peers.

Children with ASC often show extreme selectivity, food refusal and unwillingness to try new foods (Schreck, Williams & Smith, 2004; Kozlowski, Matson, Fodstad & Moree 2011). However, little is known about how autistic traits may affect adult eating behaviour, or whether there are any associations between the level of autistic traits and sensory sensitivity in adults.

Food selectivity in ASC has previously been documented (Schreck & Williams, 2006), however, to date there has been little agreement on the causes of extreme selectivity or food refusal. One possible reason for the extended food neophobic response in ASC could be the inability to generalise food choices according to the way the foods look, suggesting that there is an adherence to local rather than global features of the food (Happé & Frith, 2006; Lopez, Tchanturia, Stahl & Treasure, 2008). With this in mind it was expected that individuals with more autistic traits would show less willingness to try vegetables with presentations different from those to which they are used to.

A final factor considered in this study was gender. A previous study, using the Autism Spectrum Quotient (AQ) in a large sample of students, showed that male participants had significantly higher AQ scores than the females of the sample (Kunihira, Senju, Dairoku, Wakabayashi & Hasegawa, 2006). Another set of research has suggested that males often eat less fruit and vegetables than their female peers, while females generally follow a healthier diet than males (Logue & Smith, 1986; Thompson, Margetts, Speller & McVey, 1999). According to the literature females are more likely to eat fruit and vegetables, however it has been suggested that they will try a food fewer times before completely rejecting it from their eating repertoire (Babayan, Budayr & Lindgren, 1966). Based on studies reporting differences between the two genders on taste (Desor, Maller & Andrews, 1975), food preference (Logue & Smith, 1986) and food aversions (Babayan, Budayr & Lindgren, 1966), one would expect that vegetable acceptance patterns would also vary between the two genders.

6.2 Aims and hypotheses

This research study had a number of aims. Firstly, the study aimed to identify any gender differences in the sample regarding willingness to try vegetables, and vegetable eating habits. It was expected that male participants would have tried fewer vegetables overall in comparison to the female participants. Also, females in the sample were expected to readily reject a new food after trying it fewer times than the males.

This study also explored whether gender has any impact on the psycho-physiological factors that may affect eating behaviour, such as food neophobia, the existence of sensory processing problems and/ or autistic traits. Gender differences in terms of the existence of food neophobia and the levels of sensory processing within the sample were also explored. Given that the general ratio of males and females diagnosed with autism is higher, it was hypothesised that male participants would present with more autistic traits (Baron-Cohen, 2002).

Another intention of the study was to explore whether there is a relationship between food neophobia, the existence of autistic traits and sensory sensitivity. Based on previous research a positive correlation was expected between food neophobia and sensory sensitivity in adults, however, due to the lack of relevant research in adults it was difficult to shape a hypothesis on the relationship between food neophobia and autistic traits.

This study also intended to shed more light on how food neophobia, the presence of autistic traits and/or sensory problems affect the willingness to try the vegetables offered in this study. It was expected that the willingness to try the vegetable options would be inversely related to food neophobia scores. It was also of interest to investigate which vegetable options would be less appealing to individuals with higher food neophobia levels.

It was hypothesised that participants with more autistic traits would show lower willingness to try vegetable options that differ from those that they are used to (familiar presentation). Since there is a lack of research on whether sensory sensitivity can predict adult vegetable preferences, it was decided that further investigation was needed in order to explore whether smell-taste, visual and touch sensitivity affected the willingness to try each vegetable option offered in this study.

Apart from the psycho-physiological factors, previous eating experiences such as the number of ‘never tried’ vegetables and a wider range of vegetable preparation were also explored as possible factors related to willingness to try the vegetable options offered in this study. It was expected that participants with a larger number of ‘never tried’ vegetables would also be less willing to try the vegetable options. Conversely, experience with a wider range of vegetable preparations was expected to be linked to higher willingness to try the vegetable options offered. It was also of interest to explore which of the vegetable options offered would be the most and least popular (overall and within the tasks), based on the willingness to try scores from participants.

This study also aimed to identify the most important factors affecting participants' willingness to try vegetables. The aim of task 1 was to manipulate texture in order to create a contrast between texture familiarity/unfamiliarity and perceived liked/disliked taste. The aim of task 2 was to investigate whether blemishes in the appearance or an unfamiliar way of preparation (different texture) would more negatively affect the willingness to try vegetables. More specifically, whether perceived liking of taste (familiar vegetable but unfamiliar presentation) or familiar texture (familiar texture but less preferred vegetable) has a greater effect on the willingness to try vegetables in young adults.

Finally, this study aimed to explore whether a blemish in the appearance or an unfamiliar texture is more likely to affect the willingness to try a vegetable.

6.3 Method

6.3.1 Participants

Participants were all students (under/post graduate) at the University of Birmingham and were recruited from the University's Research Participation scheme. All of the students were currently living in the UK, and were therefore exposed to the same range of vegetables in their everyday life. Participants received academic credits for participating in this study and they were also offered a bag of crisps for completing the study as a small incentive.

Initially 86 participants took part in the first study and 77 participants finally completed the two research phases. The final sample consisted of 53 females and 24 males aged 17-35 years.

Ethical approval for this project was granted by the Science, Technology, Engineering and Mathematics Ethical Review Committee of the University.

6.3.2 Design

This was a cross-sectional study consisting of two research phases. During the first research phase participants completed an extended electronic questionnaire, reporting in detail their vegetable preferences along with the vegetables they have tried. The second phase was tailored to each individual's vegetable preferences according to the information obtained during the first phase. During the second phase, participants were visually exposed to a total of 5 different vegetable options which were divided into an array of two and three choices respectively. The participants were exposed to real food options that the participant could see and smell but were not allowed to touch or consume.

6.3.3 Measures

Willingness to try scale

Participants indicated their willingness to try each vegetable option using a 5-point Likert response scale (1= not at all, 5=very much) (See Appendix A-10). The Likert scale was offered to the participants every time a vegetable option was presented to them.*Times a food is tried before being rejected*

Participants were asked to report how many times they would try a new food before they completely rejected it from their eating repertoire (included in the questionnaire in the first part of the study, see Appendix A-12, Study C).

Vegetable preferences inventory

Participants completed a detailed questionnaire collecting information about their liked, disliked and never tried vegetables from a list of 42 vegetables (see Appendix A-11). In addition, the vegetable consumption inventory was used to compute participants' total range of vegetable preparation (the number of different ways in which participants have their vegetables). Information regarding any food allergies in the sample was also collected and any vegetables which participants were allergic to were excluded from the observational part of the study.

Food neophobia scale (FNS), (Pliner & Hobden, 1992)

The 10 item Food Neophobia Scale (FNS) for adults was used to assess participants' attitudes to trying novel foods. The FNS score was calculated as a sum of the responses, with higher scores indicating high levels of food neophobia. For this study, reliability of the 10 item FNS scale as measured by Cronbach's α was .87. The FNS was included in the questionnaire in the first part of the study (see Appendix A-3).

Adolescent/Adult Sensory Profile (AASP) (Brown & Dunn, 2002)

The AASP was included in the questionnaire in the first research phase to measure participants' responses to everyday sensory experiences. The overall sensory profile score was calculated, along with three of the sensory profile sub scores (taste-smell processing, visual processing and touch processing). The Cronbach's alpha for AASP was .73. Higher scores in the AASP indicate greater sensory sensitivity (For AASP see Appendix A-6). More detailed information can be found in Chapter 2).

Autism Spectrum Quotient (AQ, Baron-Cohen, Hoekstra, Knickmeyer, & Wheelwright, 2006)

During the completion of the questionnaire in the first research phase participants were asked to complete the Autism Spectrum Quotient (AQ), a 50-item questionnaire consisting of five subscales (social skills, attention switching, and attention to detail, imagination and communication, See Appendix A-9). The Cronbach's alpha for AQ was .69. Scoring is organised so that a high score indicates an autistic-like trait, for example, poor social skills, poor communication, poor imagination, exceptional attention to detail, poor attention switching/strong focus of attention.

6.3.4 Food stimuli

The first array of vegetable options consisted of two choices; a liked vegetable presented with an unfamiliar texture preparation (LVUT). This vegetable option was paired with a disliked vegetable presented with a familiar texture preparation (DVFT) (See Appendix C-2). These vegetable options were chosen in order to investigate whether perceived taste or texture is the most determinate factor affecting the willingness to try vegetables in adults.

The second array consisted of three vegetable options. A familiar vegetable commonly eaten raw was chosen (typically tomato or lettuce) and offered in the common raw form (RV), the same vegetable was also presented in raw form with a blemish (RBV), and in a different texture to the raw form after being cooked, (VDT) (See Appendix C-4). Vegetables were offered in a random order.

6.3.5 Procedure

Data collection was conducted in two phases:

Phase one-Completion of questionnaire:

This included questions on allergies, general vegetable purchase, demographic information, along with the Food Neophobia Scale, Adult/Adolescent Sensory Profile, AQ and the vegetable preference inventory (See Appendix).

Phase two-Exposure

Participants were exposed to food, and made visual judgements of their willingness to try each of the five vegetable options. This phase was tailored to the answers received in phase one about the eating habits and vegetable preference of each participant. This phase included two tasks of visual food exposure

Task 1: Disliked vegetable offered in familiar texture (DVFT) and Liked vegetable offered in unfamiliar texture (LVUT) (see Appendix C-3)

Task 2: Raw blemished vegetable (RBV), Vegetable offered in different texture (VDT), and Raw vegetable (RV) see Appendix C-4).

Each vegetable option was presented separately and participants were asked to rate their willingness to try each of them. Finally participants were asked to indicate which vegetable option looked the most appealing to them from Task 1 and Task 2 respectively.

6.3.6 Statistical analysis

SPSS version 21 statistical software was used to analyse the data. Histograms, Kolmogorov-Smirnov Tests and Shapiro-Wilk Test results showed that the majority of data were not normally distributed. Descriptive statistics for the sample characteristics (gender, age, ethnicity and education) were run and Mann Whitney U analyses were used to explore the sample's gender differences regarding their scores on the measures of the study.

A two related samples Wilcoxon test was carried out in order to explore differences in the willingness to try a liked vegetable offered in unfamiliar texture (LVUT) and a disliked vegetable in familiar texture (DVFT) in task 1. A two related samples Wilcoxon test was also carried out in order to explore differences in the willingness to try a raw vegetable (RV), raw blemished vegetable (RBV) and vegetable in different texture (VDT) in task 2.

A Spearman's rank correlation analysis was run to explore the relationship between food neophobia, scores on the Autism Spectrum Quotient (including sub categories), and the Adolescent/Adult Sensory Profile (including sub categories) and the overall willingness to try vegetables in task 1 and task 2.

Enter regression was considered to be the most appropriate method for theory testing (Studenmund & Cassidy, 1992) as stepwise techniques are influenced by random variation in the data and the results might not be replicable if the model is retested. Although the data were nonparametric, screening was carried out for violations of the assumptions made by multiple regression, including multicollinearity, linearity, homoscedasticity of residuals, and outliers. In a multicollinearity check, collinearity tolerance was above 0.1 and VIF was below

2.5 in every case, as a result linear regression was chosen as the most appropriate data analysis method given the lack of non-parametric equivalents.

6.4 Results

6.4.1 Descriptive statistics

Table 6.1 Characteristics of the sample divided by gender

Variables	Males (*n*=24)	Females (*n*=53)
Participants age min-max, mean(SD)	18-35, 20.6 (3.6)	17-28, 19.6 (1.7)
Education level	1.3% Post-Graduate Qualification (*n*=1) 1.3% University graduate (*n*=1) 26% A-Levels (*n*=20) 29.5% (Some) Secondary education (*n*=18) 2.6 % Other or unknown (*n*=2)	2.6% Post-Graduate Qualification (*n*=2) 3.9% University graduate (*n*=3) 62.3 % A-Levels (*n*=48) 18.2% (Some) Secondary education (*n*=8)
Ethnicity	23.4% White British/ Caucasian (*n*=18) 1.3% Black/Black British (n=1) 3.9% Asian/Asian British (n=3) 1.3% Mixed background (*n*=1) 1.3% Unknown (*n*=1)	44.2% White British/ Caucasian (*n*=34) 2.6% Black/Black British (n=2) 13% Asian/Asian British (n=10) 3.9% Mixed background (*n*=3) 2.6% Arab (n=2) 2.6 % Unknown (*n*=2)

Demographic characteristics

Table 6.1 shows the demographic characteristics of the sample. No statistically significant age difference was found between the male and female participants U=544, Z=-1.012, p=.312.

The hypothesis that male participants would present with a higher number of the 'never tried' and disliked vegetables was not proven, as no significant gender differences were noticed (See table 6.2). Although female participants presented with a wider range of the way that they have their vegetables prepared, no statistically significant gender differences were found between the 'never tried' vegetables or the range of vegetable preparation (See Table 6.2).

Table 6.2 The vegetable eating habits of the sample

Number	Males		Females		Sig
	Min-Max	Mean	Min-Max	Mean	
Number of never tried vegetables	(1-21)	6.71	(0-28)	6.08	.473
Number of disliked vegetables	(0-17)	7.54	(0-20)	7.53	.991
Total range of vegetable preparation	(23-149)	64.75	(9-184)	72.94	.385

Similarly, no significant difference was found between the number of times male and female participants would try a food before completely rejecting it from their food repertoire $\chi^2(4)$= 4974, p=.290 (See Figure 6.1). Most of the sample would try a food 2-5 times before rejecting it.

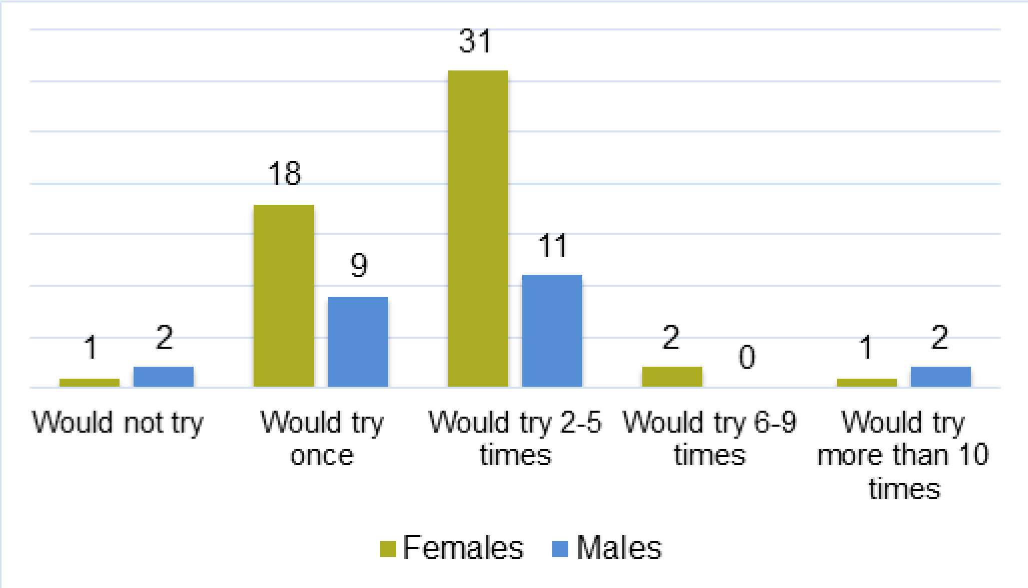


Figure 6.1 Times participants would try a food before deciding they do not like it

In order to explore any gender differences in terms of Food Neophobia, Autism Spectrum Quotient and Adolescent/Adult Sensory Profile score, a Mann Whitney U analysis was run (Table 6.3). No significant gender differences were found in food neophobia scores (U=518, Z=-1.299, p=.194). Similarly no gender differences were found in overall sensory processing score (AASP). However, female participants showed a significantly higher visual processing sensitivity than the male participants (U=438.5, Z=-2.179, p=.029). In contrast to the hypothesis, males did not show significantly higher AQ scores (U=539.5, Z=-1.064, p=.287).

In order to investigate gender differences in participants' willingness to try the vegetable options offered, an overall willingness to try score was calculated by adding participants' willingness to try scores in both Task 1 and Task 2 (Table 6.3).

Table 6.3 Scores according to the gender of the sample

	Overall		Males		Females		
	Mean	SD	Mean	SD	Mean	SD	Sig
Food Neophobia score	29.4	10.45	27.29	9.76	30.36	10.7	.194
AQ[b] score	17.39	6.35	17.75	5.44	17.23	6.76	.287
AQ[a]sub-questionnaires							
Social skills	2.68	2.23	2.33	1.76	2.83	2.42	.528
Attention switching	5.27	1.97	5.29	1.89	5.26	2.02	.902
Attention to detail	5.47	2.32	5.71	1.82	5.36	2.52	.531
Communication	2.1	1.69	2.21	2.12	2.06	1.47	.871
Imagination	1.87	1.68	2.21	1.58	1.72	1.71	.101
AASP[b]Overall Score	76.66	10.50	73.46	10.61	78.11	10.23	.109
AASP[b] sub-questionnaires							
Smell-taste processing	20.82	3.49	20.88	4.53	20.79	2.96	.987
Visual processing	25.61	4.07	24.13	3.61	26.28	4.12	.029
Touch processing	30.23	6.41	28.46	5.77	31.04	6.57	.093
Overall score willingness to try vegetable options	17.57	2.94	17.42	3.03	17.64	2.93	.753

a:Autism Spectrum Quotient b:Adolescent/Adult Sensory Profile

The data did not reveal any statistically significant difference in terms of willingness to try scores between males and females (U=607.5, Z=-.315, p=.753).

Two tailed Spearman's correlations were carried out to assess associations between food neophobia, the existence of autistic traits and sensory processing sensitivity.

No statistically significant correlations were found between food neophobia and the AQ score (r_s=.082, p=.489), or any of the following scores for the range of vegetable preparation r_s=.-165, p=.152, total never tried vegetables r_s=.122, p=.289 or the number of disliked vegetables r_s= .049, p=.674. However, food neophobia was positively correlated with the AASP overall score r_s=284, p=.012, suggesting that participants with higher food neophobia scores were also more sensory sensitive.

It was found that the most popular vegetable option was the (familiar) raw vegetable, whilst the least popular vegetable option was the commonly eaten raw vegetable, when presented with a blemish (mean score = 2.25, SD=1.22, See Figure 6.2).

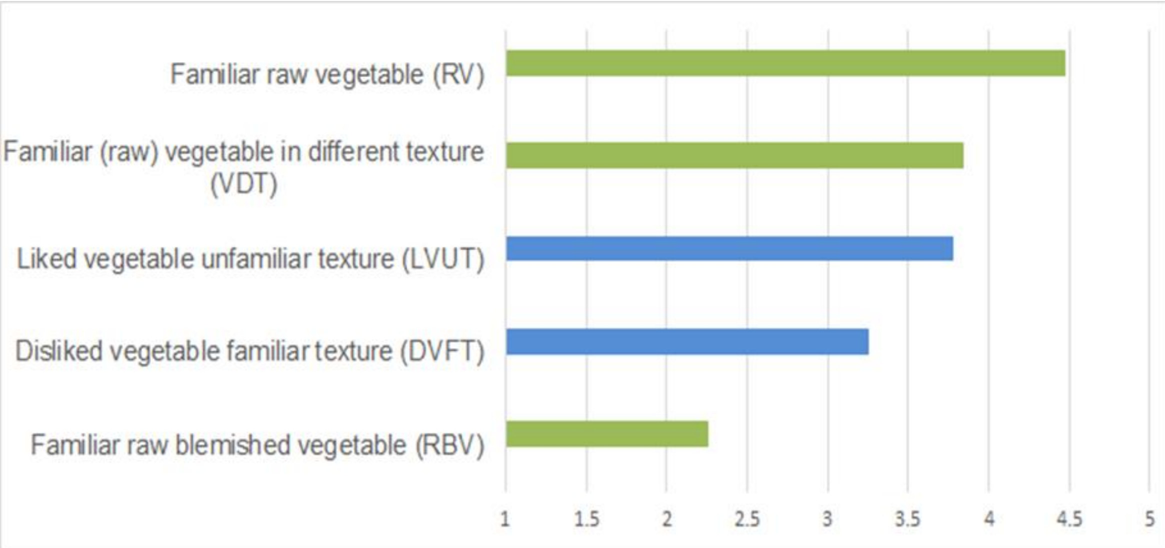


Figure 6.2 shows the ranking of all vegetable options offered in this study according to the participants' mean willingness to try score

Willingness to try vegetable options in Task 1 and Task 2

6.4.2 Results-Task 1

In order to see whether taste (liked-disliked) or texture (familiar-unfamiliar) was more likely to affect participants' willingness to try an option, a two related samples Wilcoxon test was carried out on participants' willingness to try a liked vegetable offered in unfamiliar texture (LVUT) and a disliked vegetable with a familiar texture (DVFT). The participants' mean score of their willingness to try the LVUT (3.77, SD=1.19) was significantly higher than their mean score of willingness to try the DVFT (mean score =3.25, SD=1.33), p=.019). When participants were asked to choose which vegetable option they were more likely to try in Task 1, the majority of the sample (64.9%) chose the LVUT.

Willingness to try and AQ, FNS, &AASP scores

A Spearman correlation analysis between willingness to try vegetable option DVFT and AQ overall score showed that a higher AQ score was related to higher willingness to try a DVFT. (See table 6.4)

Table 6.4 Correlations between willingness to try DVFT, LVUT and FNS, AQ, AASP and total range of preparation

Willingness to try	Food Neophobia score	Autism Spectrum Quotient score	Sensory Profile Score	Total range of vegetable preparation
Disliked vegetable familiar texture(DVFT)	-.165	.225*	.034	.164
Liked vegetable unfamiliar texture(LVUT)	-.067	-.040	-.153	.131

A further Spearman correlation analysis was conducted between the willingness to try DVFT and LVUT and the AQ sub-scales (see table 6.5) because a correlation between AQ score and willingness to try the vegetable option DVFT was observed, A statistically significant relationship was found between the subscale of the 'attention to detail' and participants' higher willingness to try a vegetable they do not like when it is presented in a familiar texture.

Table 6.5 Correlations between willingness to try DVFT and LVUT and AQ subscales

Willingness to try	Social skill	Attention switching	Attention to detail	Communication	Imagination
Disliked vegetable familiar texture(DVFT)	.077	.038	.409**	.149	.059
Liked vegetable unfamiliar texture (LVUT)	-.062	.033	-.013	.015	-.063

Spearman's correlations carried out between willingness to try each vegetable option in task 1 and the scores in the subcategories of the sensory profile showed a significant negative correlation between participants' scores in the smell-taste sensory sub-category and their willingness to try a LVUT (see table 6.6). The more sensory sensitive in this domain the less willing the participants were to try the LVUT.

Table 6.6 Correlations between sensory profile subcategories related to eating and 'willingness to try' DVFT and LVUT

Sensory profile subcategories	Smell taste	Visual processing	Touch processing
Disliked vegetable familiar texture(DVFT)	-.029	-.043	.016
Liked vegetable unfamiliar texture(LVUT)	-.225*	-.036	-.158

6.4.3 Results Task 2

The second task looked at whether changes in texture (VDT) or a blemish (RBV) were more likely to negatively affect the willingness to try a commonly eaten raw vegetable.

Wilcoxon two related samples analyses were used to see whether there was a statistical difference between participants' willingness to try the vegetable options RBV and VDT, RV and VDT, and RV and RBV. Participants' willingness to try the vegetable offered in a different texture (VDT) was significantly higher (mean score= 3.84, SD=1.21) than their willingness to try the raw blemished vegetable (mean score= 2.25, SD= 1.22), $Z=-5.556, p \leq .001$.

Participants were significantly more willing to try the common RV option (mean score= 4.47, SD=0.82) than the same vegetable when offered in a different texture (mean score= 3.84, SD=1.21), p =< .005).While participants' willingness to try the RV option (mean score= 4.47, SD=0.82) was significantly higher than their willingness to try the RBV option (mean score= 2.25, SD=1.22), $Z=-3.136$ $p \leq .001$.

Final choice task 2

When participants were asked to choose which vegetable option looked more appealing, 48 participants chose the RV option, while 28 participants found the VDT option more appealing and only one participant chose the RBV option.

Willingness to try vegetables with different presentations and AQ, FNS & SPS scores

A Spearman two tailed correlation showed that there was a significant negative correlation between participants' willingness to try the RBV option and AQ score. More specifically the findings suggest that participants with higher AQ scores were significantly less willing to try the RBV option (see Table 6.7).

A two tailed Spearman correlation revealed a negative association between food neophobia and the willingness to try a vegetable commonly eaten raw but offered in another texture (VDT), suggesting that those who were more neophobic were also significantly less willing to try the VDT option (Table 6.7). There was also a positive correlation between the range of preparations a participant had reported for their vegetable intake and willingness to try the VDT, which suggests that participants who typically have their vegetables in a variety of different textures will also be more willing to try a vegetable option offered in a texture with which they are less familiar.

Table 6.7 Correlations of willingness to try vegetable options RBV, VDT, RV and FNS, AQ, AASP and total number of preparations

Willingness to try	Food neophobia score (FNS)	Autism Spectrum Quotient score (AQ)	Sensory Profile Score (AASP)	Total range of vegetable preparation
Raw blemished vegetable (RBV)	-.051	-.332**	-.060	.240*
Vegetable offered in different texture (VDT)	-.270*	-.055	-.042	.426**
Raw vegetable (RV)	.092	-.030	.067	.170

Further analysis between the willingness to try vegetable options RBV, VDT, RV and the AQ sub-scales was conducted in an attempt to investigate which sub-scale played a more crucial role in participants' willingness to try each of these vegetable options. Both social skill and attention switching showed a significant negative relationship with participants' willingness to try the RBV option (see Table 6.8).

Table 6.8 Correlations of willingness to try vegetable options RBV, VDT, RV and the sub-questionnaires of the AQ

Autism Spectrum Quotient score sub scales	Social skill	Attention switching	Attention to detail	Communication	Imagination
Raw blemished vegetable (RBV)	-.280*	-.401**	-.023	-.171	-.202
Vegetable offered in different texture(VDT)	-.066	.106	.117	-.003	-.037
Raw vegetable (RV)	.004	-.107	.161	.100	-.156

A Spearman two tailed correlation analysis between the willingness to try the three vegetable options and the SP subcategories showed no statistically significant correlations (see table 6.9).

Table 6.9 Correlations of willingness to try vegetable options RBV, VDT, RV and three Sensory Profile subcategories

Willingness to try	Smell/taste	Visual processing	Touch processing
Raw blemished vegetable (RBV)	.120	-.031	-.116
Vegetable offered in different texture(VDT)	-.124	-.029	-.016
Raw vegetable (RV)	.028	.075	.059

Never tried vegetables and willingness to try vegetable options in Task 1 & Task 2

A two tailed Spearman correlation analysis was run in order to explore the hypothesis that participants with a larger number of 'never tried' vegetables would be less willing to try the vegetable options offered. The data showed a significant negative correlation between the number of the 'never tried' vegetables and the willingness to try the DVFT option (r_s=-.246, p=.031), suggesting that participants with a larger number of 'never tried' vegetables were less willing to try a disliked vegetable even if it was offered in a familiar texture. A significant negative correlation was also found between the number of 'never tried' vegetables and the willingness to try the VDT option (r_s=-.266, p=.019). Participants with a higher number of 'never tried' vegetables were less willing to try a vegetable offered in a different texture from that usually experienced. Moreover, a significant positive correlation was found between the number of 'never tried' vegetables and the AQ score (r_s=.284, p=.012) but there was no significant correlation with the food neophobia score (r_s=.124, p=.282) or the AASP (r_s=.053, p=.649).

6.4.4 Regression analysis

Forced entry regressions were performed to explore the significant predictors of willingness to try each vegetable option.

Table 6.10 Summary of Multiple Linear Regression for variables predicting the willingness to try the DVFT

	B	SE	*β*	*t*	*p*
FNS overall score	-.023	.014	-.180	-1.591	.116
AQ overall score	.067	.023	.319	2.951	.004
AASP overall score	-.008	.015	-.059	-.507	.614
Total range of preparation	.005	.005	.133	1.065	.291
Total number of never tried vegetables	-.046	.030	-.184	-1.531	.130

The results supported the previously observed correlations, showing that AQ was strongly positively correlated with the willingness to try the DVFT option, and suggest that AQ score is the most significant variable predicting willingness to try this vegetable option (β=.319, p.< .005, see table 6.10). Based on the Table 6.10, the equation for the regression line is DVFT= 3.266-.023x(FNS overall score) +.067x(AQ overall score) -.008x(AASP overall score) +.005x(Total range of preparation) -.046x(Total number of never tried vegetables) and the percentage of variance is 20.4% (R^2=.204).

Table 6.11 Summary of Multiple Linear Regression for variables predicting the willingness to try the LVUT

	B	SE	*β*	*t*	*p*
FNS overall score	.002	.014	.020	.162	.872
AQ overall score	.006	.022	.031	.264	.793
AASP overall score	-.025	.014	-.219	-1.733	.087
Total range of preparation	.003	.005	.091	.673	.503
Total number of never tried vegetables	-.033	.029	-.150	-1.158	.251

Regressions analysis showed that there were no significant predictors for willingness to try the LVUT. Based on the Table 6.11, the equation for the regression line is LVUT= 5.495 +.002 x(FNS overall score) +.006(AQ overall score) -.025(AASP overall score) +.003(Total range of preparation) -.033(Total number of never tried vegetables) and the percentage of variance is 7% (R^2=.070).

Table 6.12 Summary of Multiple Linear Regression for variables predicting the willingness to try the RBV

	B	SE	*β*	*t*	*p*
FNS overall score	.004	.014	.033	.286	.776
AQ overall score	-.060	.021	-.310	-2.806	.006
AASP overall score	-.008	.014	-.072	-.600	.550
Total range of preparation	.010	.004	.284	2.221	.030
Total number of never tried vegetables	.035	.028	.152	1.232	.222

The results of the regression analysis for Task 2 supported the correlation analysis and indicated that the AQ overall score is a significant negative predictor, while the total range of preparations that each participant has their vegetables in is also a significant predictor of the willingness to try the RBV option (see table 6.12). Based on the Table 6.12, the equation for the regression line is RBV= 2.904 +.004x(FNS overall score) -.060x(AQ overall score) -.008x(AASP overall score) +.010x(Total range of preparation) +.035(Total number of never tried vegetables) and the percentage of variance is 16.3 % (R^2=.163).

Table 6.13 Summary of Multiple Linear Regression for variables predicting the willingness to try the VDT

	B	SE	*β*	*t*	*p*
FNS overall score	-.014	.013	-.118	-1.068	.289
AQ overall score	.004	.020	.021	.195	.846
AASP overall score	.-028	.013	-.246	-2.155	.035
Total range of preparation	.014	.004	.414	3.397	.001
Total number of never tried vegetables	-.015	.026	-.064	-.549	.585

Regression analysis showed that a greater range of vegetable preparation can significantly predict a higher willingness to try the VDT option, while sensory sensitivity was also found to negatively affect the willingness to try VDT. Based on the Table 6.13, the equation for the regression line is VDT = 5.444 -.014x(FNS overall score) +.004x(AQ overall score) -.028x(AASP overall score) +.014x(Total range of preparation -.015x(Total number of never tried vegetables) and the percentage of variance is 24.1 % (R^2=.241).

Finally, a multiple linear regression was also run in order to explore which variables can better predict willingness to try the RV (see table 6.14).

Table 6.14 Summary of Multiple Linear Regression for variables predicting the willingness to try the RV

	B	SE	*β*	*t*	*p*
FNS overall score	.009	.010	.114	.925	.358
AQ overall score	.008	.015	.065	.557	.579
AASP overall score	-.008	.010	-.097	-.760	.450
Total range of preparation	.006	.003	.262	1.936	.057
Total number of never tried vegetables	.006	.020	.042	.318	.752

Regression analysis showed that there were no significant predictors for higher willingness to try the RV. Based on the Table 6.14, the equation for the regression line is RV=4.165 +.009x FNS overall score +.008x AQ overall score -

.008x AASP overall score +.006xTotal range of preparation+.006x(Total number of never tried vegetables) and the percentage of variance is 6% (R^2=.060).

6.5 Discussion

Previous literature has identified factors such as food neophobia, gender and sensory sensitivity as potential correlates affecting eating behaviour. However there is very limited research on how the existence of autistic traits can interact with the eating behaviour of an individual. The present study aimed to shed more light on the factors affecting the willingness to try vegetables in adults.

One of the hypotheses of the present study was that male participants would present with a higher number of never tried vegetables and that females would be more likely to reject a new food after fewer tries (Babayan, Budayr & Lindgren, 1966). It was also hypothesised that no gender differences would be present in terms of food neophobia and the existence of sensory sensitivity, and that the male participants would present more autistic traits than the females of the sample.

The results of this study provided support to some of these hypotheses. No significant differences were observed between the females and males in terms of food neophobia or in the existence of high levels of sensory sensitivity. However the findings showed that the sample was homogenous, as no gender differences were found in terms of vegetable preferences and eating habits. Furthermore, the hypothesis that male participants would present higher autistic traits was not confirmed.

Participants were visually exposed to two arrays of vegetable options. The first array of vegetables (DVFT and LVUT) was used to investigate whether taste or appearance is the most determinate factor affecting the willingness to try vegetables. The second array of vegetables (RV, VDT and RBV) aimed to explore whether a blemish or an unfamiliar texture can more negatively affect the willingness to try the vegetables offered.

The results showed that from the vegetable options offered in this study, the raw version the most popular, as was expected. The results of the observational part of Task 1 showed that the LVUT was significantly more popular than the DVFT vegetable option, suggesting that a vegetable of perceived liked taste is more likely to be preferred, even if the way it is presented is not familiar. In Task 2 the majority of the sample (N=48) was more willing to try the RV, 28 participants chose the VDT as the most appealing vegetable option, while only one participant chose the RBV as the most appealing. The findings suggested that a blemish in appearance is a significantly more negative factor than an unfamiliar texture when it comes to willingness to try a vegetable option.

When comparing the findings from the adult sample (Chapter 6) and the young children (Chapter 5) it was observed that although in both samples the familiar raw vegetable option (RV) was the most popular in terms of willingness to try, in adults the second most popular option was the raw vegetable offered in another texture (VDT), while in young children the second most popular option was the liked vegetable offered in unfamiliar texture (LVUT). Other than this difference, the ranking of vegetables based on participants' willingness to try was identical between the two groups.

The present study did not reveal a direct link between higher scores of food neophobia and lower willingness to try for most of the vegetable options offered. However, a very interesting finding was that food neophobia was negatively correlated with the willingness to try the VDT. This finding suggests that unfamiliar texture can also lead to a food neophobic response and supports the findings of previous research suggesting that food neophobia can also lead to rejection of known food when the presentation is different from what they are used to including the texture of the food (Brown, & Harris, 2012).

In terms of sensory processing it was found that smell and taste sensitivity was negatively correlated with the willingness to try the LVUT. In line with this, regression analysis identified sensory sensitivity (overall score AASP) as a significant predictor negatively affecting the willingness to try the VDT.

Research in children has previously shown that food neophobia commonly coexists with sensory sensitivity (Coulthard & Blissett, 2009, also observed in Chapter 4 of the thesis). The present study replicates this finding in an adult population, and is among the first to investigate and confirm a positive correlation between the existence of sensory sensitivity and food neophobia in adults.

Interestingly, it was found that the level of autistic traits (AQ score) played a significant role in willingness to try the vegetable options DVFT (Task 1) and RBV (Task 2). There was a strong positive relationship between the AQ score and willingness to try the DVFT, while regression analysis confirmed that the AQ score was the most important positive predictor for the willingness to try the DVFT. These findings highlight how important it is for individuals with greater levels of autistic traits that their food should look similar to that which they are used to. The positive correlation between adherence to detail and higher willingness to try the DVFT provided additional support, and a possible explanation for the previous finding. Individuals with a tendency to pay extra attention to detail were more willing to try a food option when the local features were similar to those that they were used to. In line with this, the strong negative correlation between the level of autistic traits and the willingness to try the RBV, which was also highlighted by the regression analysis, confirms that individuals with higher levels of autistic traits are deterred from trying food when the look is unusual, in this instance due to a blemish. Furthermore, correlational analysis between willingness to try the RBV and the subcategories of the AQ questionnaire revealed that greater impairment in terms of social skills were linked with a lower willingness to try this vegetable option. It could be that people who struggle with social interaction present with an overall greater level of repetitive and rigid behaviour that can also affect their food choices. However, as this is the first study to investigate the impact of adult autistic traits on the willingness to try food, further research is needed to shape a clear understanding of the mechanism underlying this finding. Moreover, it was found that difficulty in switching attention from stimuli, once attention has been engaged, was another negative factor for the willingness to try the RBV. This finding also confirms that individuals with higher levels of autistic traits, when the visual perceptual qualities of the food differ from the common (uniform image), can be negatively affected in their willingness to try food.

Overall, it can clearly be seen that the existence of autistic traits function as a restrictive force in terms of the food choices of an individual. The significant association between higher numbers of ‘never tried’ vegetables with higher levels of autistic traits in the sample further reinforce this notion.

In agreement with the findings in Chapter 5, previous eating preferences also played an important role in the willingness to try the vegetable options offered. The hypothesis that a wider range of vegetable preparations would be related to willingness to try the vegetable options offered in this study was partially confirmed. There was a positive association between willingness to try the VDT and RBV and the range of vegetable preparations previously experienced, demonstrating that participants who were more adventurous in the way they prepare their vegetables were also more ‘open’ to variations, both in terms of the appearance and texture; and this could perhaps be generalised to the acceptance of new vegetables. However it is not clear whether these individuals are generally more adventurous with food, or have become more adventurous from experiencing a wider variety of food preparations.

In Task 1 the LVUT was rated significantly higher in preference over the DVFT. This finding suggests that adult individuals value the taste of a preferred vegetable over the texture with which it is presented. In Task 2 it was clear that a blemish on the vegetable more negatively affected the willingness to try than the same vegetable offered in an unfamiliar way of preparation. It is commonly accepted that vegetables and fruits which present with spots or are bruised are not very popular with children and young adults (Hill, Casswell, Maskill, Jones & Wyllie, 1998). It was therefore not a surprise that the RBV was found to be the least popular among the vegetable options offered.

The findings of this study could be particularly beneficial in the following areas. Firstly, staff in cafeterias and restaurants or other premises catering for individuals with ASC could benefit from the findings. A suggestion would be that when a new vegetable is introduced to the menu, this should be presented in a familiar way of preparation, in order to diminish the novel elements on the plate.

Secondly, the findings of this study could also benefit adults with a diet limited in terms of vegetables. In these cases a recommendation of adopting a more adventurous way of preparing the vegetables already in their diet could be a step towards increasing their tolerance to other vegetable options that vary in both appearance and texture. This may eventually help them to adopt a more positive approach to novel vegetables or vegetables of an unfamiliar look or texture.

6.5.1 Strengths and limitations

Although this study is the first to support the idea that the existence of autistic traits play an important role in vegetable choices, even in a highly functioning adult sample, it is not without limitations. Participants who took part in this study were studying at a university, therefore the result of this study may not be generalizable to individuals coming from less educated backgrounds. A larger sample could also provide more statistical power in order to explore in depth whether gender has any effect on eating behaviour, as well as the physiological factors affecting eating.

Furthermore, in Task 2 given that cooked food (e.g. roasted tomato) would have a stronger smell in comparison to the RV and the RBV, it could be considered as a limitation. To address this problem a future study following a similar research design should control for the olfactory characteristics of the food. This could be done by possibly presenting the vegetable options in lidded or cling film covered containers. Moreover, it could be argued that roasted tomatoes are quite a familiar preparation in the UK as opposed to stir fried lettuce and as a consequence these choices could possibly add more ‘noise’ to the data of the study.

Based on the results the RBV food option may be rejected by individuals with higher autistic traits for two possible reasons: because of imperfection (e.g. creating the impression that it could be rotten) or because it is perceptually different to the common RV option. Future research, following a similar research design, could benefit by having an additional vegetable option, that of a familiar vegetable presented in a less common preparation (not of an unusual texture).Future research could also benefit from a sample including adults with greater variety in terms of the level of autistic traits, also including individuals with an ASC diagnosis, as well as a control comparison group. In this way we could shape a clearer idea on whether a higher existence of autistic traits might be linked with greater food neophobia and/or sensory sensitivity.

Despite these limitations, this study is among the first to use real food as a stimuli in order to provide observational evidence for adults’ vegetable preferences. The outcomes of this study suggest that liking of taste is more important than texture, and that the existence of autistic traits seems to be an important correlate of vegetable choices even in a highly functioning adult sample. Finally, this study suggests that eating habits and previous eating experiences play an important role in the current eating behaviour of an individual.

Consequently, it is suggested that in future research aiming to explore willingness to try food, previous eating experiences also need to be considered.

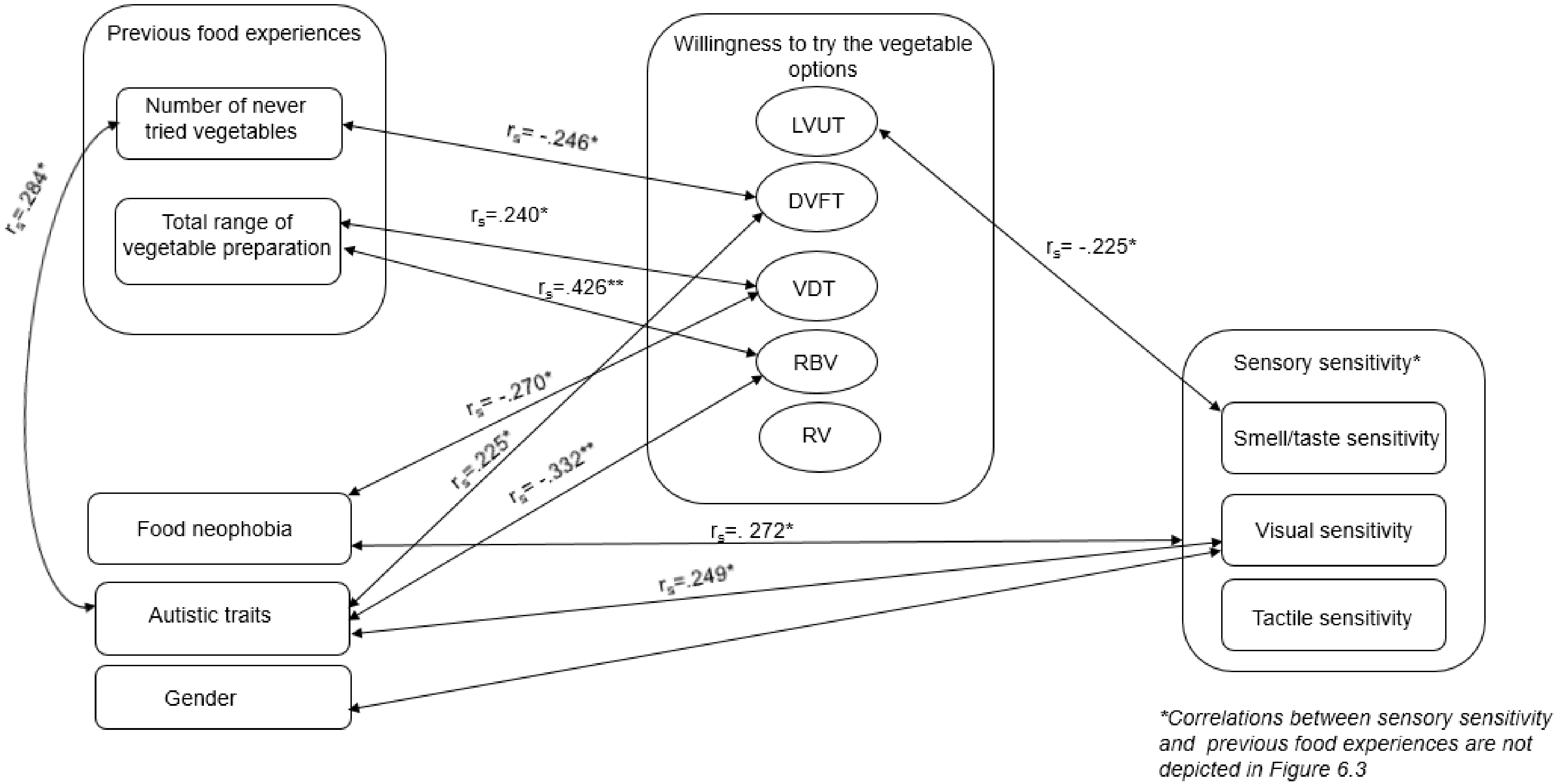


Figure 6.3 The proposed model of factors affecting willingness to try the food stimuli

CHAPTER 7

GENERAL DISCUSSION

7.1 Introduction to the general discussion

As the findings have been discussed in detail in each experimental chapter of the thesis, this chapter will initially overview the aims, summarise the key findings and discuss the clinical and research implications of these findings. Finally, the strengths and limitations of this thesis will be stated and an overall conclusion will be drawn.

7.2 Aims of the thesis

The primary aim of this thesis was to explore relationships between eating behaviour, sensory processing and neophobia in individuals with and without an ASC diagnosis. Chapter 3 focused on whether an early problematic feeding background can relate to problems in the current eating behaviour and sensory profile of children with and without ASC. Chapter 4 specifically investigated the eating and sensory processing profile of children with and without ASC aged between 2 and 14 years. This Chapter also examined associations between sensory sensitivity and problematic eating across the sample, and explored whether children with and without ASC differ in terms of their eating behaviour when categorised by similar sensory processing performance. Additionally, Chapter 4 explored whether eating and sensory problems co-exist with a more problematic social, communication and behavioural profile in both children with and without ASC.

Chapters 5 and 6 focused on a specific aspect of eating, that of the willingness to try vegetables. These studies also expanded the existing literature on how factors such as food neophobia, sensory sensitivity and previous vegetable eating experiences can affect willingness to try vegetable options that differ in terms of taste preference and texture/appearance familiarity. These two chapters followed the same research design, however different population samples were used in an attempt to cover the gaps in previous research. For the study described in Chapter 5 children aged between 3 and 4.5 years were chosen in order to explore which factors can positively affect willingness to try vegetables in pre-schoolers. For the study in Chapter 6 a population of young adults was chosen, firstly to explore whether gender can have an impact on the presence of food neophobia and secondly to investigate whether the prevalence of autistic traits could be a factor interfering with the willingness to try different vegetable options.

7.3 Key results and their contribution to the understanding of the eating behaviour of individuals with and without ASC

The main aim of this thesis was addressed in the two empirical chapters (Chapter 3 and Chapter 4), both of which explored eating behaviour in a population with and without an ASC diagnosis. Although Chapter 5 and Chapter 6 did not directly include a sample of individuals diagnosed on the autistic spectrum, these chapters nevertheless provided some valuable information regarding eating and food choices in young children (Chapter 5) as well as in an adult population with and without autistic traits (Chapter 6).

7.3.1 Early feeding and previous eating experiences

7.3.1.1 Early feeding problems in the sample

Previous research has identified early feeding stages, from birth to 2 years, as a fundamental period in the development of eating behaviour (Harris, 1993; Mennella & Beauchamp, 1991). However, research specifically focusing on the early feeding skills of children with ASC is sparse. In the Avon Longitudinal Study (ALSPAC-Emond, Emmett, Steer & Golding, 2010) although no significant difference was noticed in the eating behaviour between infants with a subsequent ASC diagnosis and typically developing infants in the first 6 months, parents' reports revealed that children with ASC were more likely to have a difficult transition to solid food and faced significantly more feeding difficulties between the ages of 15 and 54 months (ALSPAC-Emond, Emmett, Steer & Golding, 2010). This study also found that, from 15 months, children with ASC presented with a more selective diet and, at around 24 months, were more likely to eat different meals from their family. Other than these data, we know very little regarding the early feeding skills of infants who receive an ASC diagnosis in childhood.

The present thesis, in accordance with the findings of ALSPAC (Emond, Emmett, Steer & Golding, 2010), showed that children with ASC were significantly more likely to have a problematic transition from lumpy solids to family food, and faced significantly more feeding problems in the toddler period (around 18 months) than did the control group. These findings suggest that early feeding problems become more prominent in children with ASC around the age of 15-18 months, when children are expected to progress from ‘baby’ food to the food that the rest of the family eats.

Relevant literature places the appearance of more prominent autism symptomatology at around the same age (Ozonoff et al., 2010). This makes it difficult to determine whether problems in transition at this feeding stage are because children were not developmentally ready, or are due to autistic symptomatology becoming more prominent. In other words, is it possible that the feeding problems precede the autism diagnosis and could be considered as a sign of developmental disruption, or are they an indirect consequence of the autism symptomatology?

Given that the most prevalent difficulties were noticed in the eating stages around the time that the child is introduced to the family meal table, it could be that a poor development of social and communication skills inhibits the imitation of eating habits/behaviour (e.g. modeling parents or siblings when trying a new food or even a familiar food prepared in a novel way). Previous research has identified the importance of social modeling in promoting a more varied diet, and for children of this age to start trusting new or unfamiliar foods (Addessi, Galloway, Visalberghi & Birch, 2005). However, more research is needed in order to explore the nature of these problems and provide a better understanding of why feeding problems in the transition from lumpy solids to family food, and the toddler period (around 18 months) were more prevalent in children with ASC.

Chapter 3 also explored whether the existence of early feeding problems can be an indicator of problematic eating behaviour in later childhood. The data from the parental retrospective reports showed that problems in all early feeding stages apart from breast/bottle feeding were associated with more problematic current eating behaviour and sensory sensitivity in the children from both groups. In the control group the existence of early feeding problems clearly divided children into those with significantly higher food neophobia, eating selectivity, rigid/perseverant eating behaviour and selectivity in terms of texture and those without early feeding problems who had better current eating behaviour. However, the picture is more complicated in children with ASC. Problems in the transition from pureed to lumpy food signalled greater selective eating and texture selectivity in childhood. Problems in the finger food feeding stage were followed by greater problems in terms of eating selectivity and rigid/ perseverant eating in children with ASC. A similarity across the two diagnostic groups was that problems in the transition from lumpy to family food and during the toddler period signalled greater problems in all of the FBC subcategories and higher food neophobia levels, in comparison to those who presented no problems in these two feeding stages. This suggests that the transition from lumpy to solids and the toddler period are crucial for the development of a more healthy eating behaviour (in terms of eating selectivity, texture selectivity, rigidness and food neophobia in later childhood, both in children with ASC and typically developing children.

7.3.1.2 Previous eating experiences of vegetables

The various ways that previous eating experiences can have an effect on subsequent eating behaviour have been discussed in earlier research (Branen & Flecher, 1999; Cullen et al., 2001; Donadini, Fumi and Porreta, 2012). Similarly, Chapter 5 revealed that previous eating experiences could influence the eating preferences of children as young as 3-4.5 years, as 54.7% of children were more willing to try a vegetable of a liked/trusted taste (LVUT) even if the texture (due to the way of preparation) was not the one they were used to. Similarly, in Chapter 6, in a study following the same research design, it was found that (64.9%) of the adults were significantly more willing to try the LVUT over the DVFT.

The findings suggest that people are generally more willing to accept liked vegetables even in unfamiliar textures. Adults' preference for LVUT was of statistical significance. Although children also showed the same pattern of being more willing to try the LVUT over the DVFT, this finding was not statistically significant. In order to justify this, it may be that adults, as opposed to young children, had a more clear understanding of what each vegetable option was (e.g. carrot mashed consists of the same vegetable they are used to eating boiled). Whereas young children who have had fewer experiences with food may have a more vague and incomplete understanding of where a food comes from or whether they have tried it before.

Previous vegetable eating experiences in adults were also found to relate to their willingness to try the vegetable options offered. Adults with a higher number of 'never tried' vegetables were significantly less willing to try the disliked vegetable offered in familiar texture (DVFT), whereas individuals who were more adventurous in the way they prepare their vegetables were more willing to try vegetable options that they were not very familiar with (VDT) and (RBV).

7.3.2 Food neophobia

Food neophobia is perceived as a personality trait, a continuum along which people can be located in terms of their tendency to approach or avoid novel foods (Shepherd & Raats, 2006). Food neophobia has been studied in this thesis as a restrictive force working against accepting new or unfamiliar foods (Brown & Harris, 2012; Pliner 1994; Singer, Ambuel, Wade, & Jaffe, 1992). Food neophobic individuals are usually less willing to try novel foods and are more likely to choose and try a familiar food option when novel and familiar foods are paired (Pliner & Salvy, 2006). Additionally, individuals with higher food neophobia scores tend to present with a lower fruit and vegetable intake (Cooke et al., 2004).

Although some previous studies suggested that gender can have an effect on the levels of food neophobia in adult individuals (Koivisto, Sjoden, 1996; Tuorila, Lähteenmäki, Pohjalainen & Lotti, 2001), the present thesis found no statistically significant differences in terms of food neophobia and the gender or the age of the participants in all studies.

A plethora of previous studies have suggested that children with ASC are commonly unwilling to try new foods (Kozlowski, Matson, Fodstad & Moree 2011; Nadon, Feldman, Dunn & Gisel, 2011; Schreck, Williams & Smith, 2004; Whiteley, Rodgers & Shattock, 2000; Williams, Dalrymple & Neal, 2000), however, only one study (Martins, Young and Robson 2008) has previously shown, with the use of the Food Neophobia Scale, that children with ASC were more food neophobic than typically developing children. In line with this study, Chapter 3 provided additional support for these findings; children with ASC were found to be significantly more food neophobic than the control children.

The results from Chapter 3 also provided support for a link between the presence of feeding problems early in life and higher levels of food neophobia in childhood. The data showed that control group children who presented with problems in all early feeding stages (apart from breast/bottle feeding) were significantly more food neophobic in comparison to control children without early feeding problems. In the ASC group greater neophobia in later childhood was found in children with early feeding problems only in the transition from lumpy solids to family food and during the toddler period (around 18 months). However, overall, early feeding problems signalled a greater predisposition to the appearance of higher food neophobia levels in later childhood for both groups.

Chapter 5 provided additional support for the idea that food neophobia functions as a restrictive force against the acceptance of food. The results from this study revealed a strong positive correlation between food neophobia and the number of ‘never tried’ vegetables as well as the number of disliked vegetables, suggesting that the more food neophobic pre-schoolers had tried fewer vegetables and also disliked a higher number of vegetables. Additionally, a strong negative correlation was found between food neophobia and the total range of vegetable preparation (the different methods of preparation in which children had experienced each vegetable). This finding indicates that pre-schoolers with higher levels of food neophobia were less adventurous in how they have their vegetables prepared, although it could also be that the parents of more food neophobic children were offering vegetables only in the commonly accepted ways of preparation in order to diminish food rejection. In line with this, Chapter 6 also revealed a significant positive correlation between food neophobia and adults' willingness to try the vegetable in a different texture (VDT), demonstrating that perception of an unfamiliar texture may also lead to a food neophobic response, even in cases where the food is familiar.

The results of the three studies within the thesis also provided concrete support to the previously suggested association between sensory sensitivity and food neophobia (Coulthard & Blissett, 2009). A strong correlation between higher food neophobia and greater sensory sensitivity was found across all of the samples used in this thesis (pre-schoolers, children with and without ASC, as well as in the young adults). These findings suggest that greater levels of neophobia co-exist with higher sensory sensitivity, no matter the age or the diagnosis of the sample. Previous research has suggested that sensory sensitivity in infancy (more specifically tactile sensitivity) negatively affects the consumption of a new food (Coulthard, Harris & Fogel, 2016). It is however unclear whether sensory sensitivity levels remain stable throughout life. Further research could shed more light on whether there is a causational relationship, where higher sensory sensitivity precedes/results in greater food neophobia.

7.3.3 Sensory Sensitivity

Sensory sensitivity has recently been included in the criteria of ASC in DSM-V (American Psychiatric Association, 2013), however, there have been very few studies looking at the link between eating problems and the existence of sensory processing difficulties in children with ASC or in typically developing children.

Chapter 3 showed that children from both the ASC and the control group with problems in some of the early feeding stages appeared to have greater visual/auditory, taste-smell and tactile sensitivity later in childhood. More specifically, both typically developing children and children with ASC with problems in the transition from lumpy solids to family food and during the finger food stage presented with significantly higher visual-auditory sensitivity. Although difficulty in a higher number of feeding stages was linked with greater taste/smell sensitivity in both groups, as discussed in Chapter 3, there were a few differences regarding which of the early feeding problems signalled greater tactile sensitivity in each group. For instance, control group children with problems in the introduction to complementary foods and a problematic transition from solids to family food presented with greater tactile sensitivity in comparison to the control children without problems in these two feeding stages (See Figure 3.5). Whereas in the ASC group, children who presented problems in the finger food stage and the toddler period presented with significantly greater tactile sensitivity, when compared to the children with ASC without problems in these two feeding stages (See Figure 3.6). However, further research is needed to explore the observed differences between the two groups and provide a more concrete understanding of why problems in early feeding stages signal difficulties in different sensory modalities in ASC and typically developing children.

When examining the sensory processing and the social/communication skills of the sample as measured by the SCQ, a strong link was identified between the existence of greater sensory sensitivity and social/communication problems in both of the diagnostic groups. These findings indicate that social and communication difficulties could well be a result of increased sensory sensitivity to either the visual/auditory, tactile, or smell stimuli of the social environment. In the same line, it has been anecdotally observed by occupational therapists (S. Delport, personal communication, January 29, 2016) that sensory processing difficulties tend to lead to behavioural difficulties, but often the behaviour initially results in the child being labelled as ‘naughty’ or antisocial, rather than the behaviour being seen as a bi-product of sensory sensitivity. This study is the first to support the preposition that sensory sensitivity can impact on behaviour and social skills (as measured by the SDQ and SCQ, Chapter 4) as well as eating behaviour (as measured by the FBC).

Correlation analysis showed that, in both groups, higher sensitivity in terms of tactile and taste/smell input was significantly associated with a higher and more problematic score in selective eating, rigid eating, and selectivity in terms of texture across the sample. Visual/auditory sensitivity was linked with greater eating selectivity and rigidness in terms of eating, but not selectivity in terms of texture in both diagnostic groups. Given the nature of the findings it should be highlighted that exactly the same associations characterise the relationship between eating behaviour and sensory sensitivity in children with and without ASC. Furthermore, it was found that greater problems in all of the SCQ subcategories were linked with greater taste-smell sensitivity in the control group. While greater problems in all of the SCQ subcategories were linked with greater tactile sensitivity in children with ASC.

When the children of the sample were categorised based on their sensory processing performance (typical performance, probable and definite difference) in the three studied sensory modalities, children with ASC in the *typical* and *definite difference* performance group (as seen in Tables 4.3.1 and 4.3.2) showed significantly more problematic eating behaviour than the children from the control group. These findings indicate that among the children who presented with a problematic sensory performance (*definite difference*) from both groups, children with ASC showed more problematic eating behaviour. When sensory processing problems were not an issue (*typical* sensory performance) among the two diagnostic groups, children with ASC still presented with more problematic eating behaviour. In addition, it was observed that among the control children in the definite difference category, the highest percentage was found in the smell taste sensory modality, while in the ASC group the higher frequency of children with definite difference was noticed in the tactile sensitivity category (See Table 4.1). Future research needs further investigate whether taste-smell sensitivity is significantly more common among children following a typical development who present with sensory difficulties. It would also be of interest to explore whether tactile sensitivity is most common among children with ASC with sensory difficulties.

In Chapter 5 it was found that the sensory processing skills of the pre-schoolers were related to their willingness to try the vegetable options offered, as children with a greater taste/smell sensitivity preferred a vegetable with a perceived ‘liked’ taste, even if the texture it was presented in was not commonly encountered. This finding suggests that the sensory processing profile of the children can affect their willingness to try food, and could possibly form the basis of future practices on what is the best way to present food to children with greater taste/smell sensitivity. Interestingly, this finding was consistent in Chapter 6, as more taste/smell sensitive adults were found to be more willing to try the vegetable of a perceived ‘liked’ taste even if it was prepared in an uncommon way, suggesting that the association between taste/smell sensitivity and willingness to try a liked vegetable offered in an unfamiliar texture (LVUT) is consistent in preschool age and adulthood.

7.3.4 Autistic traits-Autism Spectrum Diagnosis

Analysis of the cross-sectional data on the early feeding behaviour of the sample in Chapter 3 showed that children with ASC presented with a more problematic eating performance from an early age. This finding is in agreement with previous findings from a longitudinal study (ALSPAC-Emond, Emmett, Steer & Golding, 2010) and it may be that these eating difficulties follow children with ASC into childhood. Furthermore, the present thesis found that differences in eating behaviour in children with ASC became apparent around the time that they were introduced to family food, although previous research has placed early feeding problems as appearing earlier, when infants are firstly introduced to solids. Therefore there is a need for further research, preferably following a longitudinal design, in order to replicate these findings and to identify the age of onset of eating problems in children with ASC. Future research needs to explore whether these difficulties are solely related to eating selectivity and rigidness around food, or also describe a more negative behaviour during mealtime that could be the outcome of a sensory overload, or due to social/communication challenges from the eating environment.

Overall results from Chapters 3 and 4 illustrated that children with ASC present a significantly more problematic current eating profile in comparison to the control group. Children with ASC showed significantly higher food neophobia, greater eating selectivity, higher rigid/perseverant eating behaviour and texture selectivity. Additionally, as expected, children with ASC demonstrated greater sensory sensitivity, with 53.9 % of children with ASC classified as having a *definite difference* in terms of their visual/auditory processing, 68.3% with a *definite difference* in terms of their tactile sensitivity and 61.4% with a *definite difference* in terms of their taste/smell sensitivity.

Given the health benefits of a higher fruit and vegetable intake (Graf, Reidy & Kaskel, 2016), Chapter 6 attempted to shed more light on the vegetable eating preferences of individuals with autistic traits. It was found that the existence of autistic traits can work as a restrictive force towards eating, even in highly functioning individuals (e.g. University students). A strong correlation was found between higher autistic traits and a higher number of ‘never tried’ vegetables, suggesting that these individuals were significantly more reluctant to try new vegetables. Additionally, a higher level of autistic traits was linked to lower willingness to try the raw blemished vegetable (RBV). This finding is in agreement with previous studies (Happé & Frith, 2006; Lopez, Tchanturia, Stahl & Treasure, 2008) highlighting the adherence to local rather than global visual features when visually processing food. This suggestion was also corroborated by the finding of a strong correlation between greater difficulties in attention switching and unwillingness to try the RBV. The finding highlights that individuals with higher levels of autistic traits, when the visual perceptual qualities of the food differ from the common (uniform image), can be negatively affected in their willingness to try food. In addition, individuals with higher autistic traits were more willing to try the disliked vegetable when offered in familiar texture (DVFT), suggesting that vegetable options with presentations that differ from those to which they are used to are less appealing to individuals with higher autistic traits. This highlights how important a ‘uniform’ look in the appearance of the food is for these individuals.

With these findings in mind, one could conclude that the appearance and the texture of the food plays an important role in how individuals with autistic traits select their food. Consequently, visual and tactile sensory processing should be considered when studying the eating preferences and willingness to try food of individuals with autistic traits or an ASC diagnosis.

7.4 A model describing the factors affecting the eating behaviour of the sample

Figure 7.1 Eating behaviour in typically developing children

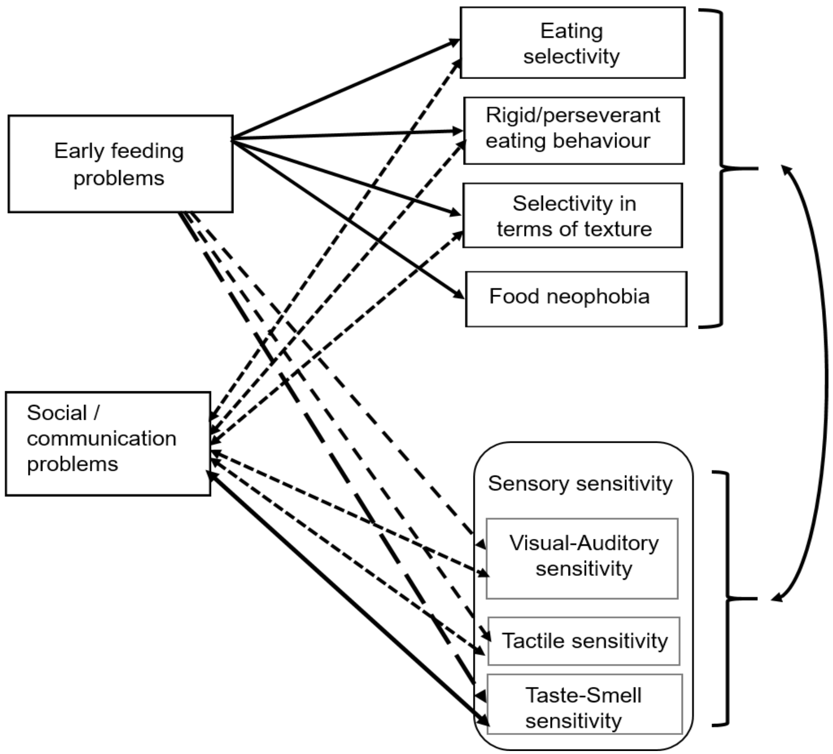
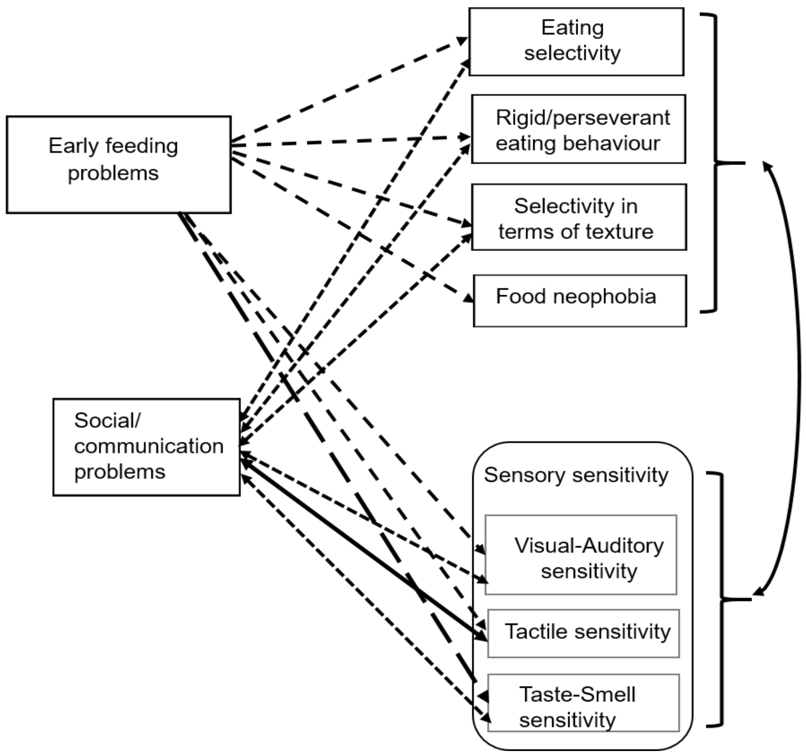


Figure 7.2 Eating behaviour in children with ASC



Figures 7.1 and 7.2 illustrate the links between factors affecting eating behaviour in children following a typical development (left) and children with ASC (right), as identified in the present thesis. Solid arrows represent strong links while dashed arrows represent links that need to be further investigated. Bi-directional arrows illustrate correlations, one directional arrows indicate time of appearance and not causality.

Figures 7.1 and 7.2 summarise the links between the factors affecting the eating behaviour in the typically developing children and children with ASC of the sample. As problems in five out of the six studied early feeding stages were linked to a more problematic eating profile (eating selectivity, rigid eating and selectivity in terms of texture and food neophobia) in the control group, solid arrows connect early feeding problems and the three FBC subcategories (Figure 7.1). In the ASC group, problems in only two of the studied early feeding stags signalled greater problematic eating behaviour in childhood, therefore dashed arrows connect early feeding problems and the three FBC subcategories and food neophobia (Figure 7.2). It is possible that feeding problems with an onset in infancy/toddlerhood follow these individuals into childhood and therefore the arrows linking early feeding problems and the three FBC subcategories in figure 7.1 and 7.2 could be bi-directional, however this is something that needs further investigation.

The results of the thesis suggest that problems in a *greater number* of early feeding stages are linked to later reports of greater taste/smell sensitivity in both groups, consequently the arrows linking early feeding problems and taste/smell sensitivity are thicker (Figure 7.1 and 7.2).

Moreover, given that correlation analysis did not reveal a link between all of the subcategories of the SCQ and the FBC subcategories, dashed arrows connect social/communication problems and eating selectivity, rigid/perseverant eating and selectivity in terms of texture in both groups. Given that a strong correlation was found between all of the SCQ subcategories and a greater taste/smell sensitivity in the control group, a solid arrow links social and communication problems with taste/smell sensitivity. A strong correlation between all of the SCQ subcategories and the tactile sensitivity was found in children with ASC, therefore a solid arrow connects social/communication problems and tactile sensitivity.

Finally, the results showed that all of the subcategories of the SSP (visual-auditory, tactile and taste-smell sensitivity) were linked with a more problematic eating profile (eating selectivity, rigid/perseverant eating, selectivity in terms of texture and food neophobia) in both groups, consequently solid arrows connect the FBC subcategories and food neophobia with sensory sensitivity (Figure 7.1 and 7.2). These findings highlight that there are probably more similarities than differences in the patterns of relationships for both groups.

7.5 Methodological strengths and weaknesses and suggestions for future research

Details of the strengths and limitations of each study can be found in the respective chapters, therefore this section will mainly focus on the strengths and limitations of the thesis as a whole.

The studies included within this thesis used a variety of research designs and large samples consisting of typically developing and ASC populations which varied in terms of age, gender and ethnicity. Another strength of this thesis is that, as opposed to previous research using generic terms such as ‘picky’/selective eating to describe a wide variety of eating behaviours, the present thesis, with the use of the FBC, sets a clearer picture of the type of eating difficulties that typically developing children and children with ASC present. This thesis further identifies the potential of developing the FBC questionnaire as a diagnostic tool for eating disorders in childhood, such as Avoidant/Restrictive Food Intake Disorder (ARFID), in which children’s food choices are limited by the food’s appearance, smell, taste, texture or previous negative experiences with food (DSM-V, APA, 2013).

Furthermore, in terms of originality, the study described in Chapter 4 is the first to investigate the association between problematic eating, sensory sensitivity and problematic social/communication and behaviour problems in children with and without ASC. Among the strengths of the research designs followed in Chapter 5 and Chapter 6 is the consideration of previous vegetable eating preferences when studying willingness to try vegetables, and these two studies are among the first to use real food stimuli tailored to the participants' preferences. Additionally, the study described in Chapter 6 is the first to explore how food neophobia, sensory sensitivity and the existence of autistic traits influence the willingness to try vegetables.

Nevertheless, the studies described in this thesis also presented some limitations, which should be considered in order to shape future research. In this thesis the use of an electronic questionnaire allowed for the collection of data from people of a wide cultural and ethnic background, which increases the generalisability of the results. However, this methodology moderated the range of the information collected from parents, consequently detailed information on the nature of the early feeding problems were missed. In addition, the wide age range used in this study meant that some parents/carers had to recall early feeding behaviour of their children from over 10 years ago. Therefore future research specifically focusing on early feeding behaviour would benefit from a longitudinal research design, ideally a birth cohort study. This would diminish the possibility of parents over-reporting early problematic eating behaviour due to their child's subsequent ASC diagnosis or the presence of a more problematic eating profile in childhood.

Another limitation of this thesis was that the inclusion and exclusion of prospective participants according to their diagnosis was based on parents'/carers' reports. Given that an electronic questionnaire was used as a recruitment method, Study A could not include any screening which required physical presence, such as ADOS-II (Lord, Rutter, DiLavore, Risi, Gotham & Bishop, 2012). Future research should aim to use an observational research design which will include further validation of the diagnostic status of the children, and will enable a comparison between the eating behaviour performance and the severity of the ASC symptoms. Given that the participants did not eat the food, willingness to try ratings might not actually translate to eating behaviour. Therefore, future research of an observational design including food consumption will allow researchers to effectively explore, in practice, how eating behaviours such as food neophobia, selective eating, rigid/perseverant eating and texture selectivity can affect eating preferences (e.g. by exploring factors such as taste liking and the effect of visual properties of food) and food consumption in children with ASC and typically developing children. Finally, the data analysis used in this thesis was somewhat compromised in terms of complexity (e.g. models of correlation could not be used) as it was limited in statistical analysis appropriate for nonparametric data.

7.6 Implications

According to the retrospective parental reports, it was suggested that children with ASC had a significantly higher prevalence of feeding difficulties around the age of 15-18 months. Rejection of new or previously accepted food towards the end of the second year of life has commonly been reported in research in children as a result of the increase of food neophobia (Cashdan, 1998). Therefore, around this age children with ASC and typically developing children may follow a more narrow or rigid diet. Consequently, as previous literature has recommended (Coulthard, Harris & Fogel, 2014), parents should attempt to benefit from the flexibility in acceptance that children show early in life (between 4 and 6 months), and provide their children with the opportunity to be exposed to, and gain eating experiences of, a wide variety of food before this ‘challenging’ feeding period (given that food neophobia peaks around 15-18 months) (Brown & Harris, 2012). In this way, toddlers will familiarise themselves with a range of tastes and textures, as well as the visual properties of the food, which have been shown to play a crucial role in food acceptance, especially in children with ASC. Shaping a wide base of eating experiences may then limit the negative factors leading to food rejection later in toddlerhood and will have a positive effect on their eating preferences in childhood.

The findings of this thesis highlighted that sensory processing skills play a crucial role in the eating behaviour of both typically developing individuals and individuals with ASC. In the control group, children with greater eating problems may have started having difficulties as early as the introduction to complementary food. In such cases, where mothers may have tried hard to shape a wide base of eating experiences for their children, perhaps sensory processing problems may also play a negative role leading to more restrictive eating. Therefore, from a clinical standpoint it is essential for clinicians and consultants working with populations with eating problems (such as eating selectivity, perseverant eating and texture selectivity) to also assess and consider the sensory processing performance of their clients. For these individuals, recognising the level of their sensory processing problems and providing them with sensory processing interventions such as sensory desensitization (looking at, smelling, and touching foods) is paramount in order increase food acceptance (Dazeley & Housten-Price, 2015).

The finding that a more problematic eating profile commonly co-existed with greater difficulty in other domains such as social/ communication and behaviour across the sample implies that from a clinical standpoint a multidisciplinary approach is needed to assess cases of problematic eating especially in children with ASC (Rommel, De Meyer, Feenstra & Veereman-Wauters, 2003). Moreover, the findings of the present thesis should alert clinicians towards the importance of monitoring the eating behaviour of children with ASC from the moment they receive their diagnosis, by incorporating a detailed record of the eating development in their follow up assessments. In this way, with the right help, difficulties could be recognised before becoming increasingly intractable. Parents of children with ASC could benefit from understanding that the types of aberrant eating behaviour that their children present are not ASC specific, and that these eating behaviours are also common in typically developing children. This may help them understand that eating problems may not be directly related to their parenting skills and may help to diminish some of the stress related to their child's problematic eating behaviour.

7. 7 Summary and explanation of main findings

Overall this thesis showed that there is great similarity between the associations of factors affecting eating behaviour in children with ASC and typically developing children, however, children with ASC still presented a significantly more problematic eating profile.

As eating is a complicated procedure that requires skills from various developmental domains (e.g. oral-motor, social/communication, feeding skills, Arvedson, 2006; Birch, 1999; Gisel, 1991), it may be that in children with ASC, the developmental nature of the disorders means that eating development progresses slowly or gets ‘caught up’ in certain developmental stages. Consequently, even if children have been successfully developing in one domain, developmental delay in other domains may still create problems with eating. This could possibly explain the various levels of severity in the appearance of eating difficulties in children with ASC, and also explain why children with ASC occasionally present with no eating difficulties. In line with this, an earlier study had suggested that it may take more time for children with ASC to ‘overcome’ eating difficulties (Martins, Young and Robson 2008), consequently when they present difficulties in a feeding stage they take longer to master the feeding skills of this stage before progressing to the next one. It could also be that for children with ASC, it takes more time to get used to or accept a new food than it does for typically developing children.

Furthermore, social and communication difficulties are perhaps another developmental obstacle which may hinder the broadening of their eating repertoire through positive social modeling, as children with ASC often adhere to a few trusted food options and do not copy what the family eats. Brisson and colleagues (2012), in an attempt to justify why children with ASC present significantly more prevalent and severe problematic eating, suggested that typically developing infants, unlike ASC infants, could learn through a repeated action such as spoon feeding, and successfully adapt to how to best react when they see the spoon. Perhaps children with ASC need more time to understand and learn how to react to goal-directed mealtime behaviour (Hamilton, 2009). As a result, common ways that parents prompt children to try something new, or encourage a balanced and varied diet (e.g. continuous exposure), would be less effective.

Finally, given the diversity of the symptom severity of individuals with ASC, it could be that different combinations of all, or some, of the previously mentioned factors result in greater eating difficulties in this population.

7.8 Conclusion

This thesis provides an insight into the type, frequency and severity of eating difficulties in children with ASC and their typically developing peers. Children with ASC presented with significantly more early feeding problems in the transition from lumpy to family foods, and during the toddler period in comparison to the control group. Whether these early feeding problems are linked with a developmental disruption or are a consequence of the onset of autistic symptomatology is something that remains to be explored.

A strong association was identified between problematic eating behaviour, sensory sensitivity and greater difficulties in the social/communication and behavioural performance both in children with and without ASC. The overall findings of this thesis revealed that eating behaviour follows the same course/ route of development (See Figures 7.1 and 7.2), in both typically developing and children with ASC. Sensory sensitivity was identified as a restrictive force negatively affecting eating in typically developing children and children with ASC. However, when children of the sample were categorised based on their sensory processing performance in the three studied sensory processing modalities, children with ASC in the typical and definite difference performance groups showed significantly more problematic eating behaviour than did the control children. These findings suggest that there are other factors, possibly related to their diagnosis, that are causing the children of this group to present with significantly more problematic eating.

REFERENCE LIST

Addessi, E., Galloway, A. T., Visalberghi, E., & Birch, L. L. (2005). Specific social influences on the acceptance of novel foods in 2–5-year-old children. *Appetite, 45*(3), 264-271. doi:10.1016/j.appet.2005.07.007

Ahearn, W. H. (2003). Using simultaneous presentation to increase vegetable consumption in a mildly selective child with autism. *Journal of Applied Behavior Analysis, 36*(3), 361-365.

Ahearn, W., Castine, T., Nault, K., & Green, G. (2001). An assessment of food acceptance in children with autism or pervasive developmental disorder-not otherwise specified. *Journal of Autism and Developmental Disorders, 31*(5), 505-511. doi:1012221026124

American Psychiatric Association (2000). *Diagnostic and statistical manual-text revision (DSM-IV-TRim, 2000)* American Psychiatric Association.

American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders (DSM-V).* American Psychiatric Association

Arvedson, J. C. (2006). Swallowing and feeding in infants and young children. *GI Motility Online,*

Ayres, A. J. (1979). *Sensory integration and the child*. United States: CA: Western Psychological Services.

Babayan, S. Y., Budayr, B., & Lindgren, H. C. (1966). Age, sex, and culture as variables in food aversion. *The Journal of Social Psychology, 68*(1), 15-17. doi:10.1080/00224545.1966.9919660

Babbitt RL, Hoch TA, Coe DA. (1994). Behavioral feeding disorders. In W. R. Tuchman DN (Ed.), *Disorders of feeding and swallowing in infants and children* (pp. 77–95). San Diego: Singular.

Badalyan, V., & Schwartz, R. H. (2011). Feeding problems and GI dysfunction in children with asperger syndrome or pervasive developmental disorder not otherwise specified; comparison with their siblings. *Open Journal of Pediatrics, 1*(4), 51-63. doi:10.4236/ojped.2011.14014

Bandini, L. G., Anderson, S. E., Curtin, C., Cermak, S., Evans, E. W., Scampini, R., & et al. (2010). Food selectivity in children with autism spectrum disorders and typically developing children. *Journal of Pediatrics, 157*(2), 259-264. doi:10.1016/j.jpeds.2010.02.013

Baranek, G. T., David, F. J., Poe, M. D., Stone, W. L., & Watson, L. R. (2006). Sensory experiences questionnaire: Discriminating sensory features in young children with autism, developmental delays, and typical development. *Journal of Child Psychology and Psychiatry, 47*(6), 591-601. doi:10.1111/j.1469-7610.2005.01546.x

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubley, E. (2001). The autism-spectrum quotient (AQ): Evidence from asperger syndrome/high-functioning autism, males and females, scientists and mathematicians. *Journal of Autism and Developmental Disorders, 31*(1), 5.

Baron-Cohen, S. (2002). The extreme male brain theory of autism. *Trends in Cognitive Sciences, 6*(6), 248-254.

Baron-Cohen, S., Hoekstra, R., Knickmeyer, R., & Wheelwright, S. (2006). The autism-spectrum quotient (AQ)—Adolescent version. *Journal of Autism and Developmental Disorders, 36*(3), 343-350. doi:10.1007/s10803-006-0073-6

Bartoshuk, L. M., Duffy, V. B., & Miller, I. J. (1994). PTC/PROP tasting: Anatomy, psychophysics, and sex effects. *Physiology & Behavior, 56*(6), 1165-1171. doi:10.1016/0031-9384(94)90361-1

Bentley, M. E., Dee, D. L., & Jensen, J. L. (2003). Breastfeeding among low income, african-american women: Power, beliefs and decision making. *The Journal of Nutrition, 133*(1), 305S.

Birch, L. L. (1999). Development of food preferences. *Annual Review of Nutrition, 19*(1), 41-62. doi:10.1146/annurev.nutr.19.1.41

Birch, L. L., & Fisher, J. O. (1998). Development of eating behaviors among children and adolescents. *Pediatrics, 101*(3 Pt 2), 539.

Birch, L. L., Gunder, L., Grimm-Thomas, K., & Laing, D. (1998). Infants' consumption of a new food enhances acceptance of similar foods. *Appetite, 30*(3), 283-295. doi:10.1006/appe.1997.0146

Birch, L. L., & Sullivan, S. A. (1991). Measuring children's food preferences. *The Journal of School Health, 61*(5), 212.

Birch, L. L., McPhee, L., Sullivan, S., & Johnson, S. (1989). Conditioned meal initiation in young children. *Appetite, 13*(2), 105-113. doi:10.1016/0195-6663(89)90108-6

Birch, L. L., & Marlin, D. W. (1982). I don't like it; I never tried it: Effects of exposure on two-year-old children's food preferences. *Appetite, 3*(4), 353-360. doi:10.1016/S0195-6663(82)80053-6

Birch, L. L. (1998). Development of food acceptance patterns in the first years of life. *Proceedings of the Nutrition Society, 57*(4), 617-624. doi:10.1079/PNS19980090

Birch, L. L. (1999). Development of food preferences. *Annual Review of Nutrition, 19*(1), 41-62.

Birch, L. L., Gunder, L., Grimm-Thomas, K., & Laing, D. G. (1998). Infants' consumption of a new food enhances acceptance of similar foods. *Appetite, 30*(3), 283-295.

Birch, L. L. (1980). Effects of peer models' food choices and eating behaviors on preschoolers' food preferences. *Child Development, 51*(2), 489-496. doi:10.2307/1129283

Blissett, J., Meyer, C., & Haycraft, E. (2011). The role of parenting in the relationship between childhood eating problems and broader behaviour problems. *Child: Care, Health and Development, 37*(5), 642-648. doi:10.1111/j.1365-2214.2011.01229.x

Blissett, J., Bennett, C., Donohoe, J., Rogers, S., & Higgs, S. (2012). Predicting successful introduction of novel fruit to preschool children. *Journal of the Academy of Nutrition and Dietetics, 112*(12), 1959-1967.

Blossfeld, I., Collins, A., Kiely, M., & Delahunty, C. (2007). Texture preferences of 12-month-old infants and the role of early experiences. *Food Quality and Preference, 18*(2), 396-404. doi:10.1016/j.foodqual.2006.03.022

Branen, L., & Fletcher, J. (1999). Comparison of college students' current eating habits and recollections of their childhood food practices. *Journal of Nutrition Education, 31*(6), 304-310.

Brion, M. A., Lawlor, D. A., Matijasevich, A., Horta, B., Anselmi, L., Araújo, C. L., . . . Smith, G. D. (2011). What are the causal effects of breastfeeding on IQ, obesity and blood pressure? evidence from comparing high-income with middle-income cohorts. *International Journal of Epidemiology, 40*(3), 670-680. doi:10.1093/ije/dyr020

Brisson, J., Warreyn, P., Serres, J., Foussier, S., & Adrien-Louis, J. (2012). Motor anticipation failure in infants with autism: A retrospective analysis of feeding situations. *Autism, 16*(4), 420-429.

Brown, C., & Dunn, W. (2002). *Adolescent-adult sensory profile: User's manual* Therapy Skill Builders San Antonio.

Brown, S., & Harris, G. (2012a). Disliked food acting as a contaminant during infancy. A disgust based motivation for rejection. *Appetite, 58*(2), 535-538. doi:10.1016/j.appet.2012.01.010

Brown, S., Harris, G., Bell, L., & Lines, L. M. (2012). Disliked food acting as a contaminant in a sample of young children. *Appetite, 58*(3), 991. doi:10.1016/j.appet.2012.02.047

Brown, S. (2010). *The rejection of known and previously accepted foods in early childhood (doctoral dissertation)* Available from University of Birmingham Research Archive.

Brown, S. D., & Harris, G. (2012b). Rejection of known and previously accepted foods during early childhood: An extension of the neophobic response? *International Journal of Child Health and Nutrition, 1*(1), 72-81.

Brug, J., Tak, N. I., te Velde, S. J., Bere, E., & de Bourdeaudhuij, I. (2008). Taste preferences, liking and other factors related to fruit and vegetable intakes among schoolchildren: Results from observational studies. *British Journal of Nutrition, 99*(S1), S14. doi:10.1017/S0007114508892458

Bryant-Waugh, R., Markham, L., Kreipe, R. E., & Walsh, B. T. (2010). Feeding and eating disorders in childhood. *The International Journal of Eating Disorders, 43*(2), NA. doi:10.1002/eat.20795

Buckley, S. D., & Newchok, D. K. (2005). Differential impact of response effort within a response chain on use of mands in a student with autism. *Research in Developmental Disabilities, 26*(1), 77-85.

Buie, T., Campbell, D. B., Fuchs, G. J., III, Furuta, G. T., Levy, J., VandeWater, J., Winter, H. (2010). Evaluation, diagnosis, and treatment of gastrointestinal disorders in individuals with ASDs: A consensus report. *Pediatrics, 125*(Supplement), S18. doi:10.1542/peds.2009-1878C

Burklow, K., Phelps, A., Schultz, J., McConnell, K., & Rudolph, C. (1998). Classifying complex pediatric feeding disorders. *Journal of Pediatric Gastroenterology & Nutrition, 27*(2), 143-147. doi:10.1097/00005176-199808000-00003

Carruth, B. R., Skinner, J., Houck, K., Moran III, J., Coletta, F., & Ott, D. (1998). The phenomenon of “picky eater”: A behavioral marker in eating patterns of toddlers. *Journal of the American College of Nutrition, 17*(2), 180-186.

Carruth, B. R., Ziegler, P. J., Gordon, A., & Barr, S. I. (2004). Prevalence of picky eaters among infants and toddlers and their caregivers’ decisions about offering a new food. *Journal of the American Dietetic Association, 104*(1 Suppl 1), 57-64. doi:10.1016/j.jada.2003.10.024

Case-Smith, J., Weaver, L., & Fristad, M. (2015). A systematic review of sensory processing interventions for children with autism spectrum disorders. *Autism, 19*(2), 133-148. doi:10.1177/1362361313517762

Cashdan, E. (1994). A sensitive period for learning about food. *Human Nature (Hawthorne, N.Y.), 5*(3), 279-291. doi:10.1007/BF02692155

Cashdan, E. (1998). Adaptiveness of food learning and food aversions in children. *Social Science Information, 37*(4), 613-632. doi:10.1177/053901898037004003

Cermak, S., Curtin, C., & Bandini, L. G. (2010). Food selectivity and sensory sensitivity in children with autism spectrum disorders. *American Dietetic Association,* , 238-246. doi:10.1016/j.jada.2009.10.032

Cesaroni, L., & Garber, M. (1991). Exploring the experience of autism through firsthand accounts. *Journal of Autism and Developmental Disorders, 21*(3), 303-313. doi:10.1007/BF02207327

Chandler, S. (2007). Validation of the social communication questionnaire in a population cohort of children with autism spectrum disorders. *J Am Acad Child Adolesc Psychiatry, 46*(10), 1324-1332. doi:10.1097/chi.0b013e31812f7d8d

Charman, T., Baird, G., Simonoff, E., Loucas, T., Chandler, S., Meldrum, D., & Pickles, A. (2007). Efficacy of three screening instruments in the identification of autistic-spectrum disorders. *The British Journal of Psychiatry, 191*(6), 554-559. doi:10.1192/bjp.bp.107.040196

Cholemkery, H., Medda, J., Lempp, T., & & Freitag, C. M. (2016). Classifying autism spectrum disorders by ADI-R: Subtypes or severity gradient? *Journal of Autism and Developmental Disorders,* , 1-13.

Clark, B. J., & Laing, S. C. (1990). Infant feeding: A review of weaning. *Journal of Human Nutrition and Dietetics, 3*(1), 11-18. doi:10.1111/j.1365-277X.1990.tb00222.x

Colas, M. V., Vaccaro, J. A., Zarini, G. G., & Huffman, F. G. (2013). Impact of vegetable preparation method and taste-test on vegetable preference for first grade children in the United States. *International Journal of Child Health and Nutrition, 2*(4), 316-325.

Collins, M., & Eaton-Evans, J. (2001). Eating behaviour and food consumption patterns in children with an autistic spectrum disorder and comparison groups of children with down's syndrome and siblings of children with autism or down's syndrome. *Proceedings of the Autism Odyssey, Collected Papers, Durham Conference,*

Constantino, J., Davis, S., Todd, R., Schindler, M., Gross, M., Brophy, S., . . . Reich, W. (2003). Validation of a brief quantitative measure of autistic traits: Comparison of the social responsiveness scale with the autism diagnostic interview-revised. *Journal of Autism and Developmental Disorders, 33*(4), 427-433. doi:1025014929212

Cooke, L. J., Wardle, J., Gibson, E., Sapochnik, M., Sheiham, A., & Lawson, M. (2004). Demographic, familial and trait predictors of fruit and vegetable consumption by pre-school children. *Public Health Nutrition, 7*(2), 295-302. doi:10.1079/PHN2003527

Cooke, L., Wardle, J., & Gibson, E. L. (2003). Relationship between parental report of food neophobia and everyday food consumption in 2–6-year-old children. *Appetite, 41*(2), 205-206. doi:10.1016/S0195-6663(03)00048-5

Cooke, L., Carnell, S., & Wardle, J. (2006). Food neophobia and mealtime food consumption in 4-5 year old children. *The International Journal of Behavioral Nutrition and Physical Activity, 3*(1), 14. doi:10.1186/1479-5868-3-14

Coombs, E., Brosnan, M., Bryant-Waugh, R., & Skevington, S. M. (2011). An investigation into the relationship between eating disorder psychopathology and autistic symptomatology in a non-clinical sample. *The British Journal of Clinical Psychology / the British Psychological Society, 50*(3), 326.

Cornish, E. (1998). A balanced approach towards healthy eating in autism. *Journal of Human Nutrition and Dietetics, 11*(6), 501-509.

Corsello, C., Hus, V., Pickles, A., Risi, S., Cook, E. H., Leventhal, B. L., & Lord, C. (2007). Between a ROC and a hard place: Decision making and making decisions about using the SCQ. *Journal of Child Psychology and Psychiatry, 48*(9), 932-940. doi:10.1111/j.1469-7610.2007.01762.x

Coulthard, H., & Harris, G. (2003). Early food refusal: The role of maternal mood. *Journal of Reproductive and Infant Psychology, 21*(4), 335-345. doi:10.1080/02646830310001622097

Coulthard, H., & Blissett, J. (2009). Fruit and vegetable consumption in children and their mothers. moderating effects of child sensory sensitivity. *Appetite, 52*(2), 410-415. doi:10.1016/j.appet.2008.11.015

Coulthard, H., Harris, G., & Emmett, P. (2009). Delayed introduction of lumpy foods to children during the complementary feeding period affects child's food acceptance and feeding at 7 years of age. *Maternal & Child Nutrition, 5*(1), 75-85. doi:10.1111/j.1740-8709.2008.00153.x

Coulthard, H., Harris, G., & Fogel, A. (2014). Exposure to vegetable variety in infants weaned at different ages. *Appetite, 78*, 89-94. doi:10.1016/j.appet.2014.03.021

Coulthard, H., Harris, G., & Fogel, A. (2016). Association between tactile over-responsivity and vegetable consumption early in the introduction of solid foods and its variation with age. *Maternal & Child Nutrition,* , n/a. doi:10.1111/mcn.12228

Coury, D. L., Ashwood, P., Fasano, A., Fuchs, G., Geraghty, M., Kaul, A., . . . Jones, N. E. (2012). Gastrointestinal conditions in children with autism spectrum disorder: Developing a research agenda. *Pediatrics, 130 Suppl 2*, S160.

Crook, C. K. (1978). Taste perception in the newborn infant. *Infant Behavior and Development, 1*, 52-69. doi:10.1016/S0163-6383(78)80009-5

Cullen, K. W., Baranowski, T., Rittenberry, L., Cosart, C., Hebert, D., & de Moor, C. (2001). Child-reported family and peer influences on fruit, juice and vegetable consumption: Reliability and validity of measures. *Health Education Research, 16*(2), 187-200. doi:10.1093/her/16.2.187

Dazeley, P., & Houston-Price, C. (2015). Exposure to foods' non-taste sensory properties. A nursery intervention to increase children's willingness to try fruit and vegetables. *Appetite, 84*, 1-6. doi:10.1016/j.appet.2014.08.040

de la Hunty, A. (1995). The COMA report on nutritional aspects of cardiovascular disease. *British Food Journal, 97*(9), 30-32. doi:10.1108/00070709510100145

Delaney, A. L., & Arvedson, J. C. (2008). Development of swallowing and feeding: Prenatal through first year of life. *Developmental Disabilities Research Reviews, 14*(2), 105-117. doi:10.1002/ddrr.16

Delport, S. (2016, January 29). Personal communication (email)

Desor, J. A., Maller, O., & Andrews, K. (1975). Ingestive responses of human newborns to salty, sour, and bitter stimuli. *Journal of Comparative and Physiological Psychology, 89*(8), 966-970. doi:10.1037/h0077171

Dindyal, S., & Dindyal, S. (2003). How personal factors, including culture and ethnicity, affect the choices and selection of food we make. *Internet Journal of Third World Medicine, 1*(2), 27-33.

Dobbelsteyn, C., Marche, D., Blake, K., & Rashid, M. (2005). Early oral sensory experiences and feeding development in children with CHARGE syndrome: A report of five cases. *Dysphagia, 20*(2), 89-100. doi:10.1007/s00455-004-0026-1

Donadini, G., Fumi, M. D., & Porretta, S. (2012). Influence of preparation method on the hedonic response of preschoolers to raw, boiled or oven-baked vegetables. *LWT - Food Science and Technology, 49*(2), 282. doi:10.1016/j.lwt.2012.07.019

Dovey, T. M., Staples, P. A., Gibson, E. L., & Halford, J. C. (2008). Food neophobia and ‘picky/fussy’eating in children: A review. *Appetite, 50*(2), 181-193.

Drewnowski, A. (1989). Sensory preferences for fat and sugar in adolescence and adult life. *Annals of the New York Academy of Sciences, 561*(1 Nutrition and), 243-250. doi:10.1111/j.1749-6632.1989.tb20986.x

Drewnowski, A., Shrager, E. E., Lipsky, C., Stellar, E., & Greenwood, M. R. C. (1989). Sugar and fat: Sensory and hedonic evaluation of liquid and solid foods. *Physiology & Behavior, 45*(1), 177-183. doi:10.1016/0031-9384(89)90182-0

Dunn Winnie. (1999). *The sensory profile manual* San Antonio: The Psychological Corporation.

Dunn, W., Myles, B. S., & Orr, S. (2002). Sensory processing issues associated with asperger syndrome: A preliminary investigation. *The American Journal of*

Occupational Therapy : Official Publication of the American Occupational Therapy Association, 56(1), 97-102. doi:10.5014/ajot.56.1.97

Eeles, A. L., Spittle, A. J., Anderson, P. J., Brown, N., Lee, K. J., Boyd, R. N., & Doyle, L. W. (2013). Assessments of sensory processing in infants: A systematic review. *Developmental Medicine & Child Neurology, 55*(4), 314-326. doi:10.1111/j.1469-8749.2012.04434.x

Emond, A., Emmett, P., Steer, C., & Golding, J. (2010). Feeding symptoms, dietary patterns, and growth in young children with autism spectrum disorders. *Pediatrics, 126*(2), e342. doi:10.1542/peds.2009-2391

Ermer, J., & Dunn, W. (1998). The sensory profile: A discriminant analysis of children with and without disabilities. *The American Journal of Occupational Therapy : Official Publication of the American Occupational Therapy Association, 52*(4), 283.

Faith, M. S., Heo, M., Keller, K. L., & Pietrobelli, A. (2013). Child food neophobia is heritable, associated with less compliant eating, and moderates familial resemblance for BMI. *Obesity, 21*(8), 1650-1655. doi:10.1002/oby.20369

Falciglia, G. A., Couch, S. C., Gribble, L. S., Pabst, S. M., & & Frank, R. (2000). Food neophobia in childhood affects dietary variety. *Journal of the American Dietetic Association, 100*(12), 1474-1481. doi:10.1016/S0002-8223(00)00412-0

Farrow, C. V., & Coulthard, H. (2012). Relationships between sensory sensitivity, anxiety and selective eating in children. *Appetite, 58*(3), 842-846. doi:10.1016/j.appet.2012.01.017

Field, D., Garland, M., & Williams, K. (2003). Correlates of specific childhood feeding problems. *Journal of Paediatrics and Child Health, 39*(4), 299-304. doi:10.1046/j.1440-1754.2003.00151.x

Fischer, A. G., Murray, E. A., & Bundy, A. C. (1991). *Sensory integration: Theory and practice* Philadelphia, FA Davis.

Fisher, J. O., Mitchell, D. C., Smiciklas-Wright, H., & Birch, L. L. (2002). Parental influences on young girls' fruit and vegetable, micronutrient, and fat intakes. *Journal of the American Dietetic Association, 102*(1), 58-64. doi:10.1016/S0002-8223(02)90017-9

Fombonne, E. (2003). Epidemiological surveys of autism and other pervasive developmental disorders: An update. *Journal of Autism and Developmental Disorders, 33*(4), 365-382. doi:1025054610557

Fombonne, E. (2005). The changing epidemiology of autism. *Journal of Applied Research in Intellectual Disabilities, 18*(4), 281-294. doi:10.1111/j.1468-3148.2005.00266.x

Fombonne, E. (2007). Epidemiological surveys of pervasive developmental disorders. *Autism and pervasive developmental disorders* (pp. 33-68).

Cambridge: Cambridge University Press. doi:10.1017/CBO9780511544446.003

Forestell, C. A., & Mennella, J. A. (2007). Early determinants of fruit and vegetable acceptance. *Pediatrics, 120*(6), 1247-1254. doi:10.1542/peds.2007-0858

French, S. A., & Stables, G. (2003). Environmental interventions to promote vegetable and fruit consumption among youth in school settings. *Preventive Medicine, 37*(6), 593-610. doi:10.1016/j.ypmed.2003.09.007

Galloway, A. T., Fiorito, L., Lee, Y., & Birch, L. L. (2005). Parental pressure, dietary patterns, and weight status among girls who are “picky eaters”. *Journal of the American Dietetic Association, 105*(4), 541-548. doi:10.1016/j.jada.2005.01.029

Galloway, A. T., Lee, Y., & Birch, L. L. (2003). Predictors and consequences of food neophobia and pickiness in young girls. *Journal of the American Dietetic Association, 103*(6), 692-698. doi:10.1053/jada.2003.50134

Gibson, E. L., Wardle, J., & Watts, C. J. (1998). Fruit and vegetable consumption, nutritional knowledge and beliefs in mothers and children. *Appetite, 31*(2), 205-228.

Gillberg, C., Ehlers, S., Schaumann, H., Jakobsson, G., Dahlgren, S. O., Lindblom, R., . . . Blidner, E. (1990). Autism under age 3 years: A clinical study of 28 cases referred for autistic symptoms in infancy. *Journal of Child*

Psychology and Psychiatry, and Allied Disciplines, 31(6), 921-934. doi:10.1111/j.1469-7610.1990.tb00834.x

Gisel, E. G. (1991). Effect of food texture on the development of chewing of children between six months and two years of age. *Developmental Medicine and Child Neurology, 33*(1), 69-79. doi:10.1111/j.1469-8749.1991.tb14786.x

Glander, K. E. (1982). The impact of plant secondary compounds on primate feeding behavior. *American Journal of Physical Anthropology, 25*(S3), 1-18. doi:10.1002/ajpa.1330250503

Goodman, R. (1997). The strengths and difficulties questionnaire: A research note. *Journal of Child Psychology and Psychiatry, and Allied Disciplines, 38*(5), 581-586. doi:10.1111/j.1469-7610.1997.tb01545.x

Gotham, K., Bishop, S. L., Hus, V., Huerta, M., Lund, S., Buja, A., . . . Lord, C. (2013). Exploring the relationship between anxiety and insistence on sameness in autism spectrum disorders. *Autism Research, 6*(1), 33-41.

Graf, L., Reidy, K., & Kaskel, F. J. (2016). Nutrition management in childhood kidney disease: An integrative and lifecourse approach. *Pediatric Nephrology,* , 341-360.

Grandin, T. (1995). *Thinking in pictures and other reports from my life with autism* (1. ed. ed.). New York [u.a.]: Doubleday.

Grieger, J. A., Scott, J., & Cobiac, L. (2011). Dietary patterns and breast-feeding in australian children. *Public Health Nutrition, 14*(11), 1939-1947. doi:10.1017/S1368980011001030

Guthrie, C. A., Rapoport, L., & Wardle, J. (2000). Young children's food preferences: A comparison of three modalities of food stimuli. *Appetite, 35*(1), 73-77. doi:10.1006/appe.2000.0329

Hagberg, K. W., & Jick, H. (2010). Autism in the UK for birth cohorts 1988–2001. *Epidemiology, 21*(3), 426-427.

Hamilton, A. F. C. (2009). Research review: Goals, intentions and mental states: Challenges for theories of autism. *Journal of Child Psychology and Psychiatry, 50*(8), 881-892.

Happé, F., & & Frith, U. (2006). The weak coherence account: Detail-focused cognitive style in autism spectrum disorders. *Journal of Autism and Developmental Disorders, 36*(1), 5-25.

Harper, L. V., & Sanders, K. M. (1975). The effect of adults' eating on young children's acceptance of unfamiliar foods. *Journal of Experimental Child Psychology, 20*(2), 206-214.

Harris, G. (2000). Developmental, regulatory and cognitive aspects of feeding disorders. *Feeding problems in children* (pp. 77-89). Oxford: Radcliffe Medical press.

Harris, G. (1993). Introducing the infant's first solid food. *British Food Journal, 95*(9), 7-10. doi:10.1108/00070709310045004

Harris, G. (2008). Development of taste and food preferences in children. *Current Opinion in Clinical Nutrition and Metabolic Care, 11*(3), 315-319. doi:10.1097/MCO.0b013e3282f9e228

Harris, G., Blissett, J., & Johnson, R. (2000). Food refusal associated with illness. *Child and Adolescent Mental Health, 5*(4), 148-156. doi:10.1111/1475-3588.00304

Harris, G., & Coulthard, H. (2016). Early eating behaviours and food acceptance revisited: Breastfeeding and introduction of complementary foods as predictive of food acceptance. *Current Obesity Reports,* , 1-8.

Harris, G., Thomas, A., & Booth, D. A. (1990). Development of salt taste in infancy. *Developmental Psychology, 26*(4), 534.

Hausner, H., Bredie, W. L. P., Mølgaard, C., Petersen, M. A., & Møller, P. (2008). Differential transfer of dietary flavour compounds into human breast milk. *Physiology & Behavior, 95*(1), 118-124. doi:10.1016/j.physbeh.2008.05.007

Hausner, H., Nicklaus, S., Issanchou, S., Mølgaard, C., & Møller, P. (2010). Breastfeeding facilitates acceptance of a novel dietary flavour compound. *Clinical Nutrition, 29*(1), 141-148. doi:10.1016/j.clnu.2009.11.007

Havermans, R. C., Jansen, A., & Nederkoorn, C. (2015). Feel your food : The influence of tactile sensitivity on picky eating in children. *Appetite, 84*, 7-10. doi:10.1016/j.appet.2014.09.014

Heiss, C. J., Moody, L. N., Crosley, J., & Campbell, E. (2005). Nutrient intake and eating behaviors of boys with and without autism. *Journal of the American Dietetic Association, 105*(8), 28. doi:10.1016/j.jada.2005.05.096

Hendrie, G. A., Coveney, J., & Cox, D. (2008). Exploring nutrition knowledge and the demographic variation in knowledge levels in an australian community sample. *Public Health Nutrition, 11*(12), 1365-1371. doi:10.1017/S1368980008003042

Hendy, H. M. (2002). Effectiveness of trained peer models to encourage food acceptance in preschool children. *Appetite, 39*(3), 217-225. doi:10.1006/appe.2002.0510

Hendy, H. M., & Raudenbush, B. (2000). Effectiveness of teacher modeling to encourage food acceptance in preschool children. *Appetite, 34*(1), 61-76. doi:10.1006/appe.1999.0286

Hepper, P. (1995). Human fetal ‘olfactory’ learning. *Int J Prenal Perinat Psychol Med, 2*, 147-151.

Hertzler, A. A. (1983). Children's food patterns--a review: II. family and group behavior. *Journal of the American Dietetic Association, 83*(5), 555.

Hetherington, M. M., Schwartz, C., Madrelle, J., Croden, F., Nekitsing, C., Vereijken, C M J L, & Weenen, H. (2015). A step-by-step introduction to vegetables at the beginning of complementary feeding. the effects of early and repeated exposure. *Appetite, 84*, 280-290. doi:10.1016/j.appet.2014.10.014

Hill, L., Casswell, S., Maskill, C., Jones, S., & Wyllie, A. (1998). Fruit and vegetables as adolescent food choices in new zealand. *Health Promotion International, 13*(1), 55-65. doi:10.1093/heapro/13.1.55

Hilton, C. L., Harper, J. D., Kueker, R. H., Lang, A. R., Abbacchi, A. M., Todorov, A., & LaVesser, P. D. (2010). Sensory responsiveness as a predictor of social severity in children with high functioning autism spectrum disorders. *Journal of Autism and Developmental Disorders, 40*(8), 937-945. doi:10.1007/s10803-010-0944-8

Hobden, K., & Pliner, P. (1995). Effects of a model on food neophobia in humans. *Appetite, 25*(2), 101-114. doi:10.1006/appe.1995.0046

Honey, E., Rodgers, J., & McConachie, H. (2012). Measurement of restricted and repetitive behaviour in children with autism spectrum disorder: Selecting a questionnaire or interview. *Research in Autism Spectrum Disorders, 6*(2), 757-776. doi:10.1016/j.rasd.2011.10.011

Howard, A. J., Mallan, K. M., Byrne, R., Magarey, A., & Daniels, L. A. (2012). Toddlers' food preferences. the impact of novel food exposure, maternal preferences and food neophobia. *Appetite, 59*(3), 818-825. doi:10.1016/j.appet.2012.08.022

Howlin, P. (1997). Prognosis in autism: Do specialist treatments affect long-term outcome? *European Child & Adolescent Psychiatry, 6*(2), 55-72.

Howlin, P., & Moore, A. (1997). Diagnosis in autism a survey of over 1200 patients in the UK. *Autism, 1*(2), 135-162.

Hubbard, K. L., Anderson, S. E., Curtin, C., Must, A., & Bandini, L. G. (2014). A comparison of food refusal related to characteristics of food in children with autism spectrum disorder and typically developing children. *Journal of the Academy of Nutrition and Dietetics, 114*(12), 1981-1987. doi:10.1016/j.jand.2014.04.017

Hursti UkK, & Sjödén Po. (1997). Food and general neophobia and their relationship with self-reported food choice: Familial resemblance in swedish families with children of ages 7–17 years. *Appetite, 29*(1), 89-103. doi:10.1006/appe.1997.0108

Huxham, M. L. (2012). *Feeding problems and current dietary practices in children with autism spectrum disorder in england*

Ibrahim, S. H., Voigt, R. G., Katusic, S. K., Weaver, A. L., & Barbaresi, W. J. (2009). Incidence of gastrointestinal symptoms in children with autism: A population-based study. *Pediatrics, 124*(2), 680-686.

Illingworth, R. S., & Lister, J. (1964). The critical or sensitive period, with special reference to certain feeding problems in infants and children. *The Journal of Pediatrics, 65*(6), 839-848. doi:10.1016/S0022-3476(64)80006-8

Jacobi, C., Agras, W. S., Bryson, S., & Hammer, L. D. (2003). Behavioral validation, precursors, and concomitants of picky eating in childhood. *Journal of the American Academy of Child & Adolescent Psychiatry, 42*(1), 76-84. doi:10.1097/00004583-200301000-00013

Jasmin, E., Couture, M., McKinley, P., Reid, G., Fombonne, E., & Gisel, E. (2009). Sensori-motor and daily living skills of preschool children with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 39*(2), 231-241. doi:10.1007/s10803-008-0617-z

Johnson, C. R., Handen, B. L., Mayer-Costa, M., & Sacco, K. (2008). Eating habits and dietary status in young children with autism. *Journal of Developmental and Physical Disabilities, 20*(5), 437-448.

Johnson, C., Handen, B., Mayer-Costa, M., & Sacco, K. (2008). Eating habits and dietary status in young children with autism. *Journal of Developmental and Physical Disabilities, 20*(5), 437-448. doi:10.1007/s10882-008-9111-y

Johnson, S. L., Davies, P. L., Boles, R. E., Gavin, W. J., & Bellows, L. L. (2015). Young children's food neophobia characteristics and sensory behaviors are related to their food intake. *The Journal of Nutrition, 145*(11), 2610. doi:10.3945/jn.115.199

Kaar, J. L., Shapiro, A. L. B., Fell, D. M., & Johnson, S. L. (2016). Parental feeding practices, food neophobia, and child food preferences: What combination of factors results in children eating a variety of foods? *Food Quality and Preference, 50*, 57-64. doi:10.1016/j.foodqual.2016.01.006

Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous Child, 2*(3), 217.

Keen, D. V. (2008). Childhood autism, feeding problems and failure to thrive in early infancy. *European Child & Adolescent Psychiatry, 17*(4), 209-216. doi:10.1007/s00787-007-0655-7

Kelder, S. H., Perry, C. L., Klepp, K. I., & Lytle, L. L. (1994). Longitudinal tracking of adolescent smoking, physical activity, and food choice behaviors. *American Journal of Public Health, 84*(7), 1121-1126. doi:10.2105/AJPH.84.7.1121

Keller, K. L., Steinmann, L., Nurse, R. J., & Tepper, B. J. (2002). Genetic taste sensitivity to 6-n-propylthiouracil influences food preference and reported intake in preschool children. *Appetite, 38*(1), 3-12. doi:10.1006/appe.2001.0441

Kern, J., Trivedi, M., Garver, C., Grannemann, B., Andrews, A., Savla, J., . . . Schroeder, J. (2006). The pattern of sensory processing abnormalities in autism. *Autism, 10*(5), 480-494. doi:10.1177/1362361306066564

Kerwin, M. E., Eicher, P. S., & Gelsinger, J. (2005). Parental report of eating problems and gastrointestinal symptoms in children with pervasive developmental disorders. *Children's Health Care, 34*(3), 217-234. doi:10.1207/s15326888chc3403_4

Kientz, M. A., & Dunn, W. (1997). A comparison of the performance of children with and without autism on the sensory profile. *The American Journal of Occupational Therapy : Official Publication of the American Occupational Therapy Association, 51*(7), 530-537. doi:10.5014/ajot.51.7.530

Klein, U., & Nowak, A. J. (1999). Characteristics of patients with autistic disorder (AD) presenting for dental treatment: A survey and chart review. *Special Care in Dentistry, 19*(5), 200-207. doi:10.1111/j.1754-4505.1999.tb01386.x

Knaapila, A. J., Sandell, M. A., Vaarno, J., Hoppu, U., Puolimatka, T., Kaljonen, A., & Lagström, H. (2015). Food neophobia associates with lower dietary quality and higher BMI in finnish adults. *Public Health Nutrition, 18*(12), 2161-11. doi:10.1017/S1368980014003024

Kodak, T., & Piazza, C. C. (2008). Assessment and behavioral treatment of feeding and sleeping disorders in children with autism spectrum disorders. *Child and Adolescent Psychiatric Clinics of North America, 17*(4), 887-905.

Koivisto, U., & Sjoden, P. (1996). Food and general neophobia in swedish families: Parent-child comparisons and relationships with serving specific foods. *Appetite, 26*, 107.

Kozlowski, A., Matson, J., Fodstad, J., & Moree, B. (2011). Feeding therapy in a child with autistic disorder: Sequential food presentation. *Clinical Case Studies, 10*(3), 236-246. doi:10.1177/1534650111405189

Kral, T. V., Eriksen, W. T., Souders, M. C., & Pinto-Martin, J. A. (2013). Eating behaviors, diet quality, and gastrointestinal symptoms in children with autism spectrum disorders: A brief review. *Journal of Pediatric Nursing, 28*(6), 548-556.

Krølner, R., Rasmussen, M., Brug, J., Klepp, K., Wind, M., & Due, P. (2011). Determinants of fruit and vegetable consumption among children and adolescents: A review of the literature. part II: Qualitative studies. *International Journal of Behavioral Nutrition and Physical Activity, 8*(1), 112.

Kunihira, Y., Senju, A., Dairoku, H., Wakabayashi, A., & Hasegawa, T. (2006). 'Autistic'traits in non-autistic japanese populations: Relationships with personality traits and cognitive ability. *Journal of Autism and Developmental Disorders, 36*(4), 553-566.

Lafraire, J., Rioux, C., Giboreau, A., & Picard, D. (2016). Food rejections in children: Cognitive and social/environmental factors involved in food neophobia and picky/fussy eating behavior. *Appetite, 96*, 347-357. doi:10.1016/j.appet.2015.09.008

Laud, R., Girolami, P., Boscoe, J., & Gulotta, C. (2009). Treatment outcomes for severe feeding problems in children with autism spectrum disorder. *Behavior Modification, 33*(5), 520-536.

Le Couteur, A., Rutter, M., Lord, C., Rios, P., Robertson, S., Holdgrafer, M., & McLennan, J. (1989). Autism diagnostic interview: A standardized investigator-based instrument. *Journal of Autism and Developmental Disorders, 19*(3), 363-387. doi:10.1007/BF02212936

Leekam, S., Nieto, C., Libby, S., Wing, L., & Gould, J. (2007). Describing the sensory abnormalities of children and adults with autism. *Journal of Autism and Developmental Disorders, 37*(5), 894-910. doi:10.1007/s10803-006-0218-7

Legge, B. (2002). *Can't eat, won't eat: Dietary difficulties and autistic spectrum disorders.* Jessica Kingsley Publishers.

Levy, S. E., Mandell, D. S., Merhar, S., Ittenbach, R. F., & Pinto-Martin, J. A. (2003). Use of complementary and alternative medicine among children recently diagnosed with autistic spectrum disorder. *Journal of Developmental & Behavioral Pediatrics, 24*(6), 418-423.

Levy, S. E., Souders, M. C., Ittenbach, R. F., Giarelli, E., Mulberg, A. E., & Pinto-Martin, J. A. (2007). Relationship of dietary intake to gastrointestinal symptoms in children with autistic spectrum disorders. *Biological Psychiatry, 61*(4), 492-497. doi:10.1016/j.biopsych.2006.07.013

Lioret, S., Betoko, A., Forhan, A., Charles, M., Heude, B., & de Lauzon-Guillain, B. (2015). Dietary patterns track from infancy to preschool age: Cross-sectional and longitudinal perspectives. *The Journal of Nutrition, 145*(4), 775. doi:10.3945/jn.114.201988

Lockner, D. W., Crowe, T. K., & Skipper, B. J. (2008). Dietary intake and parents' perception of mealtime behaviors in preschool-age children with autism spectrum disorder and in typically developing children. *Journal of the American Dietetic Association, 108*(8), 1360-1363.

Logue, A. W., & Smith, M. E. (1986). Predictors of food preferences in adult humans. *Appetite, 7*(2), 109-125.

Lopez, C., Tchanturia, K., Stahl, D., & Treasure, J. (2008). Central coherence in eating disorders: A systematic review. *Psychological Medicine, 38*(10), 1393-1404. doi:10.1017/S0033291708003486

Lord, C., Rutter, M., DiLavore, P. C., Risi, S., Gotham, K., & Bishop, S. (2012). *Autism diagnostic observation schedule: ADOS-2* Western Psychological Services Los Angeles, CA.

Lukens, C., & Linscheid, T. (2008). Development and validation of an inventory to assess mealtime behavior problems in children with autism. *Journal of Autism and Developmental Disorders, 38*(2), 342-352. doi:10.1007/s10803-007-0401-5

Lundy, B., Field, T., Carraway, K., Hart, S., Malphurs, J., Rosenstein, M., . . . Hernandez-Reif, M. (1998). Food texture preferences in infants versus toddlers. *Early Child Development and Care, 146*(1), 69-85. doi:10.1080/0300443981460107

Maier, A., Chabanet, C., Schaal, B., Issanchou, S., & Leathwood, P. (2007). Effects of repeated exposure on acceptance of initially disliked vegetables in 7-month old infants. *Food Quality and Preference, 18*(8), 1023-1032.

Mandell, D. S., Listerud, J., Levy, S. E., & Pinto-Martin, J. A. (2002). Race differences in the age at diagnosis among medicaid-eligible children with autism. *Journal of the American Academy of Child & Adolescent Psychiatry, 41*(12), 1447-1453.

Marcontell, D. K., Laster, A. E., & Johnson, J. (2003). Cognitive-behavioral treatment of food neophobia in adults. *Journal of Anxiety Disorders, 17*(2), 243-251. doi:10.1016/S0887-6185(01)00090-1

Marquenie, K., Rodger, S., Mangohig, K., & Cronin, A. (2011). Dinnertime and bedtime routines and rituals in families with a young child with an autism spectrum disorder. *Australian Occupational Therapy Journal, 58*(3), 145-154. doi:10.1111/j.1440-1630.2010.00896.x

Martins, Y., & Pliner, P. (2005). Human food choices: An examination of the factors underlying acceptance/rejection of novel and familiar animal and nonanimal foods. *Appetite, 45*(3), 214-224. doi:10.1016/j.appet.2005.08.002

Martins, Y., Young, R., & Robson, D. (2008). Feeding and eating behaviors in children with autism and typically developing children. *Journal of Autism and Developmental Disorders, 38*(10), 1878-1887. doi:10.1007/s10803-008-0583-5

Mason, S. J., Harris, G., & Blissett, J. (2005). Tube feeding in infancy: Implications for the development of normal eating and drinking skills. *Dysphagia, 20*(1), 46-61.

McFarlane, T., & Pliner, P. (1997). Increasing willingness to taste novel foods: Effects of nutrition and taste information. *Appetite, 28*(3), 227-238.

McIntosh, D. N., Miller, L. J., Shyu, V., & Dunn, W. (1999). Overview of the short sensory profile (SSP). *The sensory profile: Examiner's manual* (pp. 59-73)

Mennella, J. A., & Beauchamp, G. K. (1991). Maternal diet alters the sensory qualities of human milk and the nursling's behavior. *Pediatrics, 88*(4), 737-744.

Mennella, J. A., & Beauchamp, G. K. (1999). Experience with a flavor in mother's milk modifies the infant's acceptance of flavored cereal. *Developmental Psychobiology, 35*(3), 197-203.

Ming, X., Brimacombe, M., Chaaban, J., Zimmerman-Bier, B., & Wagner, G. C. (2008). Autism spectrum disorders: Concurrent clinical disorders. *Journal of Child Neurology, 23*(1), 6-13.

Monnery-Patris, S., Wagner, S., Rigal, N., Schwartz, C., Chabanet, C., Issanchou, S., & Nicklaus, S. (2015). Smell differential reactivity, but not taste differential reactivity, is related to food neophobia in toddlers. *Appetite, 95*, 303-309. doi:10.1016/j.appet.2015.07.021

Murphy, C., & Cain, W. S. (1980). Taste and olfaction: Independence vs interaction. *Physiology & Behavior, 24*(3), 601-605. doi:10.1016/0031-9384(80)90257-7

Nadon, G. (2007). *Le profil alimentaire des enfants présentant un trouble envahissant du développement: Un lien avec l'âge et le diagnostic'*

Nadon, G., Feldman, D. E., Dunn, W., & Gisel, E. (2011a). Association of sensory processing and eating problems in children with autism spectrum disorders. *Autism Research and Treatment, 2011*

Nadon, G., Feldman, D. E., Dunn, W., & Gisel, E. (2011b). Mealtime problems in children with autism spectrum disorder and their typically developing siblings: A comparison study. *Autism, 15*(1), 98-113.

Nadon, G., Feldman, D., & Gisel, E. (2013). Feeding issues associated with the autism spectrum disorders. In M. Fitzgerald (Ed.), *Recent advances in autism spectrum disorders* () doi:10.5772/53644

Nadon, G., Feldman, D. E., Dunn, W., & Gisel, E. (2011). Mealtime problems in children with autism spectrum disorder and their typically developing siblings: A comparison study. *Autism, 15*(1), 98-113.

Naish, K. R., & Harris, G. (2012). Food intake is influenced by sensory sensitivity. *PloS One, 7*(8), e43622. doi:10.1371/journal.pone.0043622

Nicklaus, S. (2009). Development of food variety in children. *Appetite, 52*(1), 253-255. doi:10.1016/j.appet.2008.09.018

Northstone, K., & Emmett, P. (2013). The associations between feeding difficulties and behaviours and dietary patterns at 2 years of age: The ALSPAC cohort. *Maternal & Child Nutrition, 9*(4), 533-542. doi:10.1111/j.1740-8709.2012.00399.x

Olsen, A., Ritz, C., Kramer, L., & Møller, P. (2012). Serving styles of raw snack vegetables. what do children want? *Appetite, 59*(2), 556-562. doi:10.1016/j.appet.2012.07.002

Oosterling, I., Rommelse, N., de Jonge, M., van der Gaag, Rutger Jan, Swinkels, S., Roos, S., . . . Buitelaar, J. (2010). How useful is the social communication questionnaire in toddlers at risk of autism spectrum disorder? *Journal of Child Psychology and Psychiatry, 51*(11), 1260-1268. doi:10.1111/j.1469-7610.2010.02246.x

Otis, L. P. (1984). Factors influencing the willingness to taste unusual foods. *Psychological Reports, 54*(3), 739-745. doi:10.2466/pr0.1984.54.3.739

Ozonoff, S., Iosif, A., Baguio, F., Cook, I. C., Hill, M. M., Hutman, T., . . . Young, G. S. (2010). A prospective study of the emergence of early behavioral signs of autism. *Journal of the American Academy of Child & Adolescent Psychiatry, 49*(3), 266e2. doi:10.1097/00004583-201003000-00009

Pelchat, M. L., & Pliner, P. (1986). Antecedents and correlates of feeding problems in young children. *Journal of Nutrition Education, 18*(1), 23-29.

Pelchat, M. L., & Pliner, P. (1995). “Try it. you'll like it”. effects of information on willingness to try novel foods. *Appetite, 24*(2), 153-165. doi:10.1016/S0195-6663(95)99373-8

Pliner, P., & Salvy, S. J. (2006). Food neophobia in humans. *The psychology of food choice* (pp. 75-92). Wallingford, UK: CABI. doi:10.1079/9780851990323.0075

Pliner, P. (1994). Development of measures of food neophobia in children. *Appetite, 23*(2), 147-163. doi:10.1006/appe.1994.1043

Pliner, P., & Hobden, K. (1992). Development of a scale to measure the trait of food neophobia in humans. *Appetite, 19*(2), 105-120. doi:10.1016/0195-6663(92)90014-W

Pliner, P., & Loewen, E. R. (1997). Temperament and food neophobia in children and their mothers. *Appetite, 28*(3), 239-254.

Pliner, P., & Pelchat, M. L. (1986). Similarities in food preferences between children and their siblings and parents. *Appetite, 7*(4), 333-342.

Provost, B., Crowe, T. K., Osbourn, P. L., McClain, C., & Skipper, B. J. (2010). Mealtime behaviors of preschool children: Comparison of children with autism spectrum disorder and children with typical development. *Physical & Occupational Therapy in Pediatrics, 30*(3), 220-233. doi:10.3109/01942631003757669

Raiten, D. J., & Massaro, T. (1986). Perspectives on the nutritional ecology of autistic children. *Journal of Autism and Developmental Disorders, 16*(2), 133-143. doi:10.1007/BF01531725

Rasmussen, M., Brug, J., Wind, M., Krolner, R., Klepp, K. I., & Due, P. (2011). Determinants of fruit and vegetable consumption among children and adolescents: A review of the literature. part II: Qualitative studies. *International Journal of Behavioral Nutrition and Physical Activity, 8*(1), 112. doi:10.1186/1479-5868-8-112

Rastam, M. (2008). Eating disturbances in autism spectrum disorders with focus on adolescent and adult years. *Clinical Neuropsychiatry, 5*(1), 31-42.

Raudenbush, B., & & Frank, R. A. (1999). Assessing food neophobia: The role of stimulus familiarity. *Appetite, 32*(2), 261-271. doi:10.1006/appe.1999.0229

Reilly, S., Skuse, D., Mathisen, B., & Wolke, D. (1995). The objective rating of oral-motor functions during feeding. *Dysphagia, 10*(3), 177-191.

Reynolds, S., & Lane, S. (2008). Diagnostic validity of sensory over-responsivity: A review of the literature and case reports. *Journal of Autism and Developmental Disorders, 38*(3), 516-529. doi:10.1007/s10803-007-0418-9

Ritvo, E. R., & Freeman, B. J. (1977). National society for autistic children definition of the syndrome of autism. *Journal of Pediatric Psychology, 2*(4), 146-148. doi:10.1093/jpepsy/2.4.146

Roefs, A., Werthmann, J., Nederkoorn, C., Havermans, R., Kremers, S., & Jansen, A. (2015). Bits and pieces : Food texture influences food acceptance in young children. *Appetite, 84*, 181-187. doi:10.1016/j.appet.2014.09.025

Rogers, L. G., Magill-Evans, J., & Rempel, G. R. (2012). Mothers’ challenges in feeding their children with autism spectrum disorder-Managing more than just picky eating. *Journal of Developmental and Physical Disabilities, 24*(1), 19-33.

Rogers, S., Hepburn, S., & Wehner, E. (2003). Parent reports of sensory symptoms in toddlers with autism and those with other developmental disorders. *Journal of Autism and Developmental Disorders, 33*(6), 631-642. doi:JADD.0000006000.38991.a7

Rommel, N., De Meyer, A., Feenstra, L., & Veereman-Wauters, G. (2003). The complexity of feeding problems in 700 infants and young children presenting to a tertiary care institution. *Journal of Pediatric Gastroenterology and Nutrition, 37*(1), 75-84. doi:10.1097/00005176-200307000-00014

Ross, S. (1995). 'Do I really have to eat that?': A qualitative study of schoolchildren's food choices and preferences. *Health Education Journal, 54*(3), 312-321. doi:10.1177/001789699505400306

Royeen, C. B., & Fortune, J. C. (1990). Touch inventory for elementary-school-aged children. *American Journal of Occupational Therapy, 44*(2), 155-159.

Rozin, P., Fallon, A., & Mandell, R. (1984). Family resemblance in attitudes to foods. *Developmental Psychology, 20*(2), 309-314. doi:10.1037/0012-1649.20.2.309

Rozin, P., Haidt, J., McCauley, C., & Imada, S. (1997). Disgust: Preadaptation and the cultural evolution of a food-based emotion. *Food Preferences and Taste,* , 65-82.

Rutter, M., Bailey, A., & Lord, C. (2003). *The social communication questionnaire: Manual* Western Psychological Services.

Rydell, A. M., Dahl, M., & Sundelin, C. (1995). Characteristics of school children who are choosy eaters. *The Journal of Genetic Psychology, 156*(2), 217-229. doi:10.1080/00221325.1995.9914818

Schaaf, R., Toth-Cohen, S., Johnson, S., Outten, G., & Benevides, T. (2011). The everyday routines of families of children with autism. *Autism, 15*(3), 373-389. doi:10.1177/1362361310386505

Schmitt, L., Campbell, E. E., & Heiss, C. J. (2008). A comparison of nutrient intake and eating behaviors of boys with and without autism. *Topics in Clinical Nutrition, 23*(1), 23.

Schreck, K. A., & Williams, K. (2006). Food preferences and factors influencing food selectivity for children with autism spectrum disorders. *Research in Developmental Disabilities, 27*(4), 353-363. doi:10.1016/j.ridd.2005.03.005

Schreck, K. A., Williams, K., & Smith, A. F. (2004). A comparison of eating behaviors between children with and without autism. *Journal of Autism and Developmental Disorders, 34*(4), 433-438.

Schulze, G., & Watson, N. V. (1995). Comments on ‘Flavor neophobia in selected rodent species’. *Biological Perspectives on Motivated Activities.Ablex Publishing Corporation, Norwood, New Jersey,* , 229-230.

Scott, J. A., Chih, T. Y., & Oddy, W. H. (2012). Food variety at 2 years of age is related to duration of breastfeeding. *Nutrients, 4*(10), 1464-1474.

Shepherd, R., & Raats, M. (Eds.). (2006). *The psychology of food choice* (No. 3). Cabi.

Singer, L. T., Ambuel, B., Wade, S., & Jaffe, A. C. (1992). Cognitive-behavioral treatment of health-impairing food phobias in children. *Journal of the American Academy of Child & Adolescent Psychiatry, 31*(5), 847-852. doi:10.1097/00004583-199209000-00011

Skinner, J. D., Carruth, B. R., Bounds, W., Ziegler, P., & Reidy, K. (2002). Do food-related experiences in the first 2 years of life predict dietary variety in school-aged children? *Journal of Nutrition Education and Behavior, 34*(6), 310-315. doi:10.1016/S1499-4046(06)60113-9

Smith, A. M., Roux, S., Naidoo, N. T., & Venter, D. J. L. (2005). Food choices of tactile defensive children. *Nutrition, 21*(1), 14-19. doi:10.1016/j.nut.2004.09.004

Stead, M., & Goodlad, N. (1996). *Promoting consumption of vegetables: A qualitative exploratory study of women's knowledge, attitudes and practice: Summary*

Stein, L. J., Nagai, H., Nakagawa, M., & Beauchamp, G. K. (2003). Effects of repeated exposure and health-related information on hedonic evaluation and acceptance of a bitter beverage. *Appetite, 40*(2), 119-129. doi:10.1016/S0195-6663(02)00173-3

Stevenson, R. D., & Allaire, J. H. (1991). The development of normal feeding and swallowing. *Pediatric Clinics of North America, 38*(6), 1439.

Studenmund, A. H. (2013). *Using econometrics: A practical guide* Pearson Education.

Studenmund, A. H., & Cassidy, H. J. (1992). *Instructor's manual to accompany using econometrics: A practical guide* Harper Collins Publ.

Sullivan, P. B. (2009). Feeding and nutrition in neurodevelopmental disability: An overview. *Feeding and nutrition in children with neurodevelopmental disability* (pp. 8) John Wiley & Sons.

Sullivan, S. A., & Birch, L. L. (1994). Infant dietary experience and acceptance of solid foods. *Pediatrics, 93*(2), 271-277.

Szczesniak, A. S. (2002). Texture is a sensory property. *Food Quality and Preference, 13*(4), 215-225. doi:10.1016/S0950-3293(01)00039-8

Thompson, R. L., Margetts, B. M., Speller, V. M., & McVey, D. (1999). The health education authority's health and lifestyle survey 1993: Who are the low fruit and vegetable consumers? *Journal of Epidemiology and Community Health (1979-), 53*(5), 294-299. doi:10.1136/jech.53.5.294

Tomchek, S. D., & Dunn, W. (2007). Sensory processing in children with and without autism: A comparative study using the short sensory profile. *The American Journal of Occupational Therapy : Official Publication of the American Occupational Therapy Association, 61*(2), 190-200. doi:10.5014/ajot.61.2.190

Tomchek, S. D., Little, L. M., & Dunn, W. (2015). Sensory pattern contributions to developmental performance in children with autism spectrum disorder. *The American Journal of Occupational Therapy : Official Publication of the American Occupational Therapy Association, 69*(5), 6905185040p1. doi:10.5014/ajot.2015.018044

Tuorila, H., Lähteenmäki, L., Pohjalainen, L., & Lotti, L. (2001). Food neophobia among the finns and related responses to familiar and unfamiliar foods. *Food Quality and Preference, 12*(1), 29-37. doi:10.1016/S0950-3293(00)00025-2

Twachtman-Reilly, J., Amaral, S. C., & Zebrowski, P. P. (2008). Addressing feeding disorders in children on the autism spectrum in school-based settings: Physiological and behavioral issues. *Language, Speech, and Hearing Services in Schools, 39*(2), 261-272. doi:10.1044/0161-1461(2008/025)

Vincent, J. F., & Lillford, P. J. (1991). *Feeding and the texture of food* Cambridge University Press.

Wang, L. W., Tancredi, D. J., & Thomas, D. W. (2011). The prevalence of gastrointestinal problems in children across the united states with autism spectrum disorders from families with multiple affected members. *Journal of Developmental and Behavioral Pediatrics: JDBP, 32*(5), 351-360. doi:10.1097/DBP.0b013e31821bd06a

Wardle, J., Herrera, M., Cooke, L., & Gibson, E. L. (2003). Modifying children's food preferences: The effects of exposure and reward on acceptance of an unfamiliar vegetable. *European Journal of Clinical Nutrition, 57*(2), 341-348. doi:10.1038/sj.ejcn.1601541

Wardle, J., & Cooke, L. (2008). Genetic and environmental determinants of children's food preferences. *British Journal of Nutrition, 99*(S1), S21. doi:10.1017/S000711450889246X

Wardle, J., Cooke, L. J., Gibson, E. L., Sapochnik, M., Sheiham, A., & Lawson, M. (2003). Increasing children's acceptance of vegetables; a randomized trial of parent-led exposure. *Appetite, 40*(2), 155-162. doi:10.1016/S0195-6663(02)00135-6

Watling, R. L., Deitz, J., & White, O. (2001). Comparison of sensory profile scores of young children with and without autism spectrum disorders. *The American Journal of Occupational Therapy : Official Publication of the American Occupational Therapy Association, 55*(4), 416-423. doi:10.5014/ajot.55.4.416

Wengreen, H. J., Madden, G. J., Aguilar, S. S., Smits, R. R., & Jones, B. A. (2013). Incentivizing children's fruit and vegetable consumption: Results of a united states pilot study of the food dudes program. *Journal of Nutrition Education and Behavior, 45*(1), 54-59.

Werthmann, J., Jansen, A., Havermans, R., Nederkoorn, C., Kremers, S., & Roefs, A. (2015). Bits and pieces. food texture influences food acceptance in young children. *Appetite, 84*, 181-187.

Whiteley Paul, Rodgers, Jacqui, Shattock Paul. (2000). Feeding patterns in autism. *Autism, 4*, 207-211.

Whiteley, P., Rodgers, J., & Shattock, P. (2000). Feeding patterns in autism. *Autism, 4*(2), 207-211. doi:10.1177/1362361300004002008

Williams, K. E., & Foxx, R. M. (2007). *Treating eating problems of children with autism spectrum disorders and developmental disabilities: Interventions for professionals and parents* Pro-ed.

Williams, K., Gibbons, B., & Schreck, K. (2005). Comparing selective eaters with and without developmental disabilities. *Journal of Developmental and Physical Disabilities, 17*(3), 299-309. doi:10.1007/s10882-005-4387-7

Williams, P. G., Dalrymple, N., & Neal, J. (2000). Eating habits of children with autism. *Pediatric Nursing, 26*(3), 259.

Woodbury-Smith, M. R., Robinson, J., Wheelwright, S., & Baron-Cohen, S. (2005). Screening adults for asperger syndrome using the AQ: A preliminary study of its diagnostic validity in clinical practice. *Journal of Autism and Developmental Disorders, 35*(3), 331-335. doi:10.1007/s10803-005-3300-7

Wright, P. (1991). Development of food choice during infancy. *Proceedings of the Nutrition Society, 50*(1), 107-113. doi:10.1079/PNS19910016

Yack, E., Sutton, S., & Aquilla, P. (2003). *Building bridges through sensory integration* Future Horizons.

Yeargin-Allsopp, M., Rice, C., Karapurkar, T., Doernberg, N., Boyle, C., & Murphy, C. (2003). Prevalence of autism in a US metropolitan area. *Jama, 289*(1), 49-55.

Zampollo, F., Kniffin, K. M., Wansink, B., & Shimizu, M. (2012). Food plating preferences of children: The importance of presentation on desire for diversity. *Acta Paediatrica, 101*(1), 61-66. doi:10.1111/j.1651-2227.2011.02409.x

Zimmer, M. H., Hart, L. C., Manning-Courtney, P., Murray, D. S., Bing, N. M., & Summer, S. (2012). Food variety as a predictor of nutritional status among children with autism. *Journal of Autism and Developmental Disorders, 42*(4), 549-556.

Zobel-Lachiusa, J., Andrianopoulos, M. V., Mailloux, Z., & Cermak, S. A. (2015). Sensory differences and mealtime behavior in children with autism. *American Journal of Occupational Therapy, 69*(5), 6905185050p8.

LIST OF APPENDICES

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A-3 Food neophobia Scale (FNS, Pliner & Hobden, 1992)

A-4 Feeding behaviour checklist (FBC, Harris, in publication)

A-5 Short Sensory Profile (SSP, McIntosh, Miller, Shyu, & Dunn, 1999)

A-6 Adult sensory profile (AASP, Brown & Dunn, 2002)

A-7 Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997)

A-8 Social Communication Questionnaire (SCQ; Rutter, Bailey & Lord, 2003)

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C-4 Vegetable options in Task 2:RBV-VDT-RV

Early eating behaviour questionnaire

Did your child have any difficulty in the following areas of feeding? (Please tick as appropriate and give details, including the age at which this happened.)

☐ Breastfeeding /Bottle feeding/ Transition from breast to bottle

___

___

☐ Weaning from milk to pureed foods (e.g. jars of baby food)

___

___

☐ Transition from pureed foods to lumpy solids (e.g. second stage baby foods)

___

___

☐ Transition from lumpy solids to family food

___

___

☐ Eating finger foods

___

___

☐ In the toddler period, at around 18months old

___

___

The adapted Child Food Neophobia Scale (CFNS)

Feeding behaviour checklist (FBC)

Please circle the appropriate answer with regard to how your child would respond:

1	**Refuses to eat foods of a specific colour**	Always	Frequently	Sometimes	Rarely	Never
2	**Only eats foods of a specific colour**	Always	Frequently	Sometimes	Rarely	Never
3	**Would feel upset/irritable if different foods were touching on the plate**	Always	Frequently	Sometimes	Rarely	Never
4	**Finds messy play (e.g. hand painting/muddy, outdoor play)**	Extremely enjoyable	Mildly enjoyable	Neither	Not enjoyable	Refuses to participate
5	**Pulls faces of disgust towards food**	Always	Frequently	Sometimes	Rarely	Never
6	**Becomes anxious around new foods**	Always	Frequently	Sometimes	Rarely	Never
7	**Vomits/gags in response to foods they dislike**	Always	Frequently	Sometimes	Rarely	Never
8	**Spits out foods they dislike**	Always	Frequently	Sometimes	Rarely	Never
9	**Completely refuses to eat foods they dislike**	Always	Frequently	Sometimes	Rarely	Never
10	**Only eats foods of specific brands or flavours**	Strongly agree	Agree	Unsure	Disagree	Strongly disagree
11	**Only eats/drinks from a particular plate/cup/spoon etc.**	Always	Frequently	Sometimes	Rarely	Never
12	**Becomes upset/irritable when mealtimes don't follow typical routine**	Always	Frequently	Sometimes	Rarely	Never
13	**Refuses food if packaging is changed**	Always	Frequently	Sometimes	Rarely	Never
14	**Feels upset/irritable when a meal is not prepared in the usual way (i.e. different ingredients used/baked not fried)**	Always	Frequently	Sometimes	Rarely	Never
15	**Eats different foods on the plate in a particular order**	Always	Frequently	Sometimes	Rarely	Never
16	**Eats food prepared by anybody**	Always	Frequently	Sometimes	Rarely	Never
17	**Refuses to eat food which looks different to usual (e.g. broken biscuits, bruised fruits)**	Always	Frequently	Sometimes	Rarely	Never
18	**Is a messy eater**	Strongly agree	Agree	Unsure	Disagree	Strongly disagree
19	**Has a diet that consists of only a few foods**	Strongly agree	Agree	Unsure	Disagree	Strongly disagree

20	**Is unwilling to eat many of the foods that our family eats at mealtimes.**	Strongly agree	Agree	Unsure	Disagree	Strongly disagree
21	**Is fussy or picky about what he/she eats**	Strongly agree	Agree	Unsure	Disagree	Strongly disagree
22	**Constantly samples new and different foods**	Strongly agree	Agree	Unsure	Disagree	Strongly disagree
23	**Does not trust new foods**	Strongly agree	Agree	Unsure	Disagree	Strongly disagree
24	**Won't try a new food if she/he does not know what is in it**	Strongly agree	Agree	Unsure	Disagree	Strongly disagree
25	**Is afraid to eat things she/he has never had before**	Strongly agree	Agree	Unsure	Disagree	Strongly disagree
26	**Prefers foods which have certain textures (e.g. Smooth)**	Strongly agree	Agree	Unsure	Disagree	Strongly disagree
27	**Does not like lumpy foods**	Strongly agree	Agree	Unsure	Disagree	Strongly disagree
28	**Does not like chewy foods(e.g. meat)**	Strongly agree	Agree	Unsure	Disagree	Strongly disagree
29	**Does not like mash type of foods (e.g. mashed vegetables, potatoes)**	Strongly agree	Agree	Unsure	Disagree	Strongly disagree
30	**Does not like puree smooth foods (e.g. vegetable/fruit smoothies, yoghurt)**	Strongly agree	Agree	Unsure	Disagree	Strongly disagree
31	**Does not like dry type of foods (e.g. crackers, soft crisps)**	Strongly agree	Agree	Unsure	Disagree	Strongly disagree
32	**Does not like wet foods (e.g. pasta, foods with sauces)**	Strongly agree	Agree	Unsure	Disagree	Strongly disagree
33	**Only eats particular foods in specific places (e.g. Chips only at Mcdonalds)**	Strongly agree	Agree	Unsure	Disagree	Strongly disagree
34	**Only eats when specific people are present**	Strongly agree	Agree	Unsure	Disagree	Strongly disagree
35	**Dislikes having their teeth cleaned –especially at the**	Strongly	Agree	Unsure	Disagree	Strongly

	sides of the mouth	agree				disagree
36	**Keeps food in the side of their mouth, hesitating to swallow it**	Always	Frequently	Sometimes	Rarely	Never

Short Sensory Profile (SSP)

Adult sensory profile (AASP)

Strengths and Difficulties Questionnaire (SDQ)

Social Communication Questionnaire (SCQ)

Autism Spectrum Quotient (AQ)

Willingness to try rating scales for pre-schoolers in Study B

Willingness to try rating scales for young adults in Study C

Very Much	Somewhat	Undecided	Not Really	Not at All
5	4	3	2	1

The same vegetable preferences inventory was used in Study B and Study C: However, in study C the section referring to a child has been excluded.

1.Tick the most common way, or more than one ways in which you might eat these vegetables :

Parent	never tried it	I've tried it but I don't eat it	raw	roasted	stir fried	steamed	puree	boiled	mashed	grated	sliced	chopped	quartered	whole
artichoke 														
asparagus 														
aubergine 														
green beans 														
kidney beans 														
peas 														

2.Tick the most common way, or more than one ways that <u>your child</u> might eat these vegetables:

Child	never tried it	s/he tried it but s/he doesn't it	raw	roasted	stir fried	steamed	puree	boiled	mashed	grated	sliced	chopped	quartere d	whole
artichoke 														
asparagus 														
aubergine 														
green beans 														
kidney beans 														
peas 														

3.Tick the most common way, or more than one ways in which you might eat these vegetables :

Parent	never tried it	I've tried it but I don't eat it	raw	roaste d	stir fried	steamed	puree	boiled	mashed	grated	sliced	chopped	quartered	whole
broccoli 														
brussel sprouts 														
cabbage 														
carrot 														
cauliflower 														
celery 														

4.Tick the most common way, or more than one way that your child might eat these vegetables:

Child	never tried it	s/he tried it but s/he doesn't eat it	raw	roaste d	stir fried	steamed	puree	boiled	mashed	grated	sliced	chopped	quartered	whole
broccoli 														
brussel sprouts 														
cabbage 														
carrot 														
cauliflower 														
celery 														

5.Tick the most common way, or more than one ways in which <u>you</u> might eat these vegetables :

Parent	never tried it	I've tried it but I don't eat it	raw	roasted	stir fried	steamed	puree	boiled	mashed	grated	sliced	chopped	quartered	whole
corn 														
broad beans 														
lettuce 														
soya beans 														
mushroom 														
okra 														

6.Tick the most common way, or more than one way that <u>your child</u> might eat these vegetables:

Child	never tried it	s/he tried it but s/he doesn't eat it	raw	roasted	stir fried	steamed	puree	boiled	mashed	grated	sliced	chopped	quartered	whole
corn 														
broad beans 														
lettuce 														
soya beans 														
mushroom 														
okra 														

7.Tick the most common ways that <u>you</u> might be exposed in these vegetables :

Parent	never tried it	I've tried it but I don't eat it	raw	roasted	stir fried	steamed	puree	boiled	mashed	grated	sliced	chopped	quartered	whole
garlic 														
green pepper 														
red pepper 														
onion 														
spring onion 														
yellow pepper 														

8.Tick the most common way, or more than one way that <u>your child</u> might eat these vegetables:

Child	never tried it	s/he tried it but s/he doesn't eat it	raw	roasted	stir fried	steamed	puree	boiled	mashed	grated	sliced	chopped	quartered	whole
garlic 														
green pepper 														
red pepper 														
onion 														
spring onion 														
yellow pepper 														

9.Tick the most common way, or more than one ways in which <u>you</u> might eat these vegetables:

Parent	never tried it	I've tried it but I don't eat it	raw	roasted	stir fried	steamed	puree	boiled	mashed	grated	sliced	chopped	quartered	whole
beetroot 														
courgette 														
parsnip 														
radish 														
potato 														
sweet potato 														
tomato 														

10.Tick the most common way, or more than one way that <u>your child</u> might eat these vegetables:

Child	never tried it	s/he tried it but s/he doesn't eat it	raw	roasted	stir fried	steamed	puree	boiled	mashed	grated	sliced	chopped	quartered	whole
beetroot 														
courgette 														
parsnip 														
radish 														
potato 														
sweet potato 														
Tomato 														

11.Tick the most common way, or more than one ways in which you might eat these vegetables:

Parent	never tried it	I've tried it but I don't eat it	raw	roasted	stir fried	steamed	puree	boiled	mashed	grated	sliced	chopped	quartered	whole
cucumber 														
butternut squash 														
turnip 														
chick peas 														
leek 														
lentils 														

12.Tick the most common way, or more than one way that your child might eat these vegetables:

Child	never tried it	s/he tried it but s/he doesn't it	raw	roasted	stir fried	steamed	puree	boiled	mashed	grated	sliced	chopped	quartered	whole
cucumber 														
butternut squash 														
turnip 														
chick peas 														
leek 														
lentils 														

13.Tick the most common way, or more than one ways in which you might eat these vegetables:

Parent	never tried it	I've tried it but I don't eat it	raw	roasted	stir fried	steamed	puree	boiled	mashed	grated	sliced	chopped	quartered	whole
marrow 														
spinach 														
sugar snap peas 														
swede 														
beansprouts 														

14.Tick the most common way, or more than one way that your child might eat these vegetables:

Child	never tried it	s/he tried it but s/he doesn't it	raw	roasted	stir fried	steamed	puree	boiled	mashed	grated	sliced	chopped	quartered	whole
marrow 														
spinach 														
sugar snap peas 														
swede 														
beansprouts 														

15.Myfive**favourite** vegetables are: 1. 2. 3. 4. 5.	**16.My** five**least favourite** vegetables are: 1. 2. 3. 4. 5.

17. My **child's** five**favourite** vegetables are: 1. 2. 3. 4. 5.	**18.**My **child's** five**least favourite** vegetables are: 1. 2. 3. 4. 5.

Questions exploring demographic characteristics in Study A

1. What is your child's date of birth ________________

2. a) What is the height of your child in metres/feet? _____________

b) What is the weight of your child in kg/stones and lbs?

3. Please indicate the gender of your child (that is participating in this study):
Male ☐ Female☐

4. Which ethnic group best describes your child? (please tick)
White British/Caucasian ☐ *Black/Black British* ☐
Asian/Asian British ☐ *Oriental* ☐ *Mixed* ☐
Other ☐ _______________________ *(please specify)*

5. a) What is your relationship to this child? (Please tick)
Parent ☐ Step-parent ☐Guardian ☐ Other: ___________
b)What is your gender? Male☐ Female ☐
c)What is your age? ______years
d)What is your higher level of qualifications?
No qualifications ☐ O Levels/GCSEs ☐
A Levels/BTec or other College/Further Education Qualification☐
Degree or University Diploma/Other professional qualification☐
Postgraduate level qualification ☐

e) What is your height in metres/feet?_____________
f) What is your weight in kg/stones and lbs?____________

6. Does **your child** eat a special diet for any of the following reasons?
Yes ☐ *No* ☐If yes, please describe:

Medical: ______________________ *Ethical:* _______________________
Religious: ______________________ *Weight-loss:* ___________________
Other: ________________________

7. Please tell us if your child has been diagnosed with any of the following:

1. Autism ☐
2. Asperger's Syndrome ☐
3. Any other disorder in the autistic spectrum
4. Learning difficulty or disability ☐ If yes please specify: _______________________

5. Other ☐ Please specify: ______________________________ None of the above ☐

8. Does your child have any severe speech or swallowing problems?*Yes* ☐*No* ☐

9. Please indicate if your child has been diagnosed with any of the following:

1. Allergy to any food type ☐ If **yes** to what: _________________________

2.Lactose intolerance ☐

3. Constipation ☐

4. Underweight ☐

5. Overweight ☐

7. Other serious health condition ☐ If **yes** please specify: _________________________

8. None of the above ☐

10. Has your child been diagnosed with gastroesophageal reflux (GOR)

Yes ☐*No* ☐

If **yes** answer questions **11-14** If **no please go to question 15**

Gastroesophageal reflux questions

Please answer the following questions only if your child **has gastroesophageal reflux** please answer the following questions:

11. When did your child start having gastroesophageal reflux?

Age in years:_______________

12. How long did the GOR reflux last? Please specify:________________________

13.Please rate the severity of your child's reflux:

1. vomiting less that once a day ☐ 2. vomiting once a day☐

3. vomiting 2-3 times per day 4. vomiting 4-5times per day☐

5. vomiting more than 5 times/day ☐ 6. vomiting after every feed/meal☐

14. Is/was your child receiving any medication for reflux? *Yes* ☐*No* ☐

If yes please specify:____

15. Has your child ever had any feeding difficulties? (Please tick as appropriate) *Yes* ☐ *No* ☐

If **yes** please specify:

At what age did these feeding difficulties begin?

Questions exploring demographic characteristics in Study B

1. What is the month and year ofyour child's birth?_____/____/_______

2. What is the gender of your child?*Boy ☐ Girl☐*

3.Which ethnic group best describes your child? (please tick)

White British/Caucasian, ☐Black/BlackBritish☐ Asian/Asian British☐ Oriental☐

Mixed☐Other ☐________________________ *(please specify,)I'd rather not say*☐

4. Has your child been diagnosedwith any of the following conditions?

a) Autism ☐
b) Asperger's Syndrome ☐
c) Any other disorder in the autistic spectrum ☐
d) None of the above ☐
e) **Other** (*including syndromes, learning difficulty or disability, speech or swallowing problems)*

____

____

5. Has your child been diagnosed with any of the following?

a) Allergy to any food type. ☐If yes please specify: __________________________________
b) Lactose intolerance ☐
c) Constipation ☐
d) Underweight ☐
e) Overweight ☐
f) Other serious health condition ☐If yes please specify:

____

g) None of the above:☐

6. Does your child have any brothers or sisters with any of the following conditions?

a) Autism ☐
b) Asperger's Syndrome ☐
c) Any other disorder in the autistic spectrum ☐
d) None of the above ☐
e) Other (*including syndromes, learning difficulty or disability, speech or swallowing problems*

Questions for the parent

7.What is your gender? *Female ☐Male ☐*

8.What is the month and year of your birth? ____________________

9.Which ethnic group best describes you? (please tick)
White British/Caucasian☐Black/Black British☐Asian/Asian British☐ Oriental☐
Mixed☐ Other ☐ _______________________ *(please specify)I'd rather not say☐*

10. Which of the following best describes your educational background?
(Please tick only your highest qualification)

☐ Some secondary school education
☐ GCSEs
☐ A-levels
☐ University graduate (e.g. Bachelor's degree)
☐ Post-graduate certificates (e.g. PGCE)
☐ Master's degree
☐ Professional or Doctorate degree (e.g. Ph.D.)
Other:____________________________

11.How many people live in your house (including yourself)?______ adults, _______children

Questions exploring demographic characteristics in Study C

1. What is your date of birth?

2. What is your gender?

- ☐ Female
- ☐ Male

5. Which race/ethnic group best describes you?

Check any that apply

- ☐ White British/Caucasian
- ☐ Black/Black British
- ☐ Asian/Asian British
- ☐ Oriental
- ☐ Mixed
- ☐ Prefer not to say
- ☐ Other:

6.Are you currently living in the UK? ☐ Yes ☐ No

7.Which of the following best describes your educational background?

Check any that apply

- ☐ Some secondary school education
- ☐ Post-graduate certificates (e.g. PGCE)
- ☐ GCSEs
- ☐ Master's degree

- A-levels
- University graduate (e.g. Bachelor’s degree)
- Professional or Doctorate degree (e.g. Ph.D.)
- Prefer not to say
- Other:

8. Do you follow a specific diet? Yes No

If yes please specify:

9. Do you have any kind of food allergies? Yes No

If yes please specify the foods that you are allergic to:

10.Do you have any serious health conditions (such as heart /kidney disease, gastrointestinal problems) or any other medical condition that might affect your diet)? Yes No

If yes please specify:

11. Approximately how much (in pounds) do you spend on vegetables weekly just for yourself?

12.How many times do you try a food before you decide you don’t like it? Check any that apply

- None. I refuse to eat anything that looks like it won’t taste good to me
- One time
- 2-5 times
- 6-9 times
- More than 10 times

Factor Analysis Feeding Behaviour Checklist

Factor Matrix[a]

	Factor		
	1	2	3
FB1Refuses to eat foods of a specific colour	.591		
FB2Only eats foods of a specific colour	.596		
FB3Would feel upset/irritable if different foods were touching	.656		
FB4Finds messy play (e.g. hand painting/muddy, outdoor play)	.356		
FB5Pulls faces of disgust towards food	.670		
FB6Becomes anxious around new foods	.837		
FB7Vomits/gags in response to foods they dislike	.670		
FB8Spits out foods they dislike	.614		-.311
FB9Completely refuses to eat foods they dislike	.752		
FB10Only eats foods of specific brands or flavours	.824		
FB11Only eats/drinks from a particular plate/cup/spoon etc.	.593	.413	
FB12Becomes upset/irritable when mealtimes don't follow typical routine	.615	.413	
FB13Refuses food if packaging is changed	.756	.316	
FB14Feels upset/irritable when a meal is not prepared in the usual way (i.e. different ingredients used/baked not fried)	.830		
FB15Eats different foods on the plate in a particular order	.498		
FB16Eats food prepared by anybody	.653		
FB17Refuses to eat food which looks different to usual (e.g. broken biscuits, bruised fruits)	.735		
~~FB18Is a messy eater~~			
FB19Has a diet that consists of only a few foods	.848		
FB20Is unwilling to eat many of the foods that our family eats at mealtimes.	.839		
FB21Is fussy or picky about what he/she eats	.854	-.323	
FB22Constantly samples new and different foods*	.778	-.311	
FB23Does not trust new food*	.835		
FB24Won't try a new food if she/he does not know what is in it*	.791	-.308	
FB25Is afraid to eat things she/he has never had before*	.821		
FB26Prefers foods which have certain textures (e.g. Smooth)	.755		
FB27Does not like lumpy foods	.722		
FB28Does not like chewy foods (e.g. meat)	.654		
FB29Does not like mash type of foods (e.g. mashed vegetables, pota	.584		.310
FB30Does not like puree smooth foods (e.g. vegetable/fruit smoothies, yoghurt)	.489		.311

~~FB31Does not like dry type of foods (e.g. crackers, soft crisps)~~			
FB32Does not like wet foods (e.g. pasta, foods with sauces)	.622		.328
FB33Only eats particular foods in specific places (e.g. Chips only at Mcdonalds)	.663		
FB34Only eats when specific people are present	.507	.364	
FB35Dislikes having their teeth cleaned – especially at the sides of the mouth	.431		
FB36eeps food in the side of their mouth, hesitating to swallow it	.509		

Extraction Method: Principal Axis Factoring.

a. 3 factors extracted. 6 iterations required.

*Food neophobia questions

Chapter 3-Additional analysis on the eating behaviour scores in children (controls-ASC) with early feeding problems

In an attempt to further explore whether early feeding problems have a greater negative impact on eating behaviour of children with ASC and controls Mann Whitney U analysis was run.

Frequency of sample with problems inthe breast/bottle feeding stage	**Food neophobia score** Mean score (SD)	**Sig**	**Eating selectivity** Mean score (SD)	**Sig**	**Rigid /perseverant eating behaviour** Mean score (SD)	**Sig**	**Selectivity in terms of texture** Mean score (SD)	**Sig**
Children with ASC with breast/bottle feeding problems (N=42)	20.05(3.79)	p≤.001	75.38 (16.15)	p≤.001	22.24 (5.34)	p≤.001	12.45 (3.90)	p≤.001
Controls with breast/bottle feeding problems (N=48)	14.77 (6.72)		54.21 (24.47)		15.42 (6.21)		9.15 (4.03)	

Among the sample with breast/bottle feeding problems, children from the ASC group were found significantly more food neophobic than the controls. Similarly among those with breast/bottle feeding problems the children with ASC were found significantly more eating selective, rigid, and showed greater selectivity in terms of the texture of the food, in comparison to the controls who presented breast/bottle feeding problems

Frequency of sample with problems in the introduction to complimentary food stage (weaning feeding stage)	**Food neophobia score**	**Sig**	**Eating selectivity** Mean score (SD)	**Sig**	**Rigid /perseverant eating behaviour** Mean score (SD)	**Sig**	**Selectivity in terms of texture** Mean score (SD)	**Sig**
Children with ASC with problems (N=20)	20.25 (3.87)	p=.729	75.65 (18.22)	p=.058	22.80 (5.77)	p=.018	13.40 (4.50)	p=.133
Controls with problems (N=27)	17.70 (7.19)		63.48 (21.72)		17.85 (6.69)		11.41 (3.82)	

Among the children of the sample who presented problems in their introduction of complementary food, children with ASC scored significantly higher in terms of rigid/perseverant eating behaviourin comparison to the controls with a difficult introduction food to complimentary food.

Frequency of sample with problems intransition from pureed foods to lumpy solids	**Food neophobia score**	**Sig**	**Eating selectivity** Mean score (SD)	**Sig**	**Rigid /perseverant eating behaviour** Mean score (SD)	**Sig**	**Selectivity in terms of texture** Mean score (SD)	**Sig**
Children with ASC problems (N=25)	21.64 (4.05)	p=.268	81.32 (19.51)	p=.009	23.84 (6.48)	p=.006	13.72 (3.92)	p=.064
Controls with problems (N=25)	19.04 (6.36)		65.64 (20.63)		18.20 (6.01)		11.60 (3.99)	

Among the children of the sample who presented problems in the transition from pureed to lumpy solids, children with ASC were significantly more eating selective, rigid and perseverant in comparison to the controls of the sample with problems in the transition from pureed to lumpy solids.

Frequency of sample with problems in transition from lumpy solids to family foods	**Food neophobia score**	**Sig**	**Eating selectivity** Mean score (SD)	**Sig**	**Rigid /perseverant eating behaviour** Mean score (SD)	**Sig**	**Selectivity in terms of texture** Mean score (SD)	**Sig**
Children with ASC with problems (N=31)	22.03(3.65)	p=.674	81.23 (18.01)	p=.096	24.23 (5.78)	p=.020	13.90 (3.94)	p=.020
Controls with problems (N=23)	19.91(6.30)		71.52 (24.57)		19.65 (6.64)		11.39 (3.85)	

Among the children of the sample who presented problems in the transition from lumpy solids to family foods children with ASC presented significantly more rigid/ perseverant and showed significantly greater selectivity in terms of texture.

Frequency of sample with problems in finger food feeding stage	**Food neophobia score**	**Sig**	**Eating selectivity** Mean score (SD)	**Sig**	**Rigid /perseverant eating behaviour** Mean score (SD)	**Sig**	**Selectivity in terms of texture** Mean score (SD)	**Sig**
Children with ASC with problems (N=18)	21.72 (3.06)	p=.443	86.28 (14.79)	p=.008	25.28 (5.33)	p=.004	13.83 (4.12)	p=.044
Controls with problems (N=20)	18.85 (6.68)		65.35 (23.23)		18.80 (6.62)		11.10 (4.29)	

Children with ASC presented with significantly more rigid eating behaviour and were significantly more texture selective than the controls with problems in the finger food stage.

Frequency of sample with problems in toddler period (around 18 months) feeding stage	**Food neophobia score**	**Sig**	**Eating selectivity** Mean score (SD)	**Sig**	**Rigid /perseverant eating behaviour** Mean score (SD)	**Sig**	**Selectivity in terms of texture** Mean score (SD)	**Sig**
Children with ASC with problems(N=33)	22.61 (3.03)	p=.139	85.15 (15.46)	p=.030	25.52 (5.32)	p=.005	14.09 (3.73)	p=.005
Controls with problems (N=17)	18.94 (6.75)		71.94 (25.60)		19.24 (6.63)		10.88 (3.95)	

Among the children of the sample with difficult toddler eating period. Children with ASC were significantly more eating selective, rigid/perseverant and showed greater selectivity in terms of texture.

Chapter 3- Additional analysis on the sensory sensitivity scores in children (controls-ASC) with early feeding problems

Frequency of sample with problems in the breast/bottle feeding stage	**Visual auditory processing score** Mean score (SD)	Sig	**Tactile processing score** Mean score (SD)	Sig	**Taste-smell processing score** Mean score (SD)	Sig
Children with ASC with breast/bottle feeding problems (N=42)	14.50 (4.59)	p≤.001	22.44 (7.58)	p≤.001	10.98 (4.74)	p≤.001
Controls with breast/bottle feeding problems (N=47)	20.26 (3.06)		31.00 (4.52)		15.85 (5.19)	

Children with ASC with problems in the breast/bottle feeding stage presented significantly higher visual (p≤.001), tactile (p≤.001) and taste-smell (p≤.001) sensitivity

Frequency of sample with problems in the introduction to complimentary food stage (weaning feeding stage)	**Visual auditory processing score** Mean score (SD)	Sig	**Tactile processing score** Mean score (SD)	Sig	**Taste-smell processing score** Mean score (SD)	Sig
Children with ASC with problems (N=20)	14.00(4.03)	p≤.001	22.00 (6.75)	p≤.001	10.40 (4.63)	p=.035
Controls with problems (N=27)	19.67 (3.48)		30.63 (3.83)		13.85 (5.46)	

Children with ASC with problems in the introduction to complimentary food stage presented significantly higher visual (p≤.001), tactile (p≤.001) and taste-smell (p=.035) sensitivity

Frequency of sample with problems in the transition from pureed foods to lumpy solids	**Visual auditory processing score** Mean score (SD)	Sig	**Tactile processing score** Mean score (SD)	Sig	**Taste-smell processing score** Mean score (SD)	Sig
Children with ASC with problems (N=25)	14.00 (4.04)	p≤.001	22.25 (6.75)	p≤.001	8.83 (4.52)	p=.016
Controls with problems (N=25)	19.80 (3.74)		31.48 (3.86)		12.60 (5.49)	

Children with ASC with problems in the transition from pureed foods to lumpy solids presented significantly higher visual (p≤.001), tactile (p≤.001) and taste-smell (p=.016) sensitivity

Frequency of sample with problems in the transition from lumpy solids to family foods	**Visual auditory processing score** Mean score (SD)	Sig	**Tactile processing score** Mean score (SD)	Sig	**Taste-smell processing score** Mean score (SD)	Sig
Children with ASC with problems (N=31)	13.55(3.87)	p≤.001	21.26 (6.44)	p≤.001	9.23 (4.46)	p=.050
Controls with problems (N=23)	18.65 (3.85)		30.04 (5.34)		12.30 (5.62)	

Children with ASC with problems in the transition from lumpy solids to family foods presented significantly higher visual (p≤.001), tactile (p≤.001) and taste-smell (p=.050) sensitivity

Frequency of sample with problems in the finger food stage	**Visual auditory processing score** Mean score (SD)	Sig	**Tactile processing score** Mean score (SD)	Sig	**Taste-smell processing score** Mean score (SD)	Sig
Children with ASC with feeding problems (N=18)	12.56(3.89)	p≤.001	17.17 (5.76)	p≤.001	8.44 (4.00)	p=.020
Controls with feeding problems (N=20)	18.80 (3.53)		30.85 (5.49)		13.05 (5.95)	

Children with ASC with problems in the finger food stage presented significantly higher visual (p≤.001), tactile (p≤.001) and taste-smell (p=.020) sensitivity

Frequency of sample with problems in the toddler period (around 18 months) feeding stage	**Visual auditory processing score** Mean score (SD)	Sig	**Tactile processing score** Mean score (SD)	Sig	**Taste-smell processing score** Mean score (SD)	Sig
Children with ASC with feeding problems (N=33)	13.88(4.02)	p≤.001	20.94 (6.94)	p≤.001	8.18 (4.04)	p=.003
Controls with feeding problems (N=17)	19.82 (2.92)		30.71 (3.72)		12.76 (5.19)	

Children with ASC with problems in the toddler period (around 18 months) feeding stage presented significantly higher visual (p≤.001), tactile (p≤.001) and taste-smell (p=.003) sensitivity

Chapter 3-Additional analysis on the eating behaviour scores in children (controls-ASC) without early feeding problems

Frequency of sample without problems inthe breast/bottle feeding stage	**Food neophobia score** Mean score (SD)	**Sig**	**Eating selectivity** Mean score (SD)	**Sig**	**Rigid /perseverant eating behaviour** Mean score (SD)	**Sig**	**Selectivity in terms of texture** Mean score (SD)	**Sig**
Children with ASC without breast/bottle feeding problems (N=61)	19.87(5.90)	p≤.001	72.77 (21.28)	p≤.001	21.03 (7.01)	p≤.001	12.16 (4.14)	p≤.001
Controls without breast/bottle feeding problems (N=103)	15.56 (6.72)		52.23 (18.64)		15.35 (5.87)		8.83 (3.21)	

Children without problems inthe breast/bottle feeding stage were significantly more food neophobic (p≤.001), more eating selective (p≤.001), more rigid in terms of eating (p≤.001) and presented significantly higher texture selectivity (p≤.001).

Frequency of sample without problems in the introduction to complimentary food stage (weaning feeding stage)	**Food neophobia score**	**Sig**	**Eating selectivity** Mean score (SD)	**Sig**	**Rigid /perseverant eating behaviour** Mean score (SD)	**Sig**	**Selectivity in terms of texture** Mean score (SD)	**Sig**
Children with ASC withoutproblems (N=82)	19.80 (5.41)	p≤.001	73.16 (19.65)	p≤.001	21.11 (6.49)	p≤.001	11.93 (3.83)	p≤.001
Controls without problems (N=124)	14.79 (6.51)		50.55 (19.70)		14.83 (5.68)		8.40 (3.17)	

Children without problems inthe introduction to complimentary food stage were significantly more food neophobic (p≤.001), more eating selective (p≤.001), more rigid in terms of eating (p≤.001) and presented significantly higher texture selectivity (p≤.001).

Frequency of sample without problems inthe transition from pureed foods to lumpy solids	**Food neophobia score**	**Sig**	**Eating selectivity** Mean score (SD)	**Sig**	**Rigid /perseverant eating behaviour** Mean score (SD)	**Sig**	**Selectivity in terms of texture** Mean score (SD)	**Sig**
Children with ASC without problems (N=78)	19.40 (5.34)	p≤.001	71.44 (18.75)	p≤.001	20.78 (6.21)	p≤.001	11.82 (3.97)	p≤.001
Controls without problems (N=126)	14.57 (6.55)		50.33 (19.72)		14.81 (5.81)		8.40 (3.13)	

Children without problems inthe transition from pureed foods to lumpy solids were significantly more food neophobic (p≤.001), more eating selective (p≤.001), more rigid in terms of eating (p≤.001) and presented significantly higher texture selectivity (p≤.001). 4

Frequency of sample without problems in the transition from lumpy solids to family foods	**Food neophobia score**	**Sig**	**Eating selectivity** Mean score (SD)	**Sig**	**Rigid /perseverant eating behaviour** Mean score (SD)	**Sig**	**Selectivity in terms of texture** Mean score (SD)	**Sig**
Children with ASC without problems (N=72)	19.04(5.42)	p≤.001	70.65 (19.09)	p≤.001	20.36 (6.32)	p≤.001	11.58 (3.88)	p≤.001
Controls withoutproblems (N=128)	14.48(6.46)		49.51 (17.96)		14.60 (5.51)		8.49 (3.23)	

Children without problems in the transition from lumpy solids to family foods were significantly more food neophobic (p≤.001), more eating selective (p≤.001), more rigid in terms of eating (p≤.001) and presented significantly higher texture selectivity (p≤.001).

Frequency of sample without problems in the finger food feeding stage	**Food neophobia score**	**Sig**	**Eating selectivity** Mean score (SD)	**Sig**	**Rigid /perseverant eating behaviour** Mean score (SD)	**Sig**	**Selectivity in terms of texture** Mean score (SD)	**Sig**
Children with ASC withoutproblems (N=85)	19.56 (5.40)	p≤.001	71.20 (19.19)	p≤.001	20.73 (6.33)	p≤.001	11.95 (3.95)	p≤.001
Controls withoutproblems (N=131)	14.77 (6.57)		50.95 (19.58)		14.85 (5.70)		8.60 (3.24)	

Children without problems in the finger food feeding stage were significantly more food neophobic (p≤.001), more eating selective (p≤.001), more rigid in terms of eating (p≤.001) and presented significantly higher texture selectivity (p≤.001).

Frequency of sample without problems in the toddler period (around 18 months) feeding stage	**Food neophobia score**	**Sig**	**Eating selectivity** Mean score (SD)	**Sig**	**Rigid /perseverant eating behaviour** Mean score (SD)	**Sig**	**Selectivity in terms of texture** Mean score (SD)	**Sig**
Children with ASC withoutproblems (N=70)	18.69 (5.44)	p≤.001	68.50 (18.72)	p≤.001	19.64 (6.00)	p≤.001	11.43 (3.89)	p≤.001
Controls withoutproblems (N=134)	14.85 (6.59)		50.44 (18.65)		14.88 (5.71)		8.69 (3.35)	

Children without problems in the toddler period (around 18 months) feeding stage were significantly more food neophobic (p≤.001), more eating selective (p≤.001), more rigid in terms of eating (p≤.001) and presented significantly higher texture selectivity (p≤.001).

Chapter 3- Additional analysis on the sensory sensitivity scores in children (controls-ASC) without early feeding problems

Frequency of sample without problems inthe breast/bottle feeding stage	**Visual auditory processing score** Mean score (SD)	Sig	**Tactile processing score** Mean score (SD)	Sig	**Taste-smell processing score** Mean score (SD)	Sig
Children with ASC without problems (N=42)	15.42 (4.88)	p≤.001	23.73 (6.40)	p≤.001	10.82 (5.41)	p≤.001
Controls without problems (N=47)	20.45 (3.80)		31.95 (3.61)		16.70 (4.08)	

Children without problems inthe breast/bottle feeding stage showed significantly more visual (p≤.001), tactile (p≤.001), and taste-smell (p≤.001) sensitivity in comparison to the controls without problems in this feeding stage.

Frequency of sample without problems in the introduction to complementary food stage (weaning feeding stage)	**Visual auditory processing score** Mean score (SD)	Sig	**Tactile processing score** Mean score (SD)	Sig	**Taste-smell processing score** Mean score (SD)	Sig
Children with ASC without problems (N=81)	15.37(4.89)	p≤.001	23.64 (6.89)	p≤.001	11.08 (5.24)	p≤.001
Controls without problems (N=123)	20.54 (3.59)		31.88 (3.93)		17.00 (4.02)	

Children without problems in the introduction to complimentary food stage showed significantly more visual (p≤.001), tactile (p≤.001), and taste-smell (p≤.001) sensitivity in comparison to the controls without problems in this feeding stage.

Frequency of sample without problems in the transition from pureed foods to lumpy solids	**Visual auditory processing score** Mean score (SD)	Sig	**Tactile processing score** Mean score (SD)	Sig	**Taste-smell processing score** Mean score (SD)	Sig
Children with ASC without problems (N=25)	15.38(4.95)	p≤.001	23.51 (6.66)	p≤.001	11.52 (5.16)	p≤.001
Controls without problems (N=25)	20.50 (3.55)		31.69 (3.95)		17.20 (3.81)	

Children without problems in the transition from pureed foods to lumpy solids showed significantly more visual (p≤.001), tactile (p≤.001), and taste-smell (p≤.001) sensitivity in comparison to the controls without problems in this feeding stage.

Frequency of sample without problems in the transition from lumpy solids to family foods	**Visual auditory processing score** Mean score (SD)	Sig	**Tactile processing score** Mean score (SD)	Sig	**Taste-smell processing score** Mean score (SD)	Sig
Children with ASC without problems (N=71)	15.69(4.99)	p≤.001	24.07 (6.69)	p≤.001	11.61 (5.25)	p≤.001
Controls without feeding problems (N=127)	20.70 (3.45)		31.94 (3.56)		17.18 (3.78)	

Children without problems in the transition from lumpy solids to family foods showed significantly more visual (p≤.001), tactile (p≤.001), and taste-smell (p≤.001) sensitivity in comparison to the controls without problems in this feeding stage.

Frequency of sample without problems in the finger food stage	**Visual auditory processing score** Mean score (SD)	Sig	**Tactile processing score** Mean score (SD)	Sig	**Taste-smell processing score** Mean score (SD)	Sig
Children with ASC without feeding problems (N=18)	15.57(4.78)	p≤.001	24.52 (6.44)	p≤.001	11.41 (5.20)	p≤.001
Controls without feeding problems (N=20)	20.63 (3.53)		31.78 (3.64)		16.95 (3.96)	

Children without problems in the finger food stage showed significantly more visual (p≤.001), tactile (p≤.001), and taste-smell (p≤.001) sensitivity in comparison to the controls without problems in this feeding stage.

Frequency of sample without problems in the toddler period (around 18 months) feeding stage	**Visual auditory processing score** Mean score (SD)	Sig	**Tactile processing score** Mean score (SD)	Sig	**Taste-smell processing score** Mean score (SD)	Sig
Children with ASC without feeding problems (N=33)	15.59(5.01)	p≤.001	24.31 (6.65)	p≤.001	12.19 (5.10)	p≤.001
Controls without feeding problems (N=17)	20.46 (3.65)		31.77 (3.95)		16.90 (4.15)	

Children without problems in the toddler period (around 18 months) feeding stageshowed significantly more visual (p≤.001), tactile (p≤.001), and taste-smell (p≤.001) sensitivity in comparison to the controls without problems in this feeding stage.

Correlations between FBC, SSP with SDQ (and sub-categories) in controls and children with ASC

Controls	**SDQ**	Emotional Symptoms	Conduct problems	Hyperactivity/ inattention	Peer problems	Prosocial behaviour
Overall FBC score	.544**	.403**	.361**	.315**	.240**	-.321**
Eating selectivity	.539**	.414**	.355**	.306**	.248**	-.314**
Rigid /perseverant eating behaviour	.519**	.358**	.365**	.293**	.232**	-.345**
Selectivity in terms of texture	.500**	.295**	.356**	.362**	.197*	-.232**
SSP	-.671**	-.510**	-.516**	-.466**	-.277**	.331**
Visual/ Auditory Sensitivity	-.423**	-.423**	-.317**	-.208*	-.221**	.204*
Tactile Sensitivity	-.456**	-.460**	-.378**	-.195*	-.271**	.269**
Taste/smell Sensitivity	-.470**	-.364**	-.324**	-.278**	-.174*	.279**
ASC						
Overall FBC score	.292**	.171	.294**	.295**	.031	-.275**
Eating selectivity	.289**	.165	.280**	.306**	.037	-.246*
Rigid /perseverant eating behaviour	.340**	.231*	.333**	.286**	.024	-.296**
Selectivity in terms of texture	.133	.065	.162	.205*	.008	-.218*
SSP	-.593**	-.378**	-.480**	-.537**	-.223*	.245*
Visual/ Auditory Sensitivity	-.507**	-.461**	-.340**	-.353**	-.158	.040
Tactile Sensitivity	-.517**	-.423**	-.439**	-.356**	-.169	.170
Taste/smell Sensitivity	-.291**	-.106	-.271**	-.366**	-.093	.314**

Tables of the analysis of Task 1 and Task 2 of Study B described in Chapter 5

Task 1

Willingness to try	Disliked vegetable familiar texture (DVFT)	Liked unfamiliar vegetable texture (LVUT)	Sig
	Mean (SD)	Mean (SD)	p=.428
	1.66 (0.97)	1.77 (0.89)	

Two-sample paired Wilcoxonsigned rank test analysis was run to compare willingness to try DVFT and LVUT

Task 2

Willingness to try	Raw blemished vegetable (RBV)	Vegetable offered in different texture (VDT)	Sig
	Mean (SD)	Mean (SD)	p=.020
	1.43 (0.79)	2.06 (0.92)	

Two-sample paired Wilcoxonsigned rank test analysis was run to compare willingness to try RBV- VDT

Willingness to try	Vegetable offered in different texture (VDT)	Vegetable offered raw (RV)	Sig
	Mean (SD)	Mean (SD)	p≤.001**
	2.06 (0.92)	2.45 (0.82)	

Two-sample paired Wilcoxonsigned rank test analysis was run to compare willingness to try VDT-RV

Willingness to try	Raw blemished vegetable (RBV)	Vegetable offered raw (RV)	Sig
	Mean (SD)	Mean (SD)	p≤.001**
	1.43 (0.76)	2.45 (0.82)	

Two-sample paired Wilcoxonsigned rank test analysis was run to compare willingness to try RBV-RV

Tables of the analysis of Task 1 and Task 2 of Study C described in Chapter 6

Task 1

Willingness to try	**Disliked vegetable familiar texture (DVFT)**	**Liked vegetable unfamiliar texture (LVUT)**	**Sig**
	Mean (SD)	Mean (SD)	p=.019*
	3.25 (1.33)	3.77 (1.19)	

Two-sample paired Wilcoxonsigned rank test analysis was run to compare willingness to try DVFT and LVUT

Task 2

Willingness to try	**Raw Blemished Vegetable (RBV)**	**Vegetableoffered in Different Texture (VDT)**	**Sig**
	Mean (SD)	Mean (SD)	p≤.001**
	2.25 (1.22)	3.84 (1.21)	

Two-sample paired Wilcoxonsigned rank test analysis was run to compare willingness to try RBV- VDT

Willingness to try	**Vegetable offered in Different Texture (VDT)**	**Raw vegetable (RV)**	**Sig**
	Mean (SD)	Mean (SD)	p≤.001**
	3.84 (1.21)	4.47 (0.82)	

Two-sample paired Wilcoxonsigned rank test analysis was run to compare willingness to try VDT and RV

Willingness to try	**Raw Blemished Vegetable (RBV)**	**Raw vegetable (RV)**	**Sig**
	Mean (SD)	Mean (SD)	p≤.001**
	2.25 (1.22)	4.47 (0.82)	

Two-sample paired Wilcoxonsigned rank test analysis was runto try RBV and RV

Designed post box used in study B

Parents who wanted their child to take part in the research returned the completed consent forms and questionnaires in the provided envelope and placed them in a designated post box. In this way teachers and other members of staff did not have access to the individual information provided by the parents regarding their child.

Picture of food container used for food in Study B and Study C

Task 1

Disliked vegetable
familiar texture
(DVFT)

Liked vegetable
unfamiliar texture
(LVUT)

Boiled brocoli

Mashed carrot

Task 1 has been tailored to the vegetable preferences of the sample in both Chapter 5 and Chapter 6

Task 2

Raw blemished vegetable (RBV)

Vegetable offered in different texture (VDT)

Raw vegetable (RV)

Tomato blemished

Tomato roasted

Tomato raw

Task 2 has been tailored to the vegetable preferences of the sample in both Chapter 5 and Chapter 6