Learning to like vegetables: the importance of exposure in the food preference development of preschool children

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The candidate confirms that the work submitted is her own, except where work which has formed part of jointly authored publications has been included. The contribution of the candidate and the other authors to this work has been explicitly indicated below. The candidate confirms that appropriate credit has been given within the thesis where reference has been made to the work of others.

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I was responsible for the collection and analysis of data and contributed to the manuscript. S Caton ran the study and collected and analysed data and drafted the manuscript. M Hetherington assisted with the design of the study and advised on the analysis and interpretation of the data and contributed to the manuscript

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I was responsible for the collection of data, completed all analysis and drafted the manuscript. All authors contributed to the design on the study. S Caton, H Hausner, A Olsen all ran the study and collected data in their own localities. M Hetherington and S Caton advised on the analysis and interpretation of the data and contributed to the manuscript.

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I was responsible for running the study, collecting data and assisting in the analysis. S Caton assisted in data collection, analysed data and drafted the manuscript. P Blundell assisted in the analysis of data and advised on interpretation. M Hetherington advised on the analysis and interpretation of the data and contributed to the manuscript.

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Thesis Abstract

Despite a 5-a-day recommendation many children do not consume sufficient fruits and vegetables, with vegetable intake particularly low. Children's strong dislike for vegetables is a barrier to intake (Nicklaus, Boggio, Chabanet & Issanchou, 2005; Zeinstra, Koelen, Kok, & de Graaf, 2007) indicating a need to develop strategies that will help children to develop the necessary preferences. Research has suggested that increasing children's familiarity with vegetables through repeated experience is crucial in enhancing preferences. The current thesis used quantitative and qualitative methods to explore children's earliest experiences with vegetables in order to identify critical periods and factors that impact upon liking and intake. Using experimental methods it then examined the effectiveness of strategies currently being employed by parents to promote vegetables in young children.

The data presented confirms that familiarising children with a variety of vegetables via repeated taste exposure is fundamental in increasing children's preference for and intake of novel vegetables. Results suggest that the effects of experience are mediated by age, supporting the idea of a 'sensitive period' during which children are more receptive to new tastes. The onset of food neophobia in the preschool years appears to limit the effects of repeated exposure but significant increases in consumption are observed. A theoretical model of children's vegetable intake contributes to understanding of food preference development and highlights a need to focus interventions on children who might be more resistant to the effects of exposure.

Chapter 1 Determining children's food preferences: a review of the literature

This thesis is an investigation into food preference development in young children. Through quantitative and experimental investigation, it attempts to identify critical periods and influential factors that contribute towards existing knowledge. In addition it examines how current knowledge can be applied to the promotion of healthy eating habits in children with a particular focus on increasing vegetable liking and intake.

The literature review begins by establishing current patterns in children's vegetable consumption and goes on to explore research on food preference development. Studies specifically aimed at encouraging children to consume vegetables are reviewed alongside other relevant research which explores factors that impact upon liking for and intake of target foods in children. This chapter provides a summary of the current theoretical perspectives that support this research and introduces the aims and objectives of the overall thesis.

1.1 Vegetable intake in children and influencing factors

It is known that most children eat more high energy dense foods than recommended and that for some this creates an imbalance between their energy intake and the energy they require resulting in excess weight gain. It has been suggested that dietary energy intake can be reduced by increasing intake of water rich foods such as fruits and vegetables (Rolls, 2009). Eating these foods facilitates satiation and satiety while also producing a net reduction in overall energy intake. Including more vegetables than is typical within everday meals can promote satiety and lower energy content. Vegetables also make up an important part of a healthy diet, providing much needed nutrients and fibre and reducing the risk of diet related disease (Bazzano, He, Ogden et al., 2002; Bazzano, Li, Joshipura, & Hu, 2008; Dietz, 1998). Current UK guidelines suggest a minimum of five portions of fruit and vegetables a day, although no specific recommendations are given for what proportion of these should be vegetables. Guidelines in other countries such as Australia and the US, advise that adults consume a minimum of seven and nine portions of fruits and vegetables respectively and that at least five of these portions should be vegetables (Go for 2&5, 2005; CDC, 2006). Research clearly shows that vegetable intake in the UK is well below all of these recommendations with few adults and children reaching the five combined fruit and vegetable portions per day (National Obesity Observatory (NOO) 2012).

Around 20% of 5-15 year old children are consuming the recommended amounts of fruits and vegetables every day (NOO 2012). Statistics show that 19% of boys and 20% of girls meet the 5 a day benchmark with the average child eating only 3 portions per day and around 7% of children eating no fruit or vegetables at all. When fruit intake is discounted it becomes apparent that vegetable intake is particularly low with a mean of only 1.1 portions of vegetables being consumed by children every day (NOO 2012).

Table 1:1*:* Proportion of boys and girls who had eaten vegetables and the mean number of portions consumed per day (adapted from Health Survey for England 2006)

	Boys		Girls	
	% consuming food item	Mean no. of portions consumed	% consuming food item	Mean no. of portions consumed
Any vegetables (and salads)	63	1.1	68	1.2
Vegetables	52	0.5	54	0.6
Pulses	38	0.3	34	0.3
Salad	22	0.2	28	0.3
Vegetables in composite meals	7	0.1	8	0.1

It is clear that the majority of children in this country are not consuming the recommended portions of fruit and vegetables, and that vegetables are less likely to be eaten than fruit. Such patterns of eating behaviours in children have been evidenced across other European countries (Klepp, Pérez-Rodrigo, De Bourdeaudhuij et al., 2005; Yngve, Wolf, Poortvliet et al., 2005) as well as the US and Australia (Krebs-Smith, Cook, Subar et al., 1996; Magarey, Daniels, & Smith, 2001) where children are failing to meet national recommendations. Eating habits in early life track into later life (Nicklaus and Remy, 2013) and this presents many possible negative health consequences on a large scale, both in the short and long term. This highlights the need for early interventions aimed at children to encourage intake of vegetables with their potential health benefits. However, in order to develop strategies for intervention it is important to consider why the problem exists and how children's diets are shaped.

Eating behaviours develop very early on in life and parents play the primary role in directly influencing dietary intake and preference and, therefore, indirectly affect later eating behaviours (Savage, Fisher, & Birch, 2007). The foods young children eat depend on their availability i.e. what foods they have access to. The variety of an infant's diet is therefore a result of what food is made available to them and the quantity in which it is offered. As experience with foods is an important factor in developing food preferences, it follows that children are less likely to develop preferences for foods that they are not exposed to. Parents also act as role models with their own eating habits influencing the food-related behaviours of their children. The ways they feed their children (feeding practices) can influence food choice and eating behaviour, for example restricting or promoting certain foods can greatly affect how foods are perceived by a child and impact on overall diet (Blissett, 2011; Jansen, Mulkens, Emond, & Jansen, 2008; Sleddens, Kremers, De Vries, & Thijs, 2010; Wardle, Carnell, & Cooke, 2005).

Many children simply report a strong dislike for vegetables and there are various reasons for this including the taste, appearance and texture, often influenced by how they are prepared (Zeinstra, Koelen, Kok, & de Graaf, 2010). Also the high water content and resulting low energy density is less attractive to children whose growth needs might direct choice towards higher energy density foods. Children's liking of a food is a strong predictor of intake (Gibson, Wardle, & Watts, 1998), thus improving children's liking for vegetables may be an effective way of increasing intake and improving long term eating behaviours.

1.2 Early experience with flavours

1.2.1 Preferences

Initial acceptance of tastes in infancy is influenced by the presence at birth of innate acceptance of sweet and rejection of bitter tastes that have been widely observed in both animal and human new born infants (Nicklaus, Boggio, Chabanet, & Issanchou, 2005b; Ventura & Mennella, 2011) . It has been suggested that these preferences are unlearned and are therefore a reflexive response to basic tastes, evident only hours after birth (Rosenstein & Oster, 1988). Much of the research on the "innate" liking of sweet tastes has shown that in terms of observable measures such as intake and facial expressions, newborn infants prefer sweetened solutions over water (Schwartz, Issanchou, & Nickaus, 2009). Similar research has demonstrated that infants display negative facial expressions, interpreted as dislike, in response to bitter tasting solutions as well as lower intakes (Rosenstein & Oster, 1988; Schwartz et al., 2009). It is generally accepted that these behaviours reflect an underlying adaptive response. Such instinctive responses to flavour serve to increase the consumption of foods which are a good source of energy (sweet foods) and prevent the consumption of bitter tasting foods which could be toxic and damaging to health. Given the relative sweet taste of breast milk, a preference for sweet tastes also facilitates children's acceptance of their initial food source. Historically a bias towards energy rich foods would have served to maximise the energy return of food gathering in an environment where food was well dispersed and foraging required energy expenditure (Messer, 1984; Rozin & Gohar, 2011). However, in modern food environments, where a variety of sugary and high fat foods are readily available, these adaptive tendencies may well be maladaptive (Birch & Anzman, 2010). Children's innate responses to tastes could also explain a preference for fruits and rejection of green vegetables which can be characterised by a relatively bitter flavour. Both of these innate responses have been found to be susceptible to modification through experience, reducing and changing over time (Beauchamp & Mennella, 2009; Schwartz et al., 2009).

1.2.2 The importance of exposure

Early experience with flavours can transform behavioural tendencies and help shape preferences for new foods and subsequent eating behaviour. Studies have shown that repeated experience with and exposure to a novel flavour can lead to that flavour being more readily accepted. The idea that exposure can lead to the development of preferences has its foundation in the mere exposure paradigm (Zajonc, 1968). This theory proposes that preference for a stimulus object can be developed simply by presenting that stimulus to an individual and making it accessible to their senses. With this model there is no reinforcement given and it is purely through repeated exposures to the stimulus that the individual's attitude towards it is enhanced. Familiarity is therefore a fundamental aspect of mere exposure, however, the effect is achieved only when experiences with a stimulus occur in the absence of negative affect. Unfavourable experiences with a stimulus are likely to have the opposite effect on preference as associations are formed between the stimulus and the negative outcome (Zajonc, Markus, & Wilson, 1974).

1.2.2.i Pre-natal and post-natal exposure

Exposure to odour and taste begins *in utero* via transmission through the placenta to the amniotic fluid. Experience with these cues prenatally can lead to increased acceptance of and liking for these and similar flavours during the weaning period (Cooke & Fildes, 2011). This has been demonstrated in a study in which pregnant mothers consumed carrot juice during their last trimester of pregnancy or during the first few months of breastfeeding. Infants whose mothers had consumed carrot juice either during pregnancy or lactation were more accepting of carrot flavour cereals during weaning and displayed fewer negative facial expressions than those infants whose mothers had not consumed carrot

(Mennella, Jagnow, & Beauchamp, 2001). In addition infants whose mothers had consumed carrot juice ate significantly more of the carrot flavour cereal than a plain cereal, however, intake in the experimental groups did not differ significantly from the control group who also consumed more carrot flavoured cereal. This might suggest that the carrot cereal was generally more palatable than the plain, and also raises the question as to how much 'negative' facial expressions should inform judgements regarding child liking for a food.

The composition of breast milk is directly affected by certain components of the maternal diet as well as other compounds ingested by the mother (Mennella, 1995). Infants have shown changes in their responsiveness during feeding following mothers' ingestion of different flavours (Mennella & Beauchamp, 1991a, 1991b). However, the differing chemical structures of flavour compounds mean that they are metabolised differently. Not all of the sensory properties of a flavour are detectable in breast milk and the rate at which flavours are transferred to milk differs between flavour compounds and between mothers (Hausner, Bredie, Molgaard, Petersen, & Moller, 2008). Much like transmission of flavours through amniotic fluid, exposure to flavours within the breast milk can impact on the child's preferences for and acceptance of those flavours (Beauchamp & Mennella, 2009; Forestell & Mennella, 2007; Maier, Chabanet, Schall, Leathwood, & Issanchou, 2008; Mennella et al., 2001; Sullivan & Birch, 1994). In their review of research into early flavour learning, Beauchamp and Mennella (2009) suggest that amniotic fluid and breast milk are likely to have similar flavour compositions when the mother's diet remains consistent during pregnancy and lactation. As a result they suggest that breast milk effectively acts as a 'bridge' between flavour experiences in utero and through solid foods during weaning, a concept which has been proposed previously as "chemical continuity". However, breastfeeding may be sufficient to increase novel flavours, irrespective of whether it has been consumed by the mother (Hausner, Nicklaus, Issanchou, Molgaard, & Moller, 2010).

An increase in acceptance of flavours following exposure has also been observed in studies involving formula fed infants (Liem & Mennella, 2002; Mennella, Griffin, & Beauchamp, 2004). In their study, Mennella and colleagues demonstrated that infants who had been consistently fed on a specific hydrolysate formula, a formula with a more bitter and sour taste than most other milk-based formulas, became more accepting of this formula. This increase in acceptance also generalised to another novel hydrolysate formula. These results suggest both that repeated exposure can increase acceptance of even extremely unpalatable flavours and can generalise to similar, yet novel flavours. However, in a further experimental study involving hydrolysate formula, mothers of children fed on this were more likely to report that their infants did not enjoy eating broccoli or cauliflower, cruciferous vegetables with similar flavour notes to that formula (Mennella, Kennedy, & Beauchamp, 2006). These results are accounted for as evidence of sensory-specific satiety, a temporary decrease in the enjoyment of consuming a particular food or flavour relative to other unconsumed foods or flavours following an extended period of exposure (Rolls, Rolls, Rowe, & Sweeney, 1981). Similar reductions in acceptance and intake have been demonstrated in other studies of repeated exposure involving infants. Two experiments by Mennella and Beauchamp (1993, 1999) found that infants that had received extensive exposure to a flavour in their mothers' breast milk consumed less of that flavour immediately after the exposure period indicating a possible decrease in liking for that flavour and evidence of sensory-specific satiety. In addition to this potential explanation, Mennella and colleagues (2006) argue that a newly acquired flavour preference is specific to the context in which it is first experienced and maintain that it takes time for a preference to generalise to other contexts. This would indeed explain why a preference that has developed for a flavour presented in breast milk or formula may not be evident when the flavour is presented in a solid food but, at this juncture, is something that requires further investigation.

Although flavour preferences can be shaped through formula feeding numerous studies have shown that breastfeeding benefits initial acceptance of new foods relative to formula feeding (Beauchamp & Mennella, 2009; Forestell & Mennella, 2007; Hausner et al., 2010;

Maier, Chabanet, et al., 2008; Mennella et al., 2001). This is likely to be as a result of variation in the maternal diet and the resulting diversity of flavours transmitted in breast milk to the infant. More specifically studies have demonstrated that breastfed infants consume relatively more vegetables later in childhood than those that are formula fed (de Lauzon-Guillain, Jones, Oliveira et al., 2013; Sullivan & Birch, 1994). However, it is important for studies such as these to measure other possible factors that could influence this outcome. For instance, a study by Burnier and colleagues found that exclusive breastfeeding for more than three months was linked to greater vegetable intake in four year old children (Burnier, Dubois, & Girard, 2010). However, they failed to account for potentially confounding factors such as familial diet which is known to be a strong predictor of children's vegetable intake.

1.2.2.ii Weaning and the introduction of solid Foods

It is during the introduction of solid foods (referred to as "weaning") that infants will first experience a wide array of flavours and textures. These earliest experiences allow children to learn about foods and it has been suggested that the first two years of life represent a 'sensitive period' during which infants are particularly receptive of new foods and flavours (Cashdan, 1994). Harris (1993) argues that this 'sensitive period' ends at around twelve months of age. She proposes that there is a window of opportunity for food introduction between four and six months during which new tastes and flavours are readily accepted and that textures should then be introduced between six and twelve months to avoid poor acceptance later on (Coulthard, Harris, & Emmett, 2009; Northstone, Emmett, Nethersole, & the Alspac Study Team, 2001). Subsequent difficulties in introducing new foods mean that the first few months of weaning are an opportunity for parents to expose their infants to a wide variety of foods and flavours. Early introduction to a range of vegetables can promote the development of healthy preferences in children and increase vegetable intake later in life (Birch, Birch, Marlin, & Kramer, 1982; Coulthard, Harris, & Emmett, 2010). Mere or repeated exposure is sufficient in the early years to establish acceptance and intake of novel foods (Forestell & Mennella, 2007). Offering healthy foods such as fruits and vegetables during weaning, and more importantly a variety of fruit and vegetables, can increase an infant's acceptance of novel foods and this effect can persist for several months (Cooke, 2012; Maier, Chabanet, Schaal, Issanchou, & Leathwood, 2007; Mennella, Nicklaus, Jagolino, & Yourshaw, 2008) . As previously discussed, the success of repeated exposure is contingent on a lack of negative outcome. This is consistent with the 'learned safety' hypothesis which states that animals approach all new foods as if potentially toxic and through repeated, favourable experiences with those foods, learn that they are safe to consume (Rozin & Kalat, 1971). Familiarity is therefore necessary for removing children's apprehension towards consuming novel foods. In addition to increasing preference for unfamiliar foods parent-led repeated exposure can even reverse dislike of vegetables (Fildes, van Jaarsveld, Wardle & Cooke, 2013; Maier et al., 2007).

According to most systematic studies, a child must be exposed to a flavour between 8-15 times (Birch, McPhee, Shoba, Pirok, & Steinberg, 1987; Birch et al., 1982), far more frequently than mothers tend to offer a food that their child does not appear to enjoy (Carruth, Ziegler, Gordon, & Barr, 2004; Maier, Chabanet, et al., 2008). Frequency and quality of exposures can influence the development of flavour preferences. A study by Coulthard et al. (2010) has drawn a distinction between the use of fresh home-cooked or raw fruit and vegetables during the weaning process and commercially prepared fruit and vegetable products. They found that despite frequent exposure to flavours in ready-made baby foods, there was no positive effect on vegetable intake later in childhood (at 7 years of age), an effect that was present for those exposed frequently to raw or home-cooked vegetables. This may be explained in part by the potential link between use of ready-made baby foods and convenience foods more generally, and therefore fewer fresh fruits and vegetables in the family diet. As well as signifying a lack of parental modelling for the infants in these households, it would also mean less frequent exposure to vegetable flavours after weaning. In addition commercial baby foods can often have a uniform flavour and this too might limit children's experience with variety. The ways in which solid foods are introduced, including vegetables, influence later intake (Coulthard et al., 2010; Northstone, Emmett, Nethersole, & the Alspac Study Team, 2001) as does the frequency with which they are offered. Infants frequently offered vegetables early on in the weaning process were found to eat more vegetables at 7 years old than those that were not. However, differences in intake were reduced when children introduced to vegetables later were offered them frequently (Coulthard et al., 2010). Coulthard et al. suggest that when addressing vegetable intake at a later stage in childhood, parents should offer vegetables more frequently to ensure sufficient exposure.

1.2.2.iii Food Neophobia

The initial interest in and acceptance of new foods observed in infancy is something that decreases over time, with the emergence of the neophobic response to food (Birch, 1999). Neophobia is a 'fear of the new' and in humans food neophobia is characterised by the avoidance of unfamiliar foods. Another behavioural tendency of children, the neophobic response first becomes apparent at around twelve months of age and influences what foods the infant accepts, ingests and develops preferences for (Birch, 1999; Nicklaus, Boggio, Chabanet, & Issanchou, 2005a). It is thought that this behaviour is adaptive and served to deter infants, who were becoming more mobile, from consuming foods likely to be detrimental to their health (Aldridge, Dovey, & Halford, 2009; Cashdan, 1998; Rozin & Vollmecke, 1986). Evidence suggests that infants experience their highest degree of neophobia between two and six years of age (Dovey, Staples, Gibson, & Halford, 2008) but much like the predispositions for sweet taste preference and bitter taste avoidance, the initial neophobic response can be reduced through repeated experiences with food (Birch et al., 1987; Loewen & Pliner, 1999).

In addition to avoiding novel foods, neophobic children have also been found to refuse certain familiar foods, with fruits and vegetables more likely to be rejected. It has been suggested that this is more a characteristic of fussy or picky eating rather than neophobia (Wardle & Cooke, 2008), however both behaviours are highly related (Pelchat & Pliner, 1986; Pliner & Hobden, 1992). Food neophobia is associated with low liking and intake of vegetables (Cooke, Carnell, & Wardle, 2006; Cooke, Wardle, & Gibson, 2003) making the preschool years a time when vegetable consumption might be particularly low and when vegetable introduction is difficult. As previously mentioned, reluctance to consume new foods can be overcome through repeated experience and repeated exposure has been shown to increase vegetable intake in preschool aged children (Anzman-Frasca, Savage, Marini, Fisher, & Birch, 2012; Wardle, Cooke, Gibson et al., 2003). However, evidence suggests that older children may require a greater number of exposures than those of weaning age in order produce similar shifts in liking and intake (Coulthard et al., 2010). The idea of frequency, rather than age being key to designing interventions for children is supported by research that has shown that taste exposure not only facilitates preference development in very young children but can also be used as interventions for school age children (Lakkakula, Geaghan, Zanovec, Pierce, & Tuuri, 2010; Loewen & Pliner, 1999).

1.2.2.iv The role of visual exposure

In contrast to the wealth of evidence on familiarity via taste exposure, there is less known about the importance of visual recognition. However, the rejection of foods by neophobic, or 'fussy' eaters, is often based on sight not taste. The food is rejected before it has been tasted. In their review Dovey et al. (2008) suggest that through repeated experiences with different foods children develop schemata around the sensory characteristics of 'acceptable' foods, such as their appearance and smell. Dovey and colleagues propose that when children are presented with a novel food that differs significantly from their idea of an 'acceptable' food, they will reject it.

Studies on repeated exposure generally provide both taste and visual exposures to the target foods and the specific role of each is not known. A study by Birch and colleagues (1987a) examined the relative effectiveness of visual *and* taste exposure on children's preferences for novel foods. They concluded that although repeated visual exposure to the target foods was sufficient to improve visual judgements about them, exposure to taste was required to significantly increase taste preference (Birch et al. 1987a). Birch suggested that this was because a food needs to be consumed in order for 'learned safety' to occur. However, it is worth noting that neither the 'look' (visual exposure) nor the 'taste' conditions in this experiment were restricted to purely visual or taste exposures. Children enrolled in the 'look' condition were able to both see and smell the target food while those in the 'taste' condition could also see, smell and taste the food. It seems important, therefore, not to underestimate the role of other sensory factors in building a level of familiarity with a food that helps to overcome a child's initial reluctance to taste it.

The role of visual exposure through story books has been investigated (Heath, Houston-Price, & Kennedy; Houston-Price, Burton, Hickinson et al., 2009; Houston-Price, Butler, & Shiba, 2009). In an initial experiment Houston-Price and colleagues (2009a) found evidence in support of Birch et al. (1987a) showing repeated visual exposure to food, this time in the form of pictures, increased children's visual preferences for these foods and this generalised to other visual representations of the same food item. A further study (Houston-Price, Butler, et al., 2009) then found that exposure to pictures of fruits and vegetables reduced neophobic behaviour towards these exposed foods during subsequent taste tests.

Visual exposure encourages familiarity with a food which decreases the neophobic response and therefore increases the likelihood that a novel food is tasted, meaning the child receives the vital first taste exposure. Yet many mothers report hiding disliked foods such as vegetables within other foods or dishes to disguise their appearance or simply serving them in a way that is unrecognisable (Caton, Ahern, & Hetherington, 2011). This method of 'vegetables by stealth' has been found to be an effective way to increase children's vegetable intake and reduce the energy density of their meals (Spill, Birch, Roe, & Rolls, 2011). While intake increases in the short term, however, a question is raised about whether any long term benefits exist. Given that the vegetables are hidden or unrecognisable it could follow that children are missing out on the opportunity to develop familiarity, at least on a visual level, with these foods. Nevertheless the health benefits do not depend on developing distinctive taste preferences only on intake.

1.2.2.v Exposure to variety

Studies which have explored variety during weaning suggest that very young children are able to differentiate between the flavours of different foods even when presented within the same meal and are capable of forming some memory of them (Nicklaus, 2009). Offering children variety in this way promotes the consumption of a varied diet, necessary in order to meet their nutritional needs. As well as contributing to better health, consuming a variety of foods can also increase the pleasure experienced during eating (Hetherington, Bell, & Rolls, 2000) and increase food and energy intake (Sørensen, Møller, Flint, Martens, & Raben, 2003).

As previously discussed, introducing variety in infancy promotes intake of variety and acceptance of new foods later in life (Beauchamp & Mennella, 2009; Forestell & Mennella, 2007; Gerrish & Mennella, 2001; Maier, Blossfeld, & Leathwood, 2008; Maier, Chabanet, et al., 2008; Maier, Pineau, Schaal, Leathwood, & Issanchou, 2009; Mennella et al., 2001; Mennella et al., 2008; Sullivan & Birch, 1994). Patterns in the way that mothers introduce and infants accept variety in the first year of food introduction remain similar in the second year (Story, Kaphingst, Robinson-O'Brien, & Glanz, 2008) with the child's diet becoming more varied as additional new foods are introduced. However, the emergence of the developmental phase of food neophobia or 'food fussiness' during this second year (Dovey et al., 2008) coincides with increased levels of autonomy and this appears to result in a decrease in the variety of foods selected by children between 24 and 30 months of age (Nicklaus, Boggio, et al., 2005b). Children of this age select a limited number of preferred foods despite an increase in their energy requirements and intake (Nicklaus, Chabanet, Boggio, & Issanchou, 2005). While variety seeking remains fairly stable between the ages of three and five, fruit and vegetable variety continues to decrease (Hearn, Baranowski, Baranowski et al., 1998). Furthermore vegetable variety in the first two years of life is less likely to predict that at five years, when compared with fruit variety at the same time points (Skinner, Carruth, Bounds, Ziegler, & Reidy, 2002). As a result of the negative relationship between food variety and food neophobia (Pliner & Hobden, 1992), levels of variety within children's diets only seem to improve after the age of eight with the decline of the neophobic phase. However, evidence suggests that continued frequent exposure to target foods, such as vegetables, during the neophobic phase may help to encourage their consumption (Anzman-Frasca et al., 2012; Wardle, Cooke, et al., 2003; Wardle, Herrera, Cooke, & Gibson, 2003).

While dietary variety is beneficial in terms of maintaining nutritional balance, it has been linked to increased intake of food (Hetherington, Foster, Newman, Anderson, & Norton, 2006). Where variety increases food intake of those food groups high in energy density, this can lead to increased energy intake and effect energy balance (Sørensen et al., 2003) potentially leading to overweight and obesity. Within meal variety can increase food intake and this 'variety effect' is observed when the foods that are offered differ in terms of their sensory characteristics (Rolls et al., 1981). The 'variety effect' can be explained in part by sensory specific satiety (SSS). Generally studied by measuring *ad libitum* meal consumption, research has explored the effect of variety introduced within a single course (simultaneously), by using multiple courses (successively) or by offering choice through a buffet-style meal and altering the degree of variety. Studies have been consistently successful in demonstrating a reduction in pleasantness ratings, intake and/or selection of already consumed foods (Hetherington et al., 2000; Hetherington, Pirie, & Nabb, 2002) and an increase in these measures for uneaten foods (Hetherington et al., 2006).

Again it is suggested that this human propensity to eat more when presented with a variety of foods is adaptive, as historically variety would have represented an array of nutrients beneficial for health. However, an abundance of energy dense foods in our environment means this tendency may no longer be advantageous (Raynor & Epstein, 2001). Conversely, a small number of studies have attempted to apply the principles of the variety effect to increasing consumption of foods which are beneficial to health, namely fruits and vegetables, and have shown promising results (Meengs, Roe, & Rolls, 2012; Raynor & Osterholt, 2012). A recent study by Roe and colleagues (2013) found that offering preschool children a variety of either fruits or vegetables at snack time led to them being more likely to choose to consume snack and increased their intake by approximately 31g. However, change in intake was much higher for fruit than vegetables and further research in this area will help to ascertain how effective this strategy is at promoting vegetable consumption, particularly in children.

1.2.3 Autonomy and exerting choice

In addition to offering variety, recent research has begun to investigate the importance of offering children choice in the foods that they consume and the effect this has on consumption. The importance of offering choice relates to children's emerging autonomy and nurturing a level of independence and personal control. In terms of their development an infant begins to display more autonomous behaviours at around two years of age when they are able to move around independently and have a growing sense of self. This is generally when children begin to communicate their own will and desires and attempt to influence the decisions that affect them. According to self-determination theory of motivation, allowing an individual a level of choice or personal control increases their intrinsic motivation (Deci and Ryan, 1985) and this is particularly the case for children (Tomlinson, Harbaugh, & Anderson, 1996). Providing insufficient choice or removing choice altogether can negatively impact upon intrinsic motivation. Rather than motivate, an environment that is perceived as excessively controlling is more likely to produce feelings of resistance or opposition. This may go some way towards explaining the counterproductive outcomes produced by pressuring and restricting children's eating (Blissett, 2011; Scaglioni, Salvioni, & Galimberti, 2008).

Despite indications that offering choice may promote children's vegetable consumption, little research has focussed on this topic with most evidence coming from studies where the predominant focus has been general parental feeding practices. A recent experiment by Zeinstra et al. (2007) which offered children a pre-meal or at-meal choice of two vegetables failed to increase intake or liking when compared with a no choice condition. However, children who scored highly for trait reactance on the Psychological Reactance

Scale did reduce intake when not offered choice suggesting that offering choice may be more effective for some children than others. The lack of literature which has explored involving children in food selection highlights a need for further experimental research. Studies that have investigated parents feeding styles and practices point towards offering choice as a potential strategy for fostering healthy eating habits, particularly fruit and vegetable consumption. However, its success appears to depend on the way in which it is implemented and this is influenced by parenting style, overall feeding style, and other feeding practices that parents employ.

1.2.4 Feeding styles and practices

Parents influence children's food preferences and eating behaviours by what foods are made available and via modelling. Research suggests that the way in which foods are offered, a result of parenting style, feeding style and specific feeding practices, also impacts on children's eating habits. Blissett (2011) describes a caregivers' parenting style as the 'broad emotional climate' in which all parenting practices are used (pg. 826). This differs from feeding style which instead refers to the specific emotional climate of eating and feeding interactions. Both parenting and feeding styles have been categorised into four types; authoritarian, authoritative, indulgent/permissive and neglectful/permissive (Maccoby & Martin, 1983). Characterised by low levels of parental warmth and responsiveness and high demandingness, authoritarian feeders will have high expectations of their child's diet and eating behaviours and may exert higher levels of discipline over eating situations. Authoritative feeders will also have high expectations but feeding interactions will be warmer with parents showing higher levels of responsiveness to the child. Permissive feeders are identified by low levels of responsiveness and a lack of expectations around diet quality and eating behaviours. However, permissive parents may be either indulgent, fostering warm feeding interactions, or neglectful, by remaining distant or uninvolved.

Feeding practices describe the actual techniques used by parents to facilitate or limit intake of different foods and differ according to parents concerns around children's eating (Baughcum, Burklow, Deeks, Powers, & Whitaker, 1998; Blissett, 2011; Costanzo & Woody, 1985). These can include the use of monitoring and or restrictive practices, pressuring children to consume specific foods or offering rewards for consumption. Discussion around the effect of feeding styles and feeding practices on children's eating behaviours has revealed that the level of control parents exert over their child's eating may influence eating patterns and preference development (Blissett, 2011; Vereecken, Legiest, De Bourdeaudhuij, & Maes, 2009). Parents with an authoritarian feeding style are characterised by exercising high levels of control over their children's food consumption with little regard for their preferences and offering little to no choice in terms of the food being offered (Patrick, Nicklas, Hughes, & Morales, 2005). It has been suggested that parents that adopt this feeding style are more likely to employ feeding practices such as restriction and pressure to eat, both of which may be counterproductive and are associated with the development of undesirable eating behaviours (Blissett, 2011; Scaglioni et al., 2008). Restriction of foods, such as those considered to be unhealthy, may actually result in these foods becoming preferred by children (Jansen et al., 2008) whereas pressure to eat foods, more likely to be those considered to be healthy, can actually reduce preferences for those foods (Galloway, Fiorito, Francis, & Birch, 2006). Restrictive feeding practices have been linked to lower fruit and vegetable consumption when compared with less restriction (Couthard & Blissett, 2009) and this is also the case when an overall authoritarian feeding style is compared to an authoritative style. As previously mentioned, offering children no choice in what they consume may be detrimental to later eating habits. However, more indulgent parents who employ permissive feeding practices were also more likely to have children who displayed negative eating behaviours. Permissive parents were more likely to allow children to decide when and what to eat as well as being less likely to restrict sweets and biscuits and this lack of restriction has also been associated with lower fruit and vegetable consumption (Crombie, Kiezebrink, Irvine et al., 2009). In contrast a more authoritative style of feeding characterised by encouraging healthy eating behaviours but offering children some choice of food options resulted in mothers reporting higher fruit and vegetable intake in their children (Patrick et al., 2005) with the use of moderate restriction also positively effecting consumption (Gubbels, Kremers, Stafleu et al., 2009). The NOURISH trial has incorporated this idea of structured food choice into an intervention examining the effects of guidance for parents on protective feeding practices in the prevention of obesity (Daniels, Magarey, Battistutta et al., 2009). To date this study has demonstrated that providing such guidance reduces parents use of controlling feeding practices and increases levels of responsiveness and while the impact on children's food preferences is yet to be reported, these results are promising (Daniels, Mallan, Nicholson, Battistutta, & Magarey, 2013). Research into the effects of feeding styles and practices on children's habits has so far focussed on the role of parents. Few studies have looked to determine whether parents' approaches to feeding are a response to children's eating behaviours and to what extent children respond differently to the feeding styles and practices employed.

One such study, conducted by Farrow and colleagues (2009), examined the feeding practices employed by parents with siblings in the same family in order to establish if they differed between children. The results of their investigation suggest that parents do modify practices based on their children's eating behaviours, specifically the use of restriction and pressure to eat. Parents were more likely to pressure children to eat if they were fussier, slower in eating, exhibited less enjoyment of food, were less responsive to food, were more satiety responsive and more likely to emotionally under-eat than their sibling (Farrow, Galloway, & Fraser, 2009). Similarly parents were more likely to use restriction with children who were more food fussy and exhibited a greater desire to drink than their sibling. Rodgers et al. (2013) also found evidence that child eating behaviours can predict the feeding practices employed by mothers. Instrumental feeding was found to increase where children showed a tendency to overeat but decreased where children with greater food approach behaviours (Rodgers, Paxton, Massey, et al., 2013). Mothers were also more likely to use covert control and emotional feeding with children who show emotional eating. Several studies have suggested a bi-directional relationship between children's eating behaviours and the feeding practices that parents employ (Birch & Fisher, 2000; Rodgers et al., 2013; Bergmeier, Skouteris, Horwood et al., 2014). That is to say that while parents may adapt their practices based on the eating behaviours they observe in their children, these practices will in turn influence the behaviours that are exhibited.

1.3 Classical learning theory and eating behaviour

Food choices are based on food availability and an individual's integrated knowledge about this available food. This includes how much the flavour of the food is enjoyed (its palatability) and the expected outcome of consuming the food (the post-ingestive consequences), both in terms of how filling it is and its expected effect on health. Unlike predisposed preferences, *this* knowledge is not innate but acquired through experience with food over time meaning that the consequent preferences and eating behaviours are learned.

This idea of learned eating behaviours is often accounted for in terms of associative learning theory which at its most basic level suggests that animals learn through the formation of associations between stimuli. Hall (1991) explains that 'the central representations of specified elements can become linked so that activation of one can excite its associate'. This theory has its roots in Pavlov's classical conditioning where the first stimuli, or conditioned stimuli (CS), which tends to be a neutral element, is paired with the presentation of a second, unconditioned stimulus (US). Repeated presentation of these paired stimuli produces an association which allows the subject to predict the presence of the CS on presentation on the US.

Operant or Instrumental conditioning differs from Pavlov's Classical conditioning in that it refers to the modification of voluntary behaviour. Much like the conditioning discussed above an individual changes their behaviour because of the associations that have developed between that behaviour and a stimulus. The new or changed behaviours are maintained due to resulting positive or negative consequences. Skinner expanded on this idea by introducing the concepts of reinforcement and punishment. Skinner stated that a behaviour can be reinforced when a positive consequence, be it the delivery of a rewarding stimulus or the removal of an aversive one, follows that behaviour and that it will therefore increase in frequency. When a behaviour results in the delivery of an aversive stimuli or the removal of a potentially rewarding one, that behaviour is less likely to occur. Furthermore, the consequences of a behaviour directly affect how frequently that behaviour will occur. It is the motivational significance of the reinforcing or punishing US that determines whether an individual will perform the associated behaviour.

The motivational significance of the US does not in itself guarantee that an association is formed between it and the conditioned behaviour. Several influential factors on the effectiveness of a behaviours consequence in increasing or decreasing a conditioned behaviour have been suggested. The Rescorla and Wagner model (1972, cited in Hall 1991) for example expands on associative learning stating that the associative strength, the strength of the connection between stimuli, increases when the two happen concurrently. Contingency is also of importance meaning that the positive or negative US needs to reliably and consistently follow the target behaviour in order to modify the response. Learning will be faster where there is a consistent schedule of reinforcement (or punishment) whereas if reinforcers or punishments are delivered sporadically learning will take place more slowly if at all. Successive trials result in an increase in the associative strength between stimuli until no further increase is possible suggesting that the US becomes less effective over time. As associative strength increases so the likelihood of the conditioned response increases. Evidence for this comes from animal studies which have induced both flavour preferences and aversions in rats. Rats were shown to learn faster and exhibit a stronger preference or aversion for flavours following concurrent or contingent presentations of a positive or negative reinforcer (Dickinson, Wood, & Smith, 2002; Garcia-Burgos & Gonzalez Reyes, 2011)

1.3.1 Flavour nutrient learning

Learned food preferences are thought to be a result of repeated associations between food sensory cues, such as flavour, and post-ingestive consequences. As a food is eaten, the sensory characteristics of the food item becomes associated with the resulting physiological consequences. Consumption of foods that lead to positive responses result in an increase in preference for and acceptance of that flavour. This form of learning has been demonstrated in numerous laboratory studies with animals involving the pairing of consumption of a novel neutral flavour (CS) with a nutritive solution (US) either added directly to the novel food or administered through intra-gastric infusion following ingestion. The resulting association is referred to as flavour nutrient learning (FNL). Some evidence suggests that even mildly aversive flavours can become associated with positive post-oral consequences, resulting in increased preference for and acceptance of a previously disliked flavour (Rozin & Kennel, 1983). The same learning mechanism could be responsible for the development of aversions to foods. Flavours which become associated with negative post-ingestive consequences such as gastro-intestinal malaise will be avoided and strongly disliked often resulting in a disgust response from individuals that have developed this association (Burnstein, 1998).

Recent studies involving rats, provides evidence that not only do preferences develop through FNL but that the acquisition of these preferences can develop very rapidly (Ackroff, Dym, Yiin, & Sclafani, 2009; Revelle & Warwick, 2009). In a study examining how quickly rats acquired flavour preferences for flavours paired with the post-oral effects of glucose, Ackroff and colleagues found that the effect of glucose produced a learned preference after just one trial (Ackroff et al., 2009). A study by Revelle and Warwick (2009) revealed similar effects using sucrose, with a learned preference being observed after only two conditioning trials. Their study also demonstrated that pairing novel flavours with carbohydrates, such as sucrose and glucose, resulted in a more rapid acquisition of preference than pairing flavours with fat, which took at least 6 conditioning trials. However, while flavour-nutrient learning is slower when associations are based on pairings with fat, there is no difference in the level of conditioning once the association has been learnt (Revelle and Warwick, 2009). While both of these studies demonstrate the development of flavour-nutrient associations in adult rats, studies have also evidenced FNL in rat pups (Myers & Hall, 1998) as well as their propensity to develop these associations pre-weaning (Myers, Ferris, & Sclafani, 2005).

In addition to the speed at which flavour-nutrient associations can be learned, a study by Yiin, Dwyer and Sclafani (2005) showed that preferences developed through FNL show particular resistance to extinction. Interestingly a later study by Dwyer et al. (2009) found that flavour nutrient associations remained even when extinction of the conditioned hedonic reactions to flavour cues had occurred. This apparent resistance to extinction exhibited by preferences resulting from FNL has significant implications regarding the importance of FNL in the development of valuable flavour preferences and long-term healthy eating behaviours.

There are very few successful FNL studies involving human participants. Furthermore studies that successfully demonstrate FNL in adults are scarce. Brunstrom (2005) argues that this reflects the 'plasticity' of young children who are most responsive to physiological cues. He proposes that it is during this early stage that the majority of dietary learning occurs making infancy a critical period in food preference development.

A number of human studies have examined the role of hunger as a possible influencing factor in FNL and whether an individual's energy requirements effect the associations they make between flavours and post-ingestive consequences. Appleton et al. (2006) paired novel flavoured yoghurts with two levels of energy density and asked participants to consume the yoghurts while in two states of energy requirement- low and high. Participants that consumed the novel yoghurts in a state of high energy requirement were found to develop a liking for these flavours and this liking was found to increase. Liking for flavours consumed in a state of low energy requirement were not found to increase. Moreover rated pleasantness of yoghurt flavour when paired with high energy content and consumed in a state of high energy requirement was greater after the conditioning period even when tested in a state of low energy requirement. Similar results were found in a study involving carbonated drinks paired with a sweetener. Participants that experienced both conditioning and testing in a hungry state had significantly increased liking of this drink when compared to those conditioned and tested sated (Mobini, Chambers, & Yeomans, 2007). Development of flavour preference in these cases is a direct result of associations formed between the flavour of the yoghurt or drink and the positive post-ingestive effects.

Evidence from animal and adult research suggests that FNL might be an effective strategy for promoting intake of target foods in children, however research in children is scarce. A study by Johnson et al. (1991) investigated the effect of energy density on children's liking for yoghurt drinks. Children received eight conditioning trials with either yoghurt drinks of low or high fat content. Following conditioning children's preferences were found to have increased for the high fat yoghurt drink but not for the low evergy version suggesting FNL had taken place. A subsequent study by Kern et al. (1993) replicated this study adding a mere exposure condition so that comparisons could be made between the effects of FNL and those of simple repeated exposure. Again the results showed significant increase in preference for the high energy yoghurt drinks in the high energy condition, however those in the mere exposure group increased liking for both high fat and low fat versions of the yoghurt drink. In addition Kern and colleagues found that the effects of FNL were reduced by satiety but that the increase in preference brought about by mere exposure were unaffected. This allowed Kern et al. (1993) to conclude that FNL produced by high fat content may contribute to children's development of preferences for high fat foods but also suggests that in terms of effectiveness, mere exposure is highly effective in increasing children's liking of target foods.

This review found only one study that has investigated the effectiveness of FNL in developing preferences for vegetable flavours. Recruiting children aged between 7 and 8 years, Zeinstra et al. (2009) asked participants to consume fresh vegetable juices of two energy levels. A high energy version was achieved by pairing pure vegetable juice with forty grams of maltodextrin producing 150kcal difference between the low and high energy juices. Zeinstra et al. were unable to find any evidence for FNL with preference for and consumption of juices remaining unchanged from pre-test to testing post-conditioning. They argued that this could be accounted for by the low intake of the vegetable juices during conditioning and concluded that this was likely to be a consequence of the high level of taste intensity of the juices and the possibility of the flavours becoming aversive past a certain level of intake. A recent study by Boulhal et al. (2010) examined the effect of adding sugar, salt and fat to foods and children's subsequent intake. They found that neither the addition of sugar or fat, both of which would increase the energy density, had any positive effect on intake of the foods.

1.3.1.i Flavour Nutrient Learning and Conditioned Satiety

In much the same way as learning can determine what foods are consumed it also plays an important role in determining when and how much of these foods are eaten. Traditionally theories around food intake have focussed on biological cues and internal signals for the initation and termination of feeding. However, research has shown that through repeated experiences with food, associations can also be formed with cues in the environment and that these external cues can exert control over eating behaviour. A review by Birch (1987b) suggests that these 'learned controls' can be observed as early as during pre-school years in humans.

As well as influencing liking and acceptance of a food, the post-ingestive consequences following consumption can also influence the quantity of the food that is consumed. Repeated experiences with a food mean associations develop between the sensory characteristics of that food and the experienced satiety following ingestion. These associations allow individuals to anticipate how 'full' they expect to be after eating and help to influence the portion sizes they select and overall food intake.

During infancy children rely almost completely upon their internal biological signals, specifically those indicating energy depletion, to initiate and terminate feeding. Studies have shown that even very young children are sensitive to energy density cues and are capable of regulating their own energy intake, reducing intake when consuming formulas with a high energy density and increasing intake of low energy formulas (Fomon, 1974, cited in Birch and Deysher, 1986). Several studies have demonstrated that children receiving low or high energy preloads prior to testing are able to compensate by increasing or reducing their subsequent food intake (Birch & Deysher, 1985; Birch & Deysher, 1986; Birch, McPhee, Bryant, & Johnson, 1993; Birch, McPheee, Shoba, Steinberg, & Krehbiel, 1987). However FNL studies have shown that conditioning involving the pairing of specific flavours with a high or low energy density can produce associations that are able to somewhat 'override' this self-regulation by allowing the individual to predict how filling they expect a food to be and to adjust their consumption accordingly. For example in the study by Birch and Deysher (1985), they found that the children continued to eat more following the flavour associated with the LED preload than that associated with the HED preload even when the preloads administered were isocaloric during extinction trials.

Unlike the studies using child participants studies of conditioned satiety in adults have shown much more varied results. In a study by Yeomans et al. (2005) participants were given two versions of the same breakfast cereal which differed in flavour and calorie content. Liking for the cereals were measured prior to testing and participants were then permitted to eat as much of each cereal as they liked during the first test session. During the subsequent training days participants received fixed portions of either the high or low energy cereals, alternating on each day. After conditioning trials participants were again allowed to consume as much as they would like of each cereal, receiving differing energy content on each day. Prior to conditioning *ad libitum* intake of the cereals showed no difference between conditions as both cereals were novel to participants. However, following conditioning, intake of the LED cereal was significantly higher than the more energy dense version suggesting that the LED cereal did not leave participants sufficiently sated following breakfast and so they had learned to compensate for this by consuming more of this version. However, Yeomans et al. (2005) also report that liking of the low energy cereal had significantly increased following conditioning, another possible explanation for the increased intake contradicting the idea that we learn to develop preferences for high energy foods and regulate intake accordingly. A similar study by Wilkinson and Brunstrom (2009) looked to assess conditioned satiety and 'fullness expectations' brought about by a novel dessert of two different energy contents. The results of this study showed that expected satiety did increase in the HED condition but that this did not affect subsequent intake suggesting participants had not learned to regulate their consumption based on energy content. Later studies have suggested that individuals' regulation of intake is more complex than merely learning to compensate for calorie intake and that liking for a food is as much of a strong predictor of amount consumed or portion size than how 'filling' the food is expected to be (Brunstrom & Shakeshaft, 2009; Yeomans, Gould, Leitch, & Mobini, 2009).

The evidence discussed here suggests the possibility that while young children show a reliable ability to self-regulate intake of food based purely on energy consumed, adults' control of intake is subject to other influential factors such as liking for the foods being consumed. This is perhaps a result of the many different associations and forms of learning that are acquired regarding food and eating during an individual's development from childhood to adulthood which are able to influence and disrupt the internal biological cues to which children are so responsive.

1.3.2 Flavour flavour learning

Another mechanism thought to be responsible for preference development is flavour-flavour learning (FFL). Whereas in FNL the association is formed between the flavour of a food and the consequent post-ingestive effects, FFL involves an association between a flavour cue (CS) and an already established liked flavour (US). Repeated presentations of the two flavours together results in the hedonic value of the US flavour becoming associated with the target flavour. This results in a more positive evaluative response to the target flavour when presented on its own. Similarly, if a novel flavour is paired with a disliked or aversive flavour liking for the CS flavour will decrease.

Again the majority of successful FFL research has been animal based. Rat studies involving the pairing of a novel flavour with a predisposed sweet taste have resulted in an increase in preference for the new flavour (Myers & Hall, 1998) and much like with FNL, the preferences can develop quite rapidly (Ackroff et al., 2009). Human research has also focussed on the use of a sweetener as the unconditioned, pre-liked flavour. As a preference for sweet taste is a predisposition, it has been assumed that pairing a novel flavour with a sweetener will cause liking for that flavour to increase. While studies have produced this expected outcome (Brunstrom & Fletcher, 2008; Havermans & Jansen, 2007; Mobini et al., 2007), evidence demonstrates that experiments involving pairings with sweet tastes are not always successful (Yeomans, 2010). Yeomans suggests that this inconsistency can be explained by individual differences in the evaluation of the unconditioned flavour, highlighting the need to establish a preference for sweet taste (or other conditioning flavour) in participants during recruitment rather than making these assumptions.

Research into FFL is limited and results vary greatly, however a report by Havermans et al. (2007) has proposed a possible application for FFL in increasing children's liking for and intake of vegetables. In their study twenty one children took part in six pairs of conditioning trials, tasting a vegetable flavour sweetened with dextrose and another unsweetened vegetable. In total six vegetables were used and mash of each vegetable was added to water in a sealed cup in a bid to remove any sensory characteristics of the vegetable other than taste. Following conditioning children were presented with the six vegetable flavours unsweetened and asked to rate their liking of each. Their results showed an increase in liking for the previously sweetened vegetable flavour and Havermans et al. concluded that this was evidence of FFL. However, the fact that the sweetener used in this experiment also added nutritive value to the vegetable flavour means that it is impossible to presume that it is FFL rather than FNL that has occurred.

In his review of dietary learning in humans, Brunstrom (2005) suggests that FFL merely acts as a 'short cut' for FNL. He argues that an already liked flavour such as sweetness can result in an evaluation that a food has a higher energy density and will therefore be biologically beneficial, predicting positive post-ingestive consequences. In a later study involving fruit teas sweetened with a non-nutritive sweetener, Brunstrom and Fletcher (2008) found an increase in preference for the sweetened flavour drink but only in participants that were hungry during the conditioning phase of the study. This result suggests that FFL is mediated by hunger and goes some way in supporting Brunstrom's theory that FFL could be a 'short cut' to FNL. Other studies that have worked on this same assumption that animals use sweet tastes to predict the energy content of foods have demonstrated that regularly eating non-nutritive sweet foods can disturb the animals predictive ability (Davidson, Martin, Clark, & Swithers, 2011; Swithers & Davidson, 2005; Swithers, Martin, & Davidson, 2010). This can lead to increased food intake and a positive energy balance raising questions as to the long-term benefits of employing FFL utilising non-nutritive sweeteners as a mechanism for facilitating the development of healthy eating behaviours.

1.3.3 Flavour nutrient learning vs flavour flavour learning

Research into both FFL and FNL have produced evidence that suggests that while both have their basis in the formation of associations they involve different neural mechanisms and result in different behavioural responses to conditioned flavours (Myers & Hall, 1998; Myers & Sclafani, 2006). Myers and Hall showed that flavours paired with sucrose administered orally showed increased orienting towards the conditioned flavour, an appetitive response. When flavours were paired with sucrose and administered via intragastric infusion, rats demonstrated more mouthing behaviour and were likely to consume more of the flavour when tested. Despite this evidence that these forms of learning can occur independently, it seems logical that in a real-life setting, where meals consist of many different foods consumed together, the processes occur simultaneously. This raises questions regarding how individual flavour-nutrient associations can be formed and which learning mechanism is most effective under what conditions.

Existing laboratory studies into both these learning mechanisms have highlighted the difficulty in distinguishing between the two. FNL studies that have used sugars to increase the energy density of the target flavour (Revelle and Warwick, 2009) cannot definitively conclude that their results are evidence of pure FNL because of the sweet taste that is associated with these sugars. In the same way experiments investigating FFL that use nutritive sweeteners cannot present conclusive evidence for FFL as the palatability of the sweet flavour can be confounded by its nutrient value. Studies such as one by Mobini et al. (2007) have attempted to resolve this issue by comparing the degree of shift in liking produced by a FFL condition and a FNL condition. Results clearly showed that the most significant increase in liking occurred when the flavour was paired with the nutritive sweetener. However, while evidence points to FNL producing the most robust associations (Gonzalez, Garcia-Burgos, de Brugada, & Gil, 2010), a study by Yeomans et al. (2008) suggests that it is when both take place concurrently that the optimum increases in liking can be found. Therefore the strength of the preferences that have been produced in studies using nutritive sweeteners, where both sweet taste and energy are added, could quite easily be a result both forms of learning taking place simultaneously.

1.3.4 Learning and reward

Associations can be formed between the consumption of a food and its biological consequences and these are largely unconscious or at least there is little awareness of the association. However, extrinsic or external benefits have been used to encourage children to accept novel foods, and so operant conditioning has been tested as a means to change behaviour.

Lowe et al. (2004) concluded that using reward was one of three factors that reliably influence children's eating behaviours, with the other two factors being taste exposure and social modelling. The use of extrinsic rewards to encourage desired behaviours in children is, however, controversial. It has been suggested that the use of extrinsic rewards can undermine an individual's intrinsic interest in or hedonic evaluation of performing a behaviour as it suggests that the behaviour is not worth performing for its own inherent value. This 'over justification effect' was first proposed by Lepper and colleagues (1973) in a study that rewarded preschool children with ribbons for a drawing task, typically enjoyed by children of this age. The first group of children were told that they would receive the reward for performing the task while another group performed the same drawing task and received the same ribbon but did not expect the reward. A third group performed the drawing task but did not receive the ribbons. When all children were later observed during a period of free-play the children that had been told they would receive the reward were significantly less likely to choose to take part in drawing activities than the other children. The same researchers were able to replicate these results in a second study (Greene and Lepper, 1974) and concluded that presenting a behaviour to a child as a means to a salient reward can decrease their motivation to perform that behaviour and that this effect has the potential to persist in the long term. This sort of effect has also been found when rewards have been used to encourage specific eating behaviours in children.

A study by Newman and Taylor (1992) took two equally rated snack foods of medium appeal and presented them to children with one snack food being offered as a reward for eating the other. They found that when these sorts of 'means-end' relationships were formed between two foods children tended to devalue the snack that had been presented as the means to receiving the reward food. This suggests that using rewards may not only fail to increase children's liking and intake of a food but may actually serve to decrease both. Other studies have shown similar results when other types of rewards are used to encourage consumption, such as fun activities, with the target foods again become devalued (Birch et al. 1982; Birch et al. 1984). Where food has been offered as a reward contingent upon children performing specified behaviours that were not related to eating, however, preferences for these reward foods have been found to increase (Birch, 1980).

This has not been borne out by studies in the UK (Horne et al., 1995; Wardle et al. 2003; Horne et al., 2004; Cooke et al., 2011; Horne et al., 2011). For example the 'Food Dudes' projects use of tangible rewards like stickers, in combination with social modelling resulted in a significant increase in children's intake of fruit and vegetables (Horne, et al., 1995; Horne et al., 2004; Horne et al., 2011). It is important to note that Horne et al. (1995) found evidence that the reward aspect of their intervention was a vital factor in bringing about sustained changes at 6 months after the intervention. Indeed intake of the target foods decreased at the second baseline but increased immediately when rewards were reinstated during the second intervention. At this point it is important to draw attention to the different outcome measures that have been used in the studies that have been discussed. While the 'Food Dudes' studies have shown an increase in consumption of vegetables much of the evidence for the negative effects of reward have used some sort of verbal statement or rating of preference and have not taken any measure of intake post-conditioning (Birch, Birch et al. 1982; Birch, Marlin et al. 1984; Newman & Taylor, 1992).

A recent study by Cooke et al. (2011) compared the use of tangible rewards (such as stickers) and social praise with mere exposure in increasing both liking and intake of vegetables in school children. They found that all three conditions produced increases in liking for the target vegetables and that these increases persisted at one month and three month follow ups. Vegetable intake also increased significantly for all three conditions but this effect was only found to be maintained for those children that were in either the tangible or social reward group. Thus the use of rewards is effective in increasing children's vegetable intake and these effects are relatively durable. The increase in liking found in the study by Cooke et al. (2011) also provides contradictory evidence for the 'over-justification effect'. An individual's liking of a food is often used as a measure of intrinsic motivation to consume that food (Berridge, Robinson, & Aldridge, 2009) and it is this intrinsic motivation that is said to be undermined by the introduction of rewards (Lepper et al., 1973). The persistence of increased liking into the maintenance phase of the study by Cooke and her colleagues demonstrates that the children have not come to devalue the vegetables that were paired with tangible or social rewards. However, the results of this study also suggest a child's initial evaluation of a food, their liking pre-intervention, can mediate the effects of offering rewards for its consumption. For foods that are initially disliked rewards are likely to be effective in increasing both preference and intake (Cooke et al. 2011; Corsini et al., 2011; Hendy, 1999; Remington et al., 2012). Conversely, when foods are not disliked, rather there is a reasonable level of liking pre-intervention, tangible rewards may reduce liking for these children and reduce intrinsic motivation to consume the target food (Birch et al., 1982; Birch et al., 1984; Cooke et al., 2011). This may offer an explanation for the variance in findings across studies examining the use of rewards. The growing evidence in support of the use of rewards suggests that when used appropriately they can be an effective method of promoting liking and intake of targets foods such as vegetables.

1.4 Discussion

Maternal diet is influential to the development of flavour preferences and subsequent food intake in infants. This has been shown during pregnancy and appears to continue throughout breastfeeding as flavour cues are passed from mother to child (Beauchamp & Mennella, 2009; Cooke & Fildes, 2011; Forestell & Mennella, 2007; Maier, Chabanet, et al., 2008; Mennella et al., 2001; Sullivan & Birch, 1994). To date few studies have specifically investigated the effect of exposure at these early stages on an infant's subsequent vegetable consumption and this makes it difficult to draw conclusions about the significance of this period. However, there is evidence that these early opportunities for exposure to vegetable flavours should be exploited in order to maximise acceptance of vegetables and other novel foods during weaning. Breast feeding offers an extended opportunity for exposure to a variety of flavours in breastmilk (Forestell & Mennella, 2007; Maier, Chabanet, et al., 2008; Mennella et al., 2001; Sullivan & Birch, 1994) and an opportunity to form flavour-nutrient associations pre-weaning (Myers & Sclafani, 2006). Further investigation is necessary to determine how crucial these stages are in the development of children's eating behaviours. However, education for prospective mothers about their diet during pregnancy and lactation and how it can impact on their child may help to promote both maternal and child vegetable consumption.

Maternal diet goes some way to predict familial diet and, therefore, what foods are made available to a child when they move from milk to solid foods. A child's vegetable intake has been found to be positively related to maternal vegetable consumption (Hart, Raynor, Jelalian, & Drotar, 2010) both in terms of variety and frequency of consumption. Infants' first experiences with solid foods and flavours help in reducing predisposed behavioural responses by building familiarity with novel foods. In addition repeated experiences with flavours allow a child to develop preferences for and acceptance of these foods. There is a clear indication that infancy is a period during which children are particularly susceptible to forming the necessary associations for flavour-preference learning and 'learned safety', essential for minimising neophobic responses. As infants are more willing to try new foods and flavours at around six months of age, weaning appears to be an ideal time to present children with as many new taste experiences as possible allowing them to become accustomed to and to form positive associations with new foods. Research has shown that children that are frequently exposed to a variety of vegetables during weaning consume relatively more vegetables later in life. This would indicate that the weaning process is a stage during which infants can establish lasting preferences and eating behaviours that could potentially persist into adulthood. Offering mothers information regarding the benefits of regular and varied exposure to vegetables may be beneficial, although more longitudinal studies are needed in order to confirm the long term effects of repeated exposure during weaning.

While the weaning period is an ideal opportunity for mothers to introduce their children to a varied and healthy diet, an issue for many mothers is simply getting their children to try the new foods they are offering. Clearer guidelines around repeated exposure to new foods may help with building preferences (Schwartz et al., 2011). However, a child's reluctance to consume even a tiny amount of a novel food could make the repeated exposure process an agonising experience for mothers. Mothers are being encouraged to take a vegetables by stealth approach to vegetable offering (Sneaky Chef, Deceptively Delicious) and this method of hiding vegetables in other foods has been shown to drastically increase children's vegetable intake (Spill, Birch et al., 2011), at least in the short term. However, consideration must be given to how beneficial this strategy is in building healthy eating habits in the long term. As the literature suggests that liking is the most reliable predictor of intake, it follows that increasing liking for vegetables will be the most effective way of increasing children's intake of vegetables and in continuing consumption of optimal amounts of vegetables later on in life. It is possible that hiding vegetables in composite meals or masking their flavour could deny children the opportunity to develop the familiarity needed to develop these preferences. Further examination of this topic could help to clarify to what extent vegetables by stealth should be relied upon as an effective way of introducing more vegetables into children's diets.

Offering children a variety of foods early in life is beneficial in terms of encouraging acceptance of new foods and promoting a varied and healthy diet (Forestell & Mennella, 2007; Maier, Chabanet, Schaal, Issanchou, et al., 2007; Mennella et al., 2008). In addition it appears that offering variety at meal times may be an effective strategy for promoting fruit and vegetable intake in both adults and children (Meengs et al., 2012; Raynor & Osterholt, 2012; Roe et al., 2013). However, a lack of research investigating this topic means it is difficult to draw any definitive conclusions. In terms of informing advice for parents it may be beneficial for such research to explore variety with regards to the number of the vegetables that should be offered and how best to offer these to children. Somewhat overlapping with the subject of variety is the idea that offering children choice in the foods that they consume may encourage consumption. That is to say that offering children variety on the plate may also offer a child some degree of choice in the foods that they select to eat from that plate. There are indications from the literature that allowing children some involvement in the selection of the foods that they eat will promote intake but so far experimental evidence is limited. Obviously offering choice as a strategy for encouraging vegetable consumption is most likely to be effective with children who are of an age where their autonomy is of growing importance, however, further investigation is needed to examine its effectiveness.

Animal research suggests that both FFL and FNL could be effective approaches to increasing children's liking for and intake of vegetables, benefiting from the speed at which associations can be formed. The apparent resistance of FNL to extinction and infants' seeming propensity for learning in this way would suggest it could be a highly effective strategy. However, a lack of human research and the inconsistency of results means there is still much to be understood about flavour-preference learning and the factors that influence the speed and strength of acquisition. Studies into FFL have focussed on the use of sugars or nutritive sweeteners as the US making it difficult to separate these two independent mechanisms as the effects become confounded. In terms of developing health promoting interventions aimed at children, it seems somewhat contrary to suggest sweetening vegetables is the best approach to increasing intake quite apart from the possible detrimental effects this can have in the future on the individual's ability to self regulate (Davidson et al., 2011; Swithers & Davidson, 2005; Swithers et al., 2010). Future studies might consider the use of flavour-flavour pairings that do not use sweet taste as the US and use non-nutritive flavours. Similarly, further research into FNL which relies less on sugars as an US could help in drawing some conclusions around the effectiveness of these learning mechanisms and their potential application in promoting vegetable intake in young children.

While evidence for the use of rewards in encouraging eating behaviours in children varies in outcome, the majority of the most recent research shows that the use of both tangible and social rewards can be successful in increasing vegetable intake in young children (Cooke et al. 2011; Horne, et al., 1995, Horne et al., 2004; Horne et al., 2011). This is already a strategy that many parents use, however, it is important to note that the use of foods that might be seen as more desirable, such as desserts, as rewards for eating healthier, perhaps less desirable foods, like vegetables could be detrimental to vegetable intake in the long term. Evidence suggests that these means-end contingencies can result in preference for the target food decreasing as children begin to perceive it as having less hedonic value while the reward food becomes more valued and preferred (Birch, Birch et al., 1982; Birch, Marlin et al., 1984; Newman and Taylor, 1992). More research into this topic is required to tease apart the effects of reward and exposure but it appears that the use of reward could be an effective strategy for encouraging a child's first experience with a novel or previously disliked food and a starting point for the repeated exposure process.

Much of the evidence discussed in this review suggests that repeated exposure is a reliable approach to increasing children's vegetable intake. However, it is possible that other strategies can be employed in order to speed up the rate at which these preferences are acquired. Animal research suggests the use of FFL and FNL produces rapid acquisition of flavour preferences but at present there is no evidence to suggest this is the case for children.

1.5 Aims and objectives

The studies set out in this thesis were developed in order to explore young children's experiences with vegetables in the first years of life using both quantitative and qualitative methods (Figure 1.1). The research aims to examine what strategies are currently being employed by parents to promote vegetable consumption and to examine, through experimental procedures, the effectiveness of various learning techniques in increasing acceptance and intake of novel vegetables in young children. Chapter 2 discusses, in detail, the variety of methods used.

Chapter 3 describes a study which employs qualitative methods to investigate infant feeding with a focus on the weaning period. This study was conducted to provide a foundation for subsequent research by delivering insight into how parents currently approach vegetable introduction, food refusal and encouraging vegetable intake in their infants beyond the weaning stage. Chapter 4 continues this investigation in more detail by exploring children's familiarity with vegetables and how they are prepared and offered to young children as well as what effect this has on their liking for vegetables. The findings of this study informed the development of a number of hypotheses addressed in subsequent research.

While the first two studies relied entirely on self-report measures, Chapters 5 and 6 describe two experimental studies that used measures of intake to examine the role of exposure and the effectiveness of associative conditioning in increasing liking and intake of a novel vegetable. Chapter 5 directly compares repeated exposure, flavour-flavour learning and flavour-nutrient learning in an attempt to identify any advantage of one method over another. This comparison of learning mechanisms is continued in Chapter 6 which focusses on the use of flavour-flavour conditioning to increase intake of a novel vegetable puree and compares this with a simple repeated exposure technique. Again the findings of these studies are used to inform the design of the final study described in Chapter 7 which explores the role of variety and choice in children's vegetable consumption. It tests the hypothesis that offering children a variety of vegetable snacks will lead to increased intake when compared with a single vegetable snack.

The final chapter provides a synthesis of the key research findings from Chapters 3 to 7 and explores these findings in relation to the literature previously discussed. Chapter 8 then goes on to consider the significance of this research, along with its limitations and implications for future research.

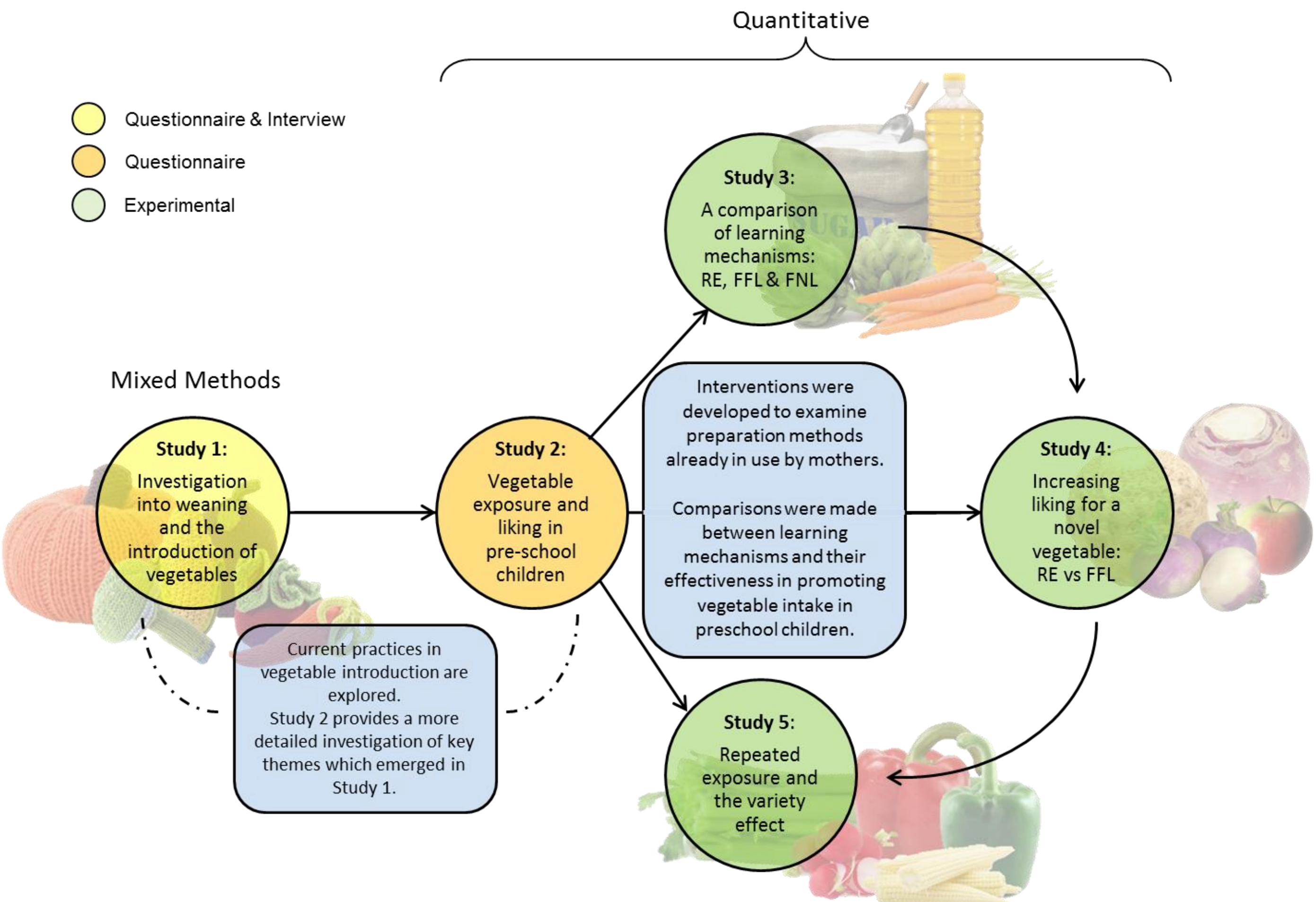

Figure 1:1: Overview of thesis progression

Chapter 2 Methodologies

Given the main aim of the thesis, to explore young children's experiences with vegetables in the first years of life the methods to undertake this are complex. In this thesis both quantitative and qualitative methods were used and are considered below. Clearly in early life, researchers must depend upon the reports of parents to describe experience of eating at home, feeding patterns of their child and feeding practices they employ. However, observations outside the home in daycare settings are possible so that research does not rely entirely on self report.

2.1 Methodological procedures

Among the main methods used to investigate children's vegetable consumption at home were questionnaires developed for this purpose. These questionnaires incorporated existing measures which have previously been validated with children of similar ages with open ended questions that aimed to probe further into parents feeding practices. In the first study a sample of participating mothers were also asked to take part in semi-structured interviews intended to explore their experiences of feeding their children in more detail. These methods are explained more thoroughly later in this chapter.

Subsequent interventions aimed to assess and compare the effectiveness of various techniques at increasing vegetable intake in preschool children. These interventions measured intake of relatively novel vegetables or vegetable purees before and after a series of regular exposures to these foods as snacks. To ensure a naturalistic research environment for participating children all interventions took place in locations that provided child care i.e. nurseries, pre-schools and children centres. This also served to maximise recruitment of children of preschool age. Children were exposed to novel vegetables at their normal snack times and were asked to consume as much or as little of the vegetable snacks as they would like. The difference in intake from the beginning to the end of the intervention was used to indicate any change in liking. Again these procedures are discussed in more detail later in this chapter along with food preparation and sensory analyses that were performed to ensure study foods were fit for purpose.

Table 2:1: Summary of methods used throughout thesis

Study (Chapter)	Methods	Included Questionnaires (section)
Study 1 (Chapter 3)	Postal Questionnaire Semi-structured interviews	Weaning Questionnaire (2.5.1i) IFQ (2.5.2i) Family FFQ (2.5.2iii)
Study 2 (Chapter 4)	Postal/Online Questionnaire	Vegetable Survey (2.5.1ii)
Study 3 (Chapter 5)	Experimental intervention Parental Questionnaire	CEBQ (2.5.2vi) CFQ (2.5.2ii) CFSQ (2.5.2viii) CFNS (2.5.2v) EAS (2.5.2vii) Maternal and Child FFQ (2.5.2iii) FNS (2.5.2iv)
Study 4 (Chapter 6)	Experimental intervention Parental Questionnaire	CEBQ CFNS Maternal and Child FFQ FNS
Study 5 (Chapter 7)	Experimental intervention Parental Questionnaire	CEBQ CFNS Maternal and Child FFQ FNS

2.2 Participants

All the studies described within this thesis focus on the eating patterns and behaviours of pre-school age children. Consequently participants are children aged between 6 months and 5 years of age or parents of children in this age group, with the exception of Study 4 which also included sensory analysis of the study foods which was performed by adult participants who were undergraduate students within the Institute of Psychological Sciences at the time (see section 6.2). Twenty undergraduate students who took part in sensory analysis of study foods were recruited through email or by responding to posters displayed within the Institute.

2.2.1 Recruitment

Parents were reached through children centres and private day nurseries. Initial contact was made with nurseries via email or telephone before a meeting was arranged with managers to discuss their involvement in the studies. For questionnaire based studies parents were contacted directly via their child care settings using postal questionnaires. In addition websites aimed at mothers (Mumsnet, www.mumsnet.com; Netmums, www.netmums.com) were also used to attract potential participants by providing a link to online versions of these questionnaires created using SurveyMonkey® (www.surveymonkey.com). As previously described all intervention studies took place within child care settings and all participating children were recruited through their nursery/preschool. Once consent was obtained from the nursery manager letters, including information sheets and consent forms, were sent out to parents.

In total eighteen childcare settings across Yorkshire were recruited to take part in the interventions.

Barnsley:

- Elsecar Nursery, Elsecar
- Railway Children Nursery, Elsecar

Bradford:

- Ashmoor Day Nursery, Shipley
- Children’s Place Burnett Fields, Burnett Fields Children & Family Centre, Little Horton
- Children’s Place Daisy Hill, Lynfield Mount
- Children’s Place Owlet, Owlet Children & Family Centre, Shipley

- Westbourne Primary School Nursery, Manningham
- Wishing Well Nursery, Bingley
- Summerlands Nursery & Pre-school, Bingley
- University of Bradford Nursery

Leeds:

- Bright Beginnings Child Care Centre, University of Leeds Campus
- Clarendon Nursery, Leeds Teaching Hospitals NHS Trust
- Grove Nursery School, Treetops Nurseries, Headingley
- Leeds Reformed Baptist Church Pre-School, Headingley
- Rosewood Nursery, Leeds Teaching Hospitals NHS Trust
- Thomas Danby Nursery, Leeds City College, Roundhay

Wakefield

- Future Einsteins Nursery, Outwood
- Happy Days Nursery, Wakefield

Fifteen of these hosted an intervention, fourteen took part until completion and thirteen produced data that was suitable to include in this thesis (Figure 2.1).

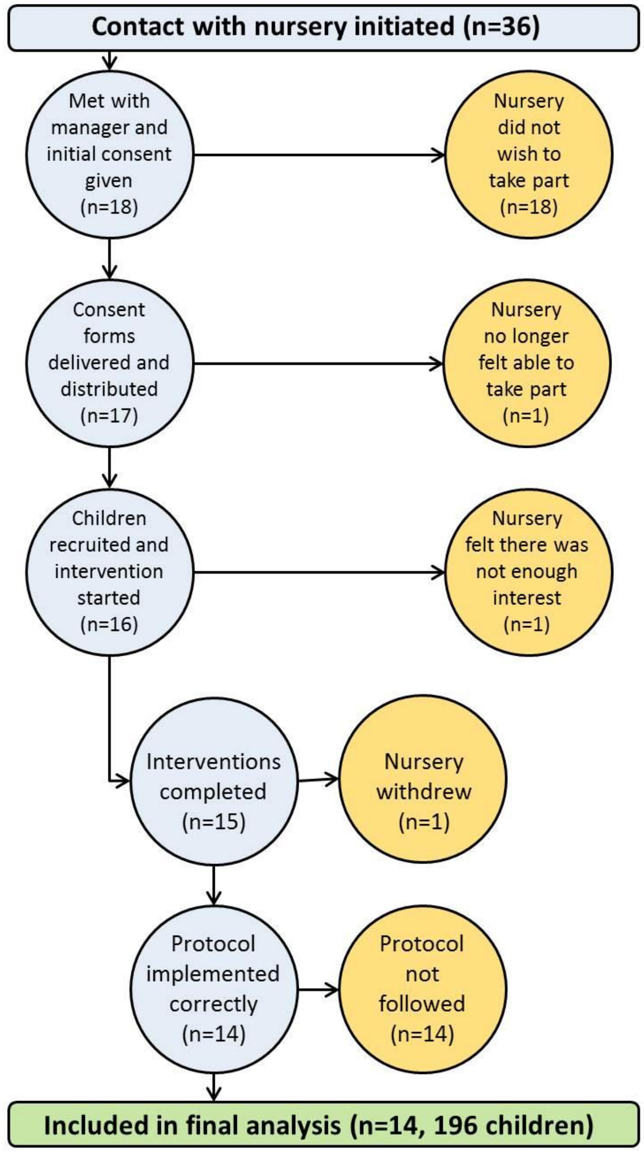

Figure 2:1: Recruitment and retention of participating nurseries for intervention studies 2011 -2013

2.3 Ethical considerations

All studies conformed to the ethical guidelines for human participation of the British Psychological Society (BPS, 2009) and received ethical approval from the University of Leeds, Institute of Psychological Sciences. Participants were recruited through questionnaires or letters sent out via children centres and day nurseries or links placed on websites. Each of these methods conformed to university ethical guidelines and gave full details of the nature of the studies and what would be required from the parents and children who took part. For intervention studies parents received information sheets and consent forms through their childcare setting (Appendix A1) and were given a month from the date they received them to decide if they would like to take part. Consent forms were attached and returned either to the child care setting or to researchers directly. Information sheets and consent forms were included in all postal and online questionnaires. Contact details for the researchers were included on all information sheets to allow participants with any questions or concerns to request further information. Undergraduate participants received detailed information and consent forms immediately prior to testing and were instructed to read them thoroughly and encouraged to ask any questions before signing the sheet in the presence of a researcher (Appendix A2).

Participants taking part in both questionnaire based studies were informed that they would be entered into prize draws (Appendix B) and those whose children took part in intervention studies and who completed and returned accompanying questionnaires understood that they would receive a £5 high street gift voucher.

Throughout recruitment and the study themselves every effort was made to be as inclusive of potential participants as possible. Where communication issues arose arrangements were made through relevant agencies to ensure information could be effectively understood by all participants. Discussions with nursery managers highlighted the communication needs of target parents and information sheets were adapted accordingly (Appendix A3 & 4).

The wellbeing of all children participating in these studies was of upmost importance. All information sheets included details of reasons why participants would not be able to take part in studies, such as potential food allergies. These exclusion criteria were listed and questions were built in to consent forms to ensure that these were not missed. In the case of intervention studies, researchers were also able to check with the child care settings to ensure participating children did not suffer with any relevant food allergies. In order to safeguard participating children and meet current requirements for working with children, all researchers were subject to the necessary criminal record checks (CRB clearance). In addition researchers were aware that the age of participating children meant that distress may be caused by being asked to consume an unfamiliar food. To minimise any distress all child-care staff were instructed not pressure children to consume any of the food offered to them and to instead use gentle encouragement. Children were free to consume as much or as little food as they wanted during the study period and every effort was made to ensure that infants that required assistance with feeding were fed by a familiar individual such as a nursery worker. Parents and childcare staff were also instructed that they could withdraw children from the study at any time.

All of the study foods used within these projects were sourced from companies who could provide products suitable for consumption by young children (see section 2.4.3) and any further necessary preparation of the foods was conducted within the Human Appetite Research Unit (HARU) at the University of Leeds. This preparation was carried out by trained researchers or other individuals certificated in food hygiene and supervised by researchers to ensure safety and hygiene were optimised.

2.4 Qualitative methods

Semi-structured interviews were used to thoroughly explore early feeding experiences (Chapter 3). The nature of the semi-structured interview allows the research topic to be explored in more detail and gives context to the information provided (Henwood & Pidgeon, 1992). Through the use of cues or prompts the interviewee can be encouraged to reflect on the question and their response and elaborate further where necessary.

2.4.1 Semi-structured interviews

A semi-structured interview schedule (Appendix B2), informed by a previous postal questionnaire, was developed which included a number of questions pertaining to infant feeding behaviour. The purpose of the interviews was to further investigate reasons why mothers had decided to introduce solids foods, where they sourced information regarding weaning and how they felt about current weaning guidelines. Mothers were also asked to reflect on the choices they had made in terms of the foods they initially introduced and when and how vegetables were introduced to their diet. In addition a question was included to explore vegetable liking and food rejection and strategies employed by mothers to encourage vegetable intake in their infants. To encourage further discussion a list of general prompts was employed by the interviewer; ‘‘can you provide an example’’, ‘‘can you tell me more about. . .’’. To check the suitability of the chosen questions a small number of pilot interviews were conducted which also assisted in determining an appropriate interview length. In total each interview lasted approximately 20 minutes and was recorded via Dictaphone. The interviews were then transcribed verbatim by researchers.

2.5 Materials

2.5.1 Study-specific questionnaires

2.5.1.i ‘Weaning and the Introduction of Foods’ postal questionnaire

With reference to existing literature around infant feeding and weaning researchers developed a number of comprehensive research questions, incorporating both open and closed questions to be used in Study 1 (Chapter 3; Appendix B1). A section of demographic questions including height and weight of the mother, school leaving age and parity was followed by a series of questions relating to her infant and feeding. A broad range of topics relating to different aspects of weaning were covered. These included questions around initial milk feeding, the age of introduction of solid foods and the age at which specific foods had been introduced. Mothers were also asked to give examples of foods offered to their child during the first month of weaning. This list of foods allowed the number of fruits and vegetables that had been introduced to the child to be calculated. Each fruit or vegetable named was counted and scores were generated for the first two-week period of weaning and the first month of weaning for each infant.

2.5.1.ii Vegetable Survey

A vegetable survey was developed to investigate pre-school children's familiarity and experience with vegetables in the first three years of life (Chapter 4; Appendix B3). The initial list of vegetables which acted as the foundation of the survey was based on a previous questionnaire used to assess children's food preferences (Nicklaus, Boggio, Chabanet, & Issanchou, 2004) and was adapted by each of the three institutions that contributed to the study. Criterion to retain vegetables was that they were available for sale in the supermarkets and main grocery stores in the individual localities.

In order to assess familiarity with different, commonly available vegetables mothers were asked to identify within the list which vegetables they were familiar with and which they had introduced to their child. For those vegetables that they had introduced to their child they were then asked to indicate how often they offer them to their children and how much their child likes those vegetables. Questions were also included to investigate commonly employed preparation techniques and seasonings used when offering vegetables to young children. The UK version of the questionnaire also included a question of how frequently mothers consumed each vegetable.

2.5.2 Standardised questionnaires

2.5.2.i Infant Feeding Questionnaire (IFQ)

The Infant Feeding Questionnaire (Baughcum, Powers, Johnson et al., 2001) is a validated instrument initially developed to identify maternal feeding practices employed by mothers in the first year of a child's life that could be linked to them becoming overweight or obese by their second year (Appendix B3). The questionnaire contains 20 items that each explores one of seven factors:

a) concern about the infant under-eating or becoming underweight
b) concern about the infant's hunger
c) awareness of the infant's cues
d) concern about the infant overeating or becoming overweight

e) feeding the infant on schedule
f) using food to calm the infant
g) social interaction during feeding

The original version of the IFQ was validated with mothers of infants aged between 11 and 24 months and has showed good levels on internal consistency (Cronbach's α 0.55-0.74, Pearson *r* 0.72-0.83) with the seven factors accounting for 61% of variance and communality scores of 0.43 - 0.81 (Baughcum et al., 2001).

Items are scored on a 5-point scale ranging from 0 (never or disagree a lot) to 5 (always or agree a lot). Scores were calculated by averaging the items for a particular factor with a minimum score of 0 and a maximum score of 5.

2.5.2.ii Child Feeding Questionnaire (CFQ)

The Child Feeding Questionnaire (Birch, Fisher, Grimm-Thomas et al., 2001) is a self-report measure of parental beliefs, attitudes and feeding practices which can be used to assess the relationship between these factors and children's developing patterns of food acceptance (Appendix C3). As previously discussed feeding practices employed by parents have been found to influence children's eating habits and shape their diets (Blissett, 2011; Wardle et al., 2005). The inclusion of this questionnaire was intended to help explain any individual differences in participant's acceptance of target vegetables and responsiveness to the different learning mechanisms during interventions.

The questionnaire includes 7 factors; perceived responsibility (PR), perceived parent weight (PPW), perceived child weight (PCW), concern about child weight (CCW), restriction (RES), pressure to eat (PE) and monitoring (MON). Factors were measured on a 5-point scale with each point on the scale represented by a word anchor. Factor scores were calculated as a mean of the item scores for that factor. The CFQ was originally designed for children aged 2 to 11 years and not all of the items were deemed relevant for the age range of children included in Study 4. For this reason 6 of the 31 items were removed.

2.5.2.iii Food Frequency Questionnaire (FFQ)

The Food Frequency Questionnaire is a dietary assessment tool used to assess the frequency with which different foods and food types are consumed across a specified period of time. In terms of collecting data on dietary habits and consumption patterns the FFQ is standardised allowing data from respondents to be collated easily. It is also relatively quick and simple for respondents to complete and can easily be adapted to a computerised or online version to further facilitate data collection.

The chosen FFQ (Hammond, Nelson, Chinn, & Rona, 1993) was originally developed to measure coronary heart disease risk factors in children and was validated with children aged 5 to 11 years. The questionnaire was included in the subsequent studies to assess habitual diet of the family as a whole or that of the parent and child individually and to explore how this relates to consumption of vegetables during interventions.

The questionnaire lists 45 foods or food types and asks respondents to report the frequency with which each food has been consumed over the previous month (Appendix B, C). The questionnaire can also be adapted in order to focus in on specific foods or food groups that of particular interest. The frequency of consumption of each food item is measured using a scale of “never”, “once per month”, “once per fortnight”, and “number of days per week” (1-7). Respondents are also asked to report the “number of times per day” the food is consumed (1-5). Overall scores for each food item are calculated from these two scores and represent how many times per week that food is eaten. Where appropriate the questionnaire was adapted to better suit the purpose of the specific study in which it was used. For example, the questionnaire was shortened to focus only on healthy foods such as fruits and vegetables and more unhealthy foods (cakes, sweets etc.) (Chapters 5, 6 and 7; Appendix C3)

2.5.2.iv Food Neophobia Scale (FNS)

The Food Neophobia Scale (Pliner & Hobden, 1992) is a 10 item self-report measure of trait food neophobia which is characterised by an avoidance of new foods. Existing research which has employed the FNS has demonstrated good levels of reliability (Pauperio, Severo, Lopes et al., 2014; Pliner & Hobden, 1992).

Studies have suggested that food neophobia is a heritable trait (Wardle & Cooke, 2008) and Pliner did in fact find that FNS scores for parents and their children were significantly correlated. This questionnaire was included to assess the level of neophobia displayed by the responding parents in order to allow exploration of relationships between parental food neophobia scores and the scores of participating children, as well as the children's vegetable intake at home and during the intervention studies (Chapters 5, 6 and 7; Appendix C7).

Participants were asked to report how strongly they agree with 10 statements relating to their perceptions of foreign or unfamiliar foods and their willingness to try them. Level of agreement is measured on a 7 point scale; "disagree strongly" (1), "disagree moderately" (2), disagree slightly (3), "neither agree nor disagree" (4), "agree slightly" (5), "agree moderately" (6) or "agree strongly" (7), with five items scored in reverse. Responses were summed to give an overall score from 10 to 70.

2.5.2.v Child Neophobia Scale (CFNS)

Adapted from the FNS (Pliner & Hobden, 1992), the Child Food Neophobia Scale (Pliner, 1994) is a 10 item parental report measure of child trait food neophobia (Appendix C2). The full ten item version of the questionnaire was originally validated with children aged 8 to 11 years and as a result four of the items were considered to lack relevance for pre-school aged children. For the purpose of this research an adapted 6 item version aimed at younger children was used (Cooke et al., 2003). Initially this adapted version was validated with children aged between 2 and 6 years and has shown good levels of reliability with this age group with high Cronbach's α (0.84-0.92) (Cooke et al., 2003; Cooke, Wardle, Gibson et al., 2004; "Food Fact Sheet: Weaning," 2005). Despite some of the participating children falling outside of this age group, it was felt the content and questions were still appropriate for the slightly younger children and so the six item version was used

(Chapters 5, 6 and 7). Its inclusion allows for the exploration of relationships between trait food neophobia and eating behaviours, including vegetable intake both at home and during interventions.

Unlike the 7-point scale of the original FNS and CFNS, the version adapted by Cooke and colleagues (2003) is scored on a 4-point scale from “disagree strongly” (1), “disagree” (2), “agree” (3), “agree strongly” (4), with two items scored in reverse. A sum of responses gave overall scores ranging from 6 to 24.

2.5.2.vi Child Eating Behaviour Questionnaire (CEBQ)

The Child Eating Behaviour Questionnaire (Wardle, Guthrie, Sanderson, & Rapoport, 2001) is a 35 item parental ratings questionnaire used to examine a range of eating styles linked to the development of overweight and obesity in children (Appendix C1). This questionnaire is widely used and has been translated into many languages including Danish, Portuguese, Mandarin, French (Caton, Blundell, Ahern et al., 2013; Mallan, Liu, Mehta et al., 2013). The CEBQ characterises key components of the eating styles thought to impact on the types and quantities of foods consumed by children (Wardle et al. 2001). These relate to children’s responsiveness to both food cues and their own internal cues of hunger and satiety as well as the speed at which they eat. It allows for individual differences in the eating styles to be explored and was included so that relationships between specific eating behaviours and vegetable consumption could be identified. In addition it allows for responses to experimental interventions to be examined in relation to children’s eating style. Originally developed with children aged 3 to 8 years of age the questionnaire was found to have good internal reliability (Wardle et al., 2001) and has since been validated with younger children of varying backgrounds (Mallan et al., 2013; Svensson, Lundborg, Cao et al., 2011).

The questionnaire includes 34 items relating to 8 factors; enjoyment of food (EF), food responsiveness (FR), satiety responsiveness (SR), emotional over-eating (EOE), emotional under-eating (EUE), food fussiness (FF), slowness in eating (SE), and desire to drink (DD). Participants rated each item on a 5-point scale; “Never” (1), “Rarely” (2), “Sometimes” (3), “Often” (4) and “always” (5). Overall scores for each factor are calculated as a sum of the related individual item scores.

2.5.2.vii EAS Temperament

The EAS Temperament Survey is a 20 item parental ratings questionnaire covering four temperament factors; emotionality (EM), activity (ACT), sociability (SOC) and shyness (SHY) (Appendix C5). Such personality traits or temperament factors have been linked to expressions of food neophobia and food fussiness in young children (Dovey et al., 2008) and therefore important to the response to novel vegetable presentations (Chapter 5).

The EAS is scored on a 5-point scale with 1 representing a factor which is “Not characteristic or typical of your child” and 5 being “Very characteristic or typical of your child”. Questions 7, 8, 12, 16, 17 and 20 are reverse scored. Overall scores for each temperament factor were calculated as the mean of individual item scores for that subscale.

2.5.2.viii Caregivers Feeding Style Questionnaire (CFSQ)

The Child Feeding Style Questionnaire (Hughes, Power, Orlet Fisher, Mueller, & Nicklas, 2005) is a self-report assessment of caregivers’ feeding styles with a focus on their levels of control and responsiveness towards their child’s eating behaviours (Appendix C4). Literature has identified links between parental feeding styles and children’s eating behaviour (Blissett, 2011; Sleddens et al., 2010), specifically vegetable consumption (Wardle et al., 2005). The CFSQ therefore allows the examination of relationships, if any, between feeding styles and children’s vegetable intake both at home and throughout the experiments (Chapter 5).

Parents were asked how often they displayed certain behaviours at meal times rating answers on a 5-point scale; “Never” (1), “Rarely” (2), “Sometimes” (3), “Most of the time” (4) and “Always” (5). There are two main approaches to the scoring of the CFSQ which are dependent on the purpose of the study. The first is the *typological* approach which aims to evaluate the general pattern, organization, and climate of parental feeding. The second, the *dimensional* approach is used more as a clinical tool to test specific hypotheses regarding parenting practices and child outcomes. For the purpose of the studies described in this thesis the typological approach was taken. Initially scores for demandingness and responsiveness were calculated. For demandingness this is the mean score of the 19 items and for responsiveness the mean of 7 items (3, 4, 6, 8, 9, 15 and 17) divided by the overall mean. The median split for the sample on these two dimensions was then used to place parents into categories; high or low responsiveness and high or low demandingness. These categories then allow further categorisation according to feeding style; Authoritative – high demandingness/high responsiveness, Authoritarian – high demandingness/low responsiveness, Indulgent – low demandingness/high responsiveness, or Uninvolved – low demandingness/low responsiveness.

2.5.3 Study foods

2.5.3.i Purees

All target vegetables were selected on the basis of being relatively novel to the designated age group of participating children. They were identified using results from the vegetable survey used in Study 2 and chosen based the following inclusion criteria. Vegetables must not have been offered to more than 60% of children, must not have been offered more frequently than 1-3 times per month and/or must not have been rated as well liked by mothers. For the purpose of assessing associative conditioning and to permit the easy addition of other flavours and/or energy it was decided that presenting the vegetables as purees would be most appropriate. This also allowed the influence of sensory properties other than flavour to be limited.

- Artichoke puree

Artichoke was identified as an extremely novel vegetable as it had only been offered to 12.5% of UK pre-school children and on average was offered approximately once per month. Artichoke purees were produced using baby food grade frozen artichoke hearts

(France Recherche & Developpement), water, sucrose (Vermandoise), sunflower oil (Huileries de Lapalisse) and salt (Vermand). All recipes were developed in the Centre des Sciences du Gouˆt et de l'Alimentation. For the RE condition a basic puree was produced using minimal amounts of oil, salt and sugar. To examine the effectiveness of associative condition two further purees were produced incorporating the chosen unconditioned stimuli. For FFL this was sweetness and was achieved by increasing the amount of sucrose in the original recipe. To investigate FNL energy density was increased by adding more sunflower oil. In order to avoid other conflicting properties recipes were developed so that the energy content of the RE and FFL versions were comparable and the sensory properties of the RE and FNL versions were not significantly different.

Figure 2:2: Vegetable purees used in Study 3; clockwise from top, FFL artichoke, RE artichoke, FNL artichoke and carrot

Purees were produced by Freshinov, a company experienced in the production of purees and children's products and accredited to prepare baby foods. Following a test of industrial production recipes were adjusted. Final purees were produced from the same batch of fresh vegetables as were initially used to reduce the chance of seasonal variation.

For all purees ingredients were steamed for 20 min at 90ºC, mixed, conditioned in a 100 (SEM 2) g jar with lid and sterilised at 1208C for 75 min at 2 bars. The Departmental

Laboratory of Analysis and Research (Barenton- Bugny) conducted bacteriological analyses on the final products and the nutritional composition was assessed by a certified laboratory (INZO) (Table 2.2).

Table 2:2: Nutritional composition and recipes of artichoke purees: repeated exposure (RE), flavour–flavour learning (FFL), flavour–nutrient learning (FNL) and carrot (adapted from Caton, Ahern et al. 2012)

Nutritional Composition per 100kcal		RE	FFL	FNL	Carrot
Protein (g)		1·1	1·1	1·2	0·3
Carbohydrates (g)		8·9	11·1	10·7	4·5
Fat (g)		1·0	0·3	10·7	0·4
Sodium (g)		182·3	135·0	136·0	40·0
Energy					
	kcal	48	51	144	27
	KJ	201	213	602	113
Recipe (g/100g)					
Artichoke		78·9	76·2	78·3	
Water		19·0	20·1	9·0	
Sunflower Oil		1·0	0·0	11·6	
Sugar		1·0	3·6	1·0	
Salt		0·1	0·1	0·1	

Purees were presented in clear plastic pots and stickers with each child's name on were placed on both the pots and the lids (Figure 2.2).

- Carrot puree

A baby food carrot purée, used as a control, was supplied by the Nestle´ group (NaturNes; Nestlé; Figure 2; Table 2.2).

- Root vegetable purees

Four root vegetables were initially selected for use in Study 4 based on the inclusion criteria (Table 2.3). Celeriac, swede and turnip were then selected for use in the study based on sensory profiling (see section 6.2).

Table 2:3: Familiarity of root vegetables based on results from vegetable survey: percentage of children offered, mean frequency of offering, mean liking scores.

Familiarity of Vegetables	Beetroot	Celeriac	Swede	Turnip
Children Offered (%)	40.3	15.3	54	38.9
Frequency of Offering (mean score)	1.5	1.2	1.4	1.4
Liking (mean score)	3.3	3.2	3.4	3.4

Purees were produced using organic frozen celeriac, swede and turnip (JE Hartley, York), boiled and blended using a hand blender and with no other ingredients added. Purees were prepared in 5 to 10 kg batches and refrozen as individual 100g portions in small freezer bags. Sufficient portions for each test visit were defrosted while being refrigerated overnight. For the RE condition children received the basic plain puree with nothing added. To assess the effectiveness of FFL a pre-liked flavour in this case, apple puree was added. For the FFL recipe 21.5g of Ella's Kitchen© First Taste apple puree (Table 2.4) was added to 100g of vegetable puree and stirred until fully mixed. For a portion, 100g of this mixed puree was then extracted (18% apple). The concentration of apple puree for the FFL recipes was selected using earlier sensory profiling (see section 6.2).

Before testing sessions purees were transferred from freezer bags to identical Tommee Tippee™ Pop Up Weaning Pots (Figure 2.3) to ensure that they were visually similar and stickers with each child's name were placed on the pots and lids.

Table 2:4: Nutritional composition and recipe of Ella's Kitchen Apples Apples Apples (apple puree) taken from www.ellaskitchen.co.uk and approximate nutritional composition of root vegetable purees (values calculated from www.fondation-louisbonduelle.org) with recipes per 100g

Nutritional composition per 100g	Apple puree	RE celeriac puree	FFL celeriac puree	RE swede puree	FFL swede puree	RE turnip puree	FFL turnip puree
Protein (g)	0.4	1	0.9	1.3	1.2	0.8	0.7
Carbohydrates (g)	11.1	2.8	4.3	8.7	9.1	2.9	4.4
Fat (g)	0.1	0.3	0.3	0.2	0.3	0.1	0.1
Sodium (g)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Energy							
kcal	46	18	23	39	40	15	21
KJ	161	75	91	163	163	63	81
Recipe (%/100g)							
Organic apples	100	0	18	0	18	0	18
Organic celeriac	0	100	92	0	0	0	0
Organic swede	0	0	0	100	92	0	0
Organic turnip	0	0	0	0	0	100	92

Figure 2:3: Vegetable purees used in Study 4; clockwise from top, swede, turnip, and celeriac

2.5.3.ii Raw vegetable snacks

When raw vegetables were selected for tasks within the experiments presented here, the survey data was used to identify suitable candidate items (Chapter 6). This reduced a list of 54 to 25. This list was then reduced further by excluding those vegetables that cannot feasibly be offered as a finger food, such as leaf vegetables. From this list of 10 another 3 were excluded on the basis of them already being offered an average of 1-3 times per week. Discussions were then held with two nursery managers and a group of five mothers with relation to the remaining 7 vegetables and their suitability as nursery snack foods and further suggestions were given. A final list of 5 vegetables was produced; baby sweet corn, celery, green pepper, red pepper and radish.

All vegetables were supplied by Country Fresh Foods Ltd a British Retail Consortium accredited company supplying both whole and pre-prepared vegetables. All vegetables were sterilised in the HARU using Milton Sterilising Fluid (half cap/2.5L) and rinsed thoroughly before the snacks were prepared. Vegetable snacks were prepared as crudités so as to be easily handled and eaten by young children. The peppers and celery were cut into batons, the baby sweet corn was halved lengthways and the radishes were halved.

Snacks were presented as 100g portions in Sainsbury's small zip-lock clear plastic freezer bags; for RE 100g of a single vegetable and for Variety 20g of each vegetable. Stickers depicting a "Veggiesaurus" dinosaur and with each child's name on were placed on the bags to make them more attractive to the children (Figure 2.4).

Figure 2:4 Variety vegetable snack used in Study 5; baby sweet corn, celery, green pepper, red pepper and radish

2.6 Measures

2.6.1 Liking, acceptance and intake

The literature suggests various methods for reliably measuring young children's liking for foods and flavours. However, the suitability of these methods is often dependent on the age and cognitive capacity of the children participating in the research.

Observable measures such as facial expressions have been found to reliably demonstrate liking and disliking in infants in the first year of life (Mennella et al., 2001; Rosenstein & Oster, 1988; Schwartz et al., 2009) (Forestell & Mennella, 2007). While expressions of liking are easily identifiable, those thought to depict disgust may also be instinctive reactions to a flavour or texture that is unfamiliar or surprising to the child and so may be too quickly attributed to disliking. Researchers wishing to reliably analyse facial expressions are therefore subject to comprehensive training. These kinds of measures are time consuming, requiring every child to be recorded so that thorough analysis can be conducted. Given that the experimental studies described here took place in busy child care settings with varying numbers of children taking part, this scale was impractical and therefore not pursued. Similarly studies have relied on mothers to interpret their children's responses to foods or flavours. It has been demonstrated that mothers can reliably identify liking and dislike responses from their children during feeding when compared with trained researchers and parental reports of children's food preferences have been found to be highly correlated with children's own reports of liking. This might suggest that caregivers in child care settings, who spend considerable amounts of time with the children in their care and who witness numerous episodes of eating, should also be able to reliably judge liking in these children. However, the number of children consuming snack at any one time would again have made these types of observations impractical and so these observational measures were not included.

Another commonly used tool for assessing liking and preferences in children is the preference rank-order procedure, developed by Birch and colleagues (1979). Children are asked to categorise foods as "yummy", "just ok" or "yucky" using cartoon faces and then then to identify the best liked product. This is then repeated until the foods can be ranked in terms of liking. While this method has proved successful in numerous studies involving young children, children of preschool age have varying levels of communication ability. Given an age range of 6 months to 5 years a large proportion of the children taking part in the studies included in this thesis would be unable to successfully complete a ranking measure. A more basic measure was required in order to identify an increase in liking and to be used effectively for all children participating in experimental studies.

At the most basic level food refusal and food acceptance give an indication of whether or not a food is liked, as does how much of a food is consumed. Studies including children of infants and pre-school age often employ such measures to establish preferences and liking (Anzman-Frasca et al., 2012; Maier et al., 2007; de Wild, de Graaf & Jager, 2013). Given that eating behaviours are often motivated by pleasure of eating it seems reasonable to suggest that children will eat larger amounts of a food that they like than they will a food they dislike or like less. Eating behaviours are of course sensitive to other internal factors, such as a child's level of hunger or the mood of the child that day and may be seen as much as a measure of wanting as they are of liking if taken at a single point in time. A child's health may also influence how much a food they consume on a particular day with children who are feeling unwell less likely to consume even a liked food.

Similarly a child's food intake can be influenced by external factors such as portion size (Fisher, Arreola, Birch, & Rolls, 2007; Fisher, Liu, Birch, & Rolls, 2007) and social interactions (Greenhalgh, Dowey, Horne et al., 2009). Studies have shown that individuals eating in the presence of an eating partner tend to match or model the intake of that partner irrespective of hunger or fullness levels (Goldman, Herman, & Polivy, 1991; Herman, Roth, & Polivy, 2003). Work as part of the Food Dudes project as also demonstrated that children are more or less accepting of novel foods following positive or negative responses to those foods by a group of peers. The experimental studies described within this thesis took place in nursery settings at class snack times according to a testing schedule making these additional factors difficult to control for. Portion sizes of snacks were standardised and children's usual snack times were selected to optimise hunger, however variation in the social influence of peers and the health and mood of children from day to day was an unavoidable result of a naturalistic study. Group snack sessions within nurseries maximised participation in each study and provided a naturalistic setting, improving the generalisabilty of results. Intake therefore remained the most practical and appropriate measure of liking for the purposes of the experimental studies contained within this thesis. It was decided that liking would be inferred from amount consumed. Thus the more eaten, the more liked and vice versa.

Intake of all study foods was calculated by weighing snacks before and after an eating session. Snacks were weighed including pots and lids/bags and labels depending on how they were presented to participants. Measurements were completed by trained researchers using an OHAUS Pioneer™ Precision Balance scale (Figure 2.5).

Figure 2:5 Pre-test weighing of variety snack for Study 5 using OHAUS scales

2.6.2 Anthropometric measures

During each intervention children whose parents had consented had their heights and weights measured. Children were weighed using s Seca 888 compact digital floor scale and measured using a Leicester SMSSE portable stadiometer. For infants under the age of two years Seca infant scales and a Seca mobile measuring board were used. Weight-for-height z-scores were calculated using the WHO anthropometric calculator (http://www.who.int/childgrowth/software/en/).

Chapter 3 An investigation into the introduction of vegetables in the weaning period

Abstract

The weaning period is an ideal opportunity for parents to introduce children to a variety of new foods and flavours, including vegetables. Acceptance of these foods is influenced by previous experiences with the flavours in utero and during breastfeeding as well as the timing and method of introduction. In order to examine the current weaning practices of UK mothers and their approaches to vegetable introduction, quantitative and qualitative methods were employed. Mothers of infants aged 6 to 18 months (*n* 75) completed postal questionnaires exploring infant feeding and solid food introduction and a randomly selected subsample went on to participate in more detailed interviews (*n* 13). Analyses revealed that on average mothers introduced solid foods at around 20 weeks with vegetables one of three first foods offered. Children who were breastfed tended to be weaned later when compared with formula fed children but no difference was found in the number of vegetables introduced in the first month of weaning. For interviewed mothers offering children a healthy balanced diet was a priority and vegetables were a fundamental part of this. They reported offering a variety of vegetables frequently with an emphasis on the need for children to consume as much as possible. Several strategies for encouraging intake were reported including repeatedly offering new vegetables and incorporating them into other dishes. Mothers reported that vegetables were well liked by children suggesting that their techniques are successful.

The author was responsible for the collection of questionnaire data included in this study as well as the analysis of questionnaire and interview data.

3.1 Introduction

Parents have a fundamental role in the development of children's eating behaviours (Savage et al., 2007) through decisions about what foods are made available, how frequently they are offered to children and through modelling of their own eating habits. In addition parents' feeding practices can impact on children's diet and food choices (Blissett, 2011; Sleddens et al., 2010; Wardle et al., 2005).

The pre and post natal environments could constitute early taste exposure (Cooke & Fildes 2011). Research demonstrates that the maternal diet can influence the flavour of the amniotic fluid (Hauser, Chitayat, Berns, Braver, & Muhlbauer, 1985; Mennella, Johnson, & Beauchamp, 1995) and breastmilk (Hausner et al., 2008; Mennella & Beauchamp, 1991) and that this in turn might impact up on later taste preferences especially for specific flavours in solid foods (Mennella et al., 2001). In addition to evidence that breast feeding facilitates acceptance of novel foods it is also suggested that it can increase acceptance of a wider variety of novel foods (Maier et al. 2008) due to exposure ot particular tastes or the frequency of change in tastes in breast milk.

During weaning infants are introduced to their first solid foods, encountering a multitude of new flavours and textures. Weaning is an opportunity for parents to expose children to a variety of tastes and flavours and assist them in developing healthy eating habits (Birch et al., 1982; Coulthard et al., 2010) prior to the onset of neophobia. Studies have also demonstrated that repeated exposure to a variety of vegetables early in weaning increases acceptance and intake of those vegetables and other novel foods (Maier, Blossfeld, et al., 2008).

Current UK guidelines recommend that solid foods should be introduced when a child reaches six months of age and certainly no earlier than four months (Department of Health (DH) 2008; WHO, 2003) and exclusive breastfeeding is advised until six months. Despite this (EFSA Panel on Dietetic Products - Nutrition and Allergies (NDA), 2009) practices of a large proportion of UK mothers deviate from the official guidelines (van Odijk, Hulthen, Ahlstedt, & Borres, 2004). Associations have been identified between the early introduction of solids, before four months, and rapid infant weight gain (Sloan, Gildea, Stewart, Sneddon, & Iwaniec, 2008), an increased risk of both childhood and adult obesity (Baird, Fisher, Lucas et al., 2005; Ong & Loos, 2006) and the potential for the development of diseases such as celiac disease and type 1 diabetes (European Food Safety Authority Panel on Dietetic Products - Nutrition and Allergies, 2009). However, evidence that weaning prior to six months is detrimental to children's health is lacking (EFSA, 2009) and several studies have indicated that early weaning, before six months, may actually be beneficial. This is because of a proposed 'sensitive period' between the ages of 16 and 36 weeks during which infants are most accepting of different foods highlighting it as a crucial opportunity for children to develop valuable dietary preferences (Harris, 1993). Reasons for mothers choosing to wean their children early vary, however, studies have suggested that timing of weaning is closely related to a perception that infants are no longer satisfied by purely milk feeds and a desire to settle infants and encourage a full night's sleep (Alder, Williams, Anderson et al., 2004; Anderson, Guthrie, Alder et al., 2001; Harris, 1988; Savage, Reilly, Edwards, & Durnin, 1998; White, 2009). Despite official recommendations to delay weaning, mothers report that decisions about when to introduce their children to solid foods should be based on the readiness of the individual child and for this reason mothers 'know best' (Alder et al. 2004).

It is clear from the statistics that children in the UK are not consuming sufficient fruits and vegetables and that vegetable intake is particularly low (Chapter 1). Children's general dislike for vegetables (Cooke & Wardle, 2005; Gibson, Wardle, & Watts, 1998) can make encouraging intake difficult, however, offering children frequent exposure to a variety of vegetables early on has been found to promote acceptance and increase liking and consumption (Beauchamp & Mennella, 2008; Maier, Chabanet, Schaal, Issanchou, et al., 2007; Sullivan & Birch, 1994). The literature suggests 8-10 offerings of a new food may be necessary in order for children to develop liking for that food. However, it is unlikely that parents persist in offering new foods this many times, particularly when faced with recurrent rejection (Maier, Chabanet, et al., 2008). Additionally, while the current printed and on-line guidance for weaning does refer to a need for repeated experiences with new foods few recommend a specific number of exposures (DOH & Unicef, 2008; NHS Start4Life, 2013) instead suggesting offering a new food "lots of times" leaving this open to interpretation by the parents (NHS, 2013; Start 4 Life leaflet, 2011). This supports the suggestion by Schwartz and colleagues (2011) that improved guidance for parents around repeated exposure may assist parents in guiding their children's food preference development.

Overal it is recommended that mothers should delay weaning until six months and that early exposure to vegetable or indeed a variety of flavours, during breastfeeding or throughout weaning, might be beneficial for preference development. The weaning period is crucial in shaping healthy dietary habits given infants readiness to accept a variety of new foods and the opportunity for new taste experiences before the onset of neophobia. The primary aim of the current chapter was to explore parental feeding practices relative to official recommendations and to investigate the ways parents encourage their children to consume vegetables, using qualitative and quantitative methods. The findings of this study were used to identify areas in need of further research which are then addressed in the remainder of the thesis.

3.2 Method

3.2.1 Participants

220 families with children aged between six and eighteen months were identified via SureStart (Hoyland, Barnsley, South Yorkshire, UK) and were sent a postal questionnaire. A total of 75 parents and caregivers completed and returned the questionnaire and of these 13 mothers were randomly selected to take part in a follow-up interview (Table 3.1).

3.2.2 Procedure

3.2.2.i Postal questionnaires

Postal questionnaires (Appendix B1) incorporated a selection of demographic questions, questions relating to milk feeding and the introduction of solid foods, the Infant Feeding

Questionnaire (IFQ, Baughcum et al 2001) and a Food Frequency Questionnaire (FFQ) (Hammond et al. 1995).

Table 3:1: Participant characteristics (mean ± SEM) (adapted from Caton et al. 2011)

	Postal Questionnaire Respondents (*n* = 75)		Interviewees (*n* = 13)	
	Mean ± SEM	Range	Mean ± SEM	Range
Maternal age (years)	30.5 ± 0.6	16 – 41	28.5 ± 1.2	20 -36
Maternal BMI (kg/m2)	24.6 ± 4.2	19.7 - 44.5	24.6 ± 1.4	19.2 -38
School leaving age (years)	18.3 ± 0.3	15 – 26	17.3 ± 0.5	15 -21
Parity	1.7 ± 0.3	1 – 4	1.7 ± 0.3	1 – 4
Birth weight (g)	3474.6 ± 62.5	1980 – 4564	3498.3 ± 161.2	2495 – 4564
Age of child at the time of the questionnaire (weeks)	61.5 ± 1.7	32 – 94	58.4 ± 4.2	34 – 76
Breast-fed/Formula fed	46/29	-	8/5	-
Age of child when solid foods introduced (weeks)	20.2 ± 0.5	8 - 30	20.6 ± 1.0	16 – 24

3.2.2.ii Interviews

A semi-structured interview was developed to investigate current weaning practices employed by UK mothers (Appendix B2). Interview was selected as a method in order to allow more detailed exploration of the topic and to give context to the data collected through previous questionnaires. The nature of the interview was intended to allow participants to offer their own experiences of the weaning process and to feel comfortable in sharing their opinions. Questions also gave some focus on the introduction of vegetables during weaning and strategies used by mothers to encourage intake. Mothers were also asked to describe experiences of food rejection and to explain if and how this was overcome. Where it was felt that expansion on a theme would be beneficial or clarification was needed, prompts were used to encourage further discussion; ‘can you provide an example’’, ‘‘can you tell me more about. . .’’.

3.3 Data analysis

3.3.1 Statistical analysis

Data were analysed using SPSS version 20.0 (SPSS Inc., Chicago, IL, USA).

Associations between age of solid food introduction and birth weight, duration of breastfeeding, maternal age and school leaving age and maternal BMI were evaluated using Pearson’s correlation coefficient. The same analyses were used to examine relationships between age of introduction of solids and experience with fruit and vegetables in the first month of weaning and the factors on the IFQ and fruit and vegetable exposure and scores on the family FFQ.

Differences in the feeding practices used by mothers who breast-fed (BF), either exclusively or otherwise, and those who formula fed (FF) their children were examined using independent groups t-tests. Oneway analysis of variance (ANOVA) was used to explore effects of weaning age group (<16 wks, 16-23 wks, ≤24 wks)on birth weight and maternal body mass index (BMI), fruit and vegetable exposure and the age at which different food items were introduced. A Chi-square test was used to examine differences in frequencies of breast-fed, formula fed and mixed fed infants.

3.3.2 Content analysis

Content analysis of transcripts was conducted by two researchers. A directed approach was employed meaning that initial categorization of the data was guided by prior research (Potter & Levine-Donnerstein, 1999), in this case the findings of previous questionnaires. Researchers then immersed themselves in the data in order for predominant themes to emerge (Hsieh & Shannon, 2005). To achieve immersion in the data transcripts were read and then re-read by researchers. During the first reading of the transcripts notes were made on recurring concepts and this continued through subsequent readings so that patterns could be identified in the topics discussed and the terminology used. These were then grouped and coded according to subject matter allowing the researchers to identify themes based on their prevalence within the data and how well they related to the research question (Dey, 1993; Hsieh & Shannon, 2005). Continuous and reflexive dialogue took place between researchers in an attempt to effectively reach consensus and to highlight and overcome differences in interpretation of comments made by participants (Henwood & Pidgeon, 1992) and to achieve consistency in coding. Coding was carried out by both researchers and discussions and reviews of the data took place at each stage to establish that identified themes were appropriate and accurately reflected the content of the interviews (Henwood & Pidgeon, 1992). A final coding scheme was agreed upon with definitions and rules for assigning codes and categories (Weber, 1990). This was tested using a sample of the data before the final codes were then applied to each of the transcripts so that data could be collated under each theme heading. Again this was carried out by both researchers and then checked for consistency (Potter & Levine-Donnerstein, 1999). Given that one of the aims of this study was to inform the development of subsequent research a pragmatic, rather than exhaustive, approach was taken to the analysis of the data.

3.4 Results

3.4.1 Milk feeding practices

Mothers who breast-fed (BF) made up 60.5% (*n* 46) of the total sample, including both those who exclusively breast-fed or breast-fed alongside the use of formula feeding (FF). Mothers who exclusively FF their children accounted for the other 39.5% (*n* 29). Of the 46 mothers who BF, 30 did so exclusively (65.2%) with the other 16 using a combination of BF and FF (34.8%). On average mothers that BF did so for 22.4 ± 2.6 weeks, however, mothers who chose to exclusively BF were found to BF for significantly longer, 27.1 ± 3.1 weeks, than those who used a combination of methods, 13.1 ± 3.9 weeks [t (43) = 2.7, p=0.01]. Significant differences in mothers' age and school leaving age were found between BF mothers (both exclusive and combination) and FF mothers with BF mothers being older at the time they left school (Table 3.2). Mothers' parity, BMI and child birth weight were not found to differ between groups.

Table 3:2: Characteristics of participating mothers by milk feeding practice (means ± SEM), adapted from Caton et al. 2011)

	Breast-fed (*n* = 46)	Formula fed (*n* = 29)	*p* value
Age (years)	31.7 ± 0.7	28.5 ± 1.0	0.008
School leaving age (years)	19.1 ± 0.4	16.9 ± 0.4**	0.00
Parity	1.6 ± 1.3	1.8 ± 1.3	0.30
Maternal BMI	24.8 ± 0.7	24.2 ± 0.6	0.54
Child's birth weight (g)	3489.9 ± 71.5	3498.9 ± 109.2	0.94

** significantly different ($p < 0.01$)

3.4.2 Introductions of solid foods

3.4.2.i Age of introduction of solids

Weaning was found to commence between the ages of 8 and 30 weeks and infants were, on average, 20.2 ± .5 weeks when first introduced to solid foods. Mothers who BF, regardless of duration or exclusivity, were found to wean their children significantly later when compared with FF mothers; 21.6 ± 0.5 weeks (BF), 17.8 ± 0.8 weeks (FF), [t (73) = 4.1, $p<0.001$. No differences were found in age of introduction of solid foods based on child gender.

Analysis of the data showed that a large proportion of mothers reported introducing solids at three specific ages, 16 weeks (20%), 20 weeks (17.3%) and 24 weeks (21.3%) highlighting these as ages that mothers specifically choose as appropriate for solid food introduction (Figure 1). In order to further investigate solid food introduction participants were categorised into 'weaning age' groups based on current guidelines and consisting of those who weaned before 4 months (<16 wks, *n* 6), those who weaned between 4 and 6 months (16-23 wks, *n* 49) and those who weaned at 6 months or after (≥24 wks, *n* 25).

When compared with <16 wks weaning age group, a significantly greater number of infants were weaned between 16 and 23 wks, χ^2 (1, 50) = 28.9, p< 0.001. In addition significantly more infants were weaned at 16-23 wks in comparison to those weaned ≥24 wks, χ^2 (1, 69) = 5.2, p=0.02. No difference in birth weight was found between three groups (<16 wks = 3624.5 ± 259.4g, 16-23 wks = 3520.6 ± 71.8g, ≥24 wks = 3414.0 ± 584.5g). Age of weaning was not found to be significantly associated with birth weight, maternal school leaving age, maternal BMI or duration of breast feeding but was positively associated with mother's age [*r* (75) = .26, p<0.05], suggesting that younger mothers tend to wean their children earlier. Milk feeding practice was significantly associated with weaning age group [χ^2 (2, 75) = 13.3, p=0.001], with no BF mothers introducing solid foods before 16 weeks compared with 6 FF mothers and 20 of the 25 mothers who weaned at 24 weeks or later coming from the BF sample.

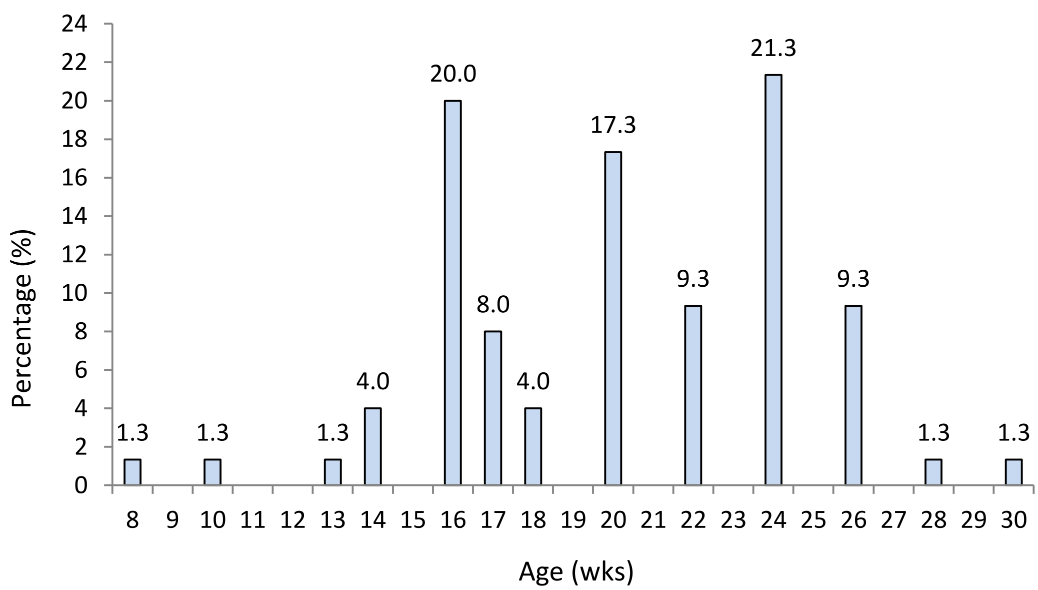

Figure 3:1: Percentage of mothers introducing solid foods at each age

3.4.2.ii Vegetable exposure in the first month of weaning

Participants provided examples of foods they had introduced to their infants in the first two to four weeks of solid food introduction. Scores were derived from the number of fruits and vegetables that had been offered to infants at these stages of weaning. Overall infants were introduced to between 1 and 7 vegetables in the first two weeks with an average offering of 2.6 ± 2.1 vegetables. This had risen to 3.1 ± 2.1 by the fourth week, still with a minimum offering of 1 vegetable, and a maximum of 9. Slightly less fruits had been offered in the first two weeks with an average of 1.9 ± 0.1 (range of 1 - 4) which increased to 2.0 ± 1.1 (range of 1 - 5) by the end of the first month. Most mothers (88.8%) tended to introduce baby cereals in the first two weeks while 11.8% reported using only fruits and vegetables. Age of introduction of solid foods differed significantly between these two groups of mothers [t (74) = -2.02, p=0.05], with mothers who weaned earlier more likely to use baby cereals. The number of fruits and vegetables introduced in the first two and four weeks of weaning was not effected by age of introduction of solid foods, however maternal BMI was positively associated with the number of fruits offered in the first month [r (56) = 0.30, p<0.05]. Positive correlations were also found between the number of vegetables offered in the first two weeks and both the number of fruit offered in the first two weeks [r (42) = .42, p<0.01] and the number of vegetables offered in the first month [r (46) = 0.78, p<0.001]. The number of fruits offered in the first month was also positively associated with the number of fruits offered in the first two weeks [r (56) =0.90, p=0.001) and the number of vegetables offered in the first month [r (57) =0.40, p<0.01].

3.4.2.iii Introduction of different food types

The majority of mothers (97.4%) offered their infant's first solid foods with a spoon with only 2.6% offering them added to their infant's bottle [χ^2 (1, 76) = 68.2, p<0.001]. Mothers were also asked whether they introduced solid foods as a single food item, mostly mixed with other foods or if they used a combination of both methods. Most mothers (50%) had offered foods mixed together with 43.9% offering single food items and 6.1% using both methods. No significant difference existed between the number of infants who received first foods singularly and those who received them mixed. When asked about food preparation, 10 mothers reported offering only ready-made foods, 34 used only home cooked foods and 32 offered their infants a mixture of both [χ^2 (2, 76) = 14, p=0.001]. Again no significant difference was found between the number of infants offered ready-made foods when compared with those who received home-cooked foods or a mixture of both, however, when compared by milk feeding practice, significant differences were found [χ^2 (2, 75) = 12.4, p<0.01]. Only 2 of the 46 mothers who BF offered purely ready-made food to their infants while 27 offered homemade foods only (compared to 7 FF mothers). A similar number of FF and BF mothers offered a mixture of both food types to their children (*n* 14; *n* 17). Significant differences were also found when compared by weaning age group [χ^2 (4, 75) = 12.1, p<0.05]; none of the mothers who weaned at 24 weeks or later offered purely ready-made food to their infants while none of the mothers who weaned before 16 weeks offered purely homemade foods. A similar number of FF and BF mothers offered a mixture of both food types to their children (*n* 14; *n* 17)

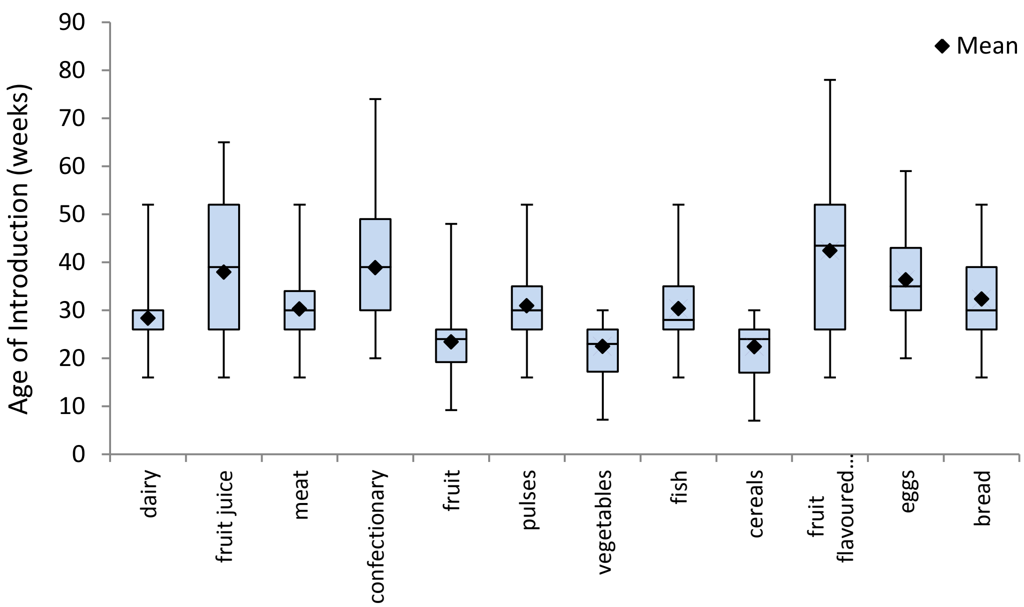

Figure 3:2: Average age of introduction of food types in weeks (median, interquartile range and total range are also shown)

Mothers were then asked to report the age at which they had introduced different types of foods. Figure 3.2 shows both the age range and average age of introduction of each food with Table 3.3 giving the recommended ages for introduction, based on an NHS weaning leaflet which is distributed to all new mothers in the study area (BDA Factsheet, Barnsley NHS). When compared by milk feeding practice significant differences in age of introduction were found for vegetables [t (73) = 3.21, p<0.01], meat [t (70) = 2.51, p=0.01] and confectionary [t (63) = 2.88, p<0.01] with BF mothers offering all three significantly later than FF mothers. The two groups did not differ significantly in the age at which they introduced any other food type.

Table 3:3: Summary of ''age appropriate'' recommended food adapted from paediatric group of the BDA food fact sheet (2005, adapted from Caton et al. 2011).

Age Range	Foods
6 months	Fruit, vegetables, rice, potatoes, meat, yoghurt, cows' milk (used in cooking, yoghurts)
6 -9 months	Pasta, bread and cereals, fish, pulses, egg, custard
12 months	Cows' milk (drink)

Analysis of variance also revealed a main effect of weaning age group on the introduction of fruits and vegetables [F (2, 75) = 8.34, p=0.001; F (2, 75) = 38.94, p<0.001], cereals [F (2, 74) = 26.91, p<0.001] and bread [F (2, 74) = 4.10, p<0.05]. Those mothers who weaned their children before 16 weeks were most likely to offer cereals first, followed by vegetables and then fruit and were found to offer both cereals and vegetables significantly earlier than both other age groups (Table 3.4). Mothers who introduced solids after 16 weeks were likely to introduce cereals, vegetables and fruits at a similar time with those in the 16-23 weeks group offering all four previously mentioned food types significantly earlier than those who weaned at or after 24 weeks (Table 3.3). None of the other listed food types differed in age of introduction when compared by weaning age group (p>0.05).

Table 3:4: Age of introduction of food types (weeks) by weaning age group (mean ± SEM*)

	<16 wks (n = 6)	16-23 wks (n = 44)	≥24 wks (n = 25)	p value
Fruit	21.5 ± 5.3 ^{a}	21.7 ± 0.6 ^{a}	26.6 ± 0.5 ^{b}	0.001
Vegetables	16.5 ± 1.3 ^{a}	21.1 ± 0.5 ^{b}	26.3 ± 0.2 ^{c}	0.000
Cereals	15.5 ± 3.9 ^{a}	21.1 ± 0.6 ^{b}	26.1 ± 0.3 ^{c}	0.000
Bread	27.3 ± 2.5 ^{a}	31.1 ± 0.5 ^{a}	35.6 ± 1.1 ^{b}	0.02

* Means with a different letter (a, b, c) are significantly different

3.4.3 Infant Feeding Questionnaire

Correlational analyses revealed a significant positive association between age of introduction of solids (weeks) and factor 1 on the IFQ (concerns about the infant under eating and becoming underweight), [r (73) = .24, $p<0.05$], suggesting that mothers who weaned later were more concerned that their child may not eat enough and about possible weight faltering. Age of introduction of solids was also found to be negatively associated with both factor 2 [concern about infant's hunger [r (73) = -.48, $p<0.001$] and factor 3 (awareness of infant's hunger and satiety cues) [r (73) = -.36, $p=0.001$] suggesting that mothers who weaned earlier were both more likely to be attentive to their child's cues of hunger and fullness and more likely to be concerned about their child's hunger.

3.4.4 Food Frequency Questionnaire

Scores for all vegetables on the FFQ were added to together to give an overall suggestion of frequency of consumption by each family. The same was done for high fat/sugar snack foods such as sweets, biscuits and crisps. Results revealed that overall vegetable consumption was 11.5±0.8 servings a week and fruit consumption was 8.3±0.8 servings a week. Daily servings were then calculated, revealing that families' average daily fruit and vegetable consumption was lower than the recommended 5 portions a day; vegetables 1.6±0.1 servings and fruit 1.2±0.1 servings. Mean high fat and sugary snack consumption stood at 9.7±0.8 servings a week (1.4 servings a day) showing that these types of snack foods are more regularly consumed by than fresh fruit.

3.4.5 Qualitative results

Through thematic analysis of the interview transcripts, researchers identified 5 themes; vegetables (1), concerns about child's diet (2), child's eating status (3), guidelines versus reality (4), weaning and sleep (5).

3.4.5.i Vegetables

The majority of mothers stated that they and their children frequently consumed vegetables and emphasised that offering variety was important (Table 3.5, 1A). Mothers acknowledged a sense of responsibility for ensuring that their children eat a sufficient amount of vegetables and described actively offering an array of fruit and vegetable types. To support intake mothers reported that they kept an ample amount of vegetables in the house with others describing trying to ‘’get as many down them’’ as possible (Table 3.5, 1A).

Ten of the thirteen mothers interviewed described vegetables as being well liked by their child and reported that their child had liked all the vegetables that they had been introduced to suggesting that methods employed by these mothers to encourage intake of vegetables are effective. Only one mother reported an overall disliking of vegetables by her child (Table 3.55, 1B). Where mothers were recounting their child's liking for vegetables they often applied strong descriptors such as “love” (Table 3.5, 1B).

Family meals were mentioned frequently when mothers were asked how they encouraged intake. Mothers reported adapting family meals to include new vegetables or those that are liked by their children with some actually making modifications to the family diet as a whole to include a greater number of fruits and vegetables (Table 3.5, 1C). Two mothers revealed that, since having children, they had started eating more fruits and vegetables.

When asked about the issue of food rejection, mothers provided a variety of examples of how they attempt to tackle this. A number of mothers gave examples of modelling, describing eating meals with their child, or as a family, and consuming vegetables in front of them. Others attempted to make vegetables fun, for example referring to broccoli as “little trees” or arranging vegetables into faces on the plate (Table 3.5, 1D). Popular techniques were to modify the taste, texture or appearance of vegetables. Mothers did this by using dips and sauces, incorporating the vegetables into meals, sauces or soups or by mashing, pureeing or chopping them very finely (Table 3.5, 1D). This suggestion of offering vegetables by stealth was a recurring theme with one or all of these strategies employed by the majority of mothers. Again these accounts of efforts made by mothers to incorporate vegetables into their children’s diets seemed to emphasise the importance mothers attach to promoting vegetable intake and establishing healthy eating patterns. Where mothers perceived initial dislike responses to new foods they reported a readiness to persevere with vegetables as an important component of their child’s diet.

3.4.5.ii Concern about their child’s diet

The importance of incorporating a variety of fruits and vegetables into the familial diet was frequently mentioned by mothers. Additionally many also prioritised nutrient quality when deciding on suitable foods for their children. Mothers mentioned attending to the levels of salt and sugar in foods, preferring to offer those low in both. Others referred to offering foods which are easily digestible with some opting to buy only organic or ‘‘natural’’ produce. For a number of mothers the quality of the foods they gave to their children seemed to be linked to its preparation. These mothers reported a preference for home-cooked foods when feeding their children believing them to be superior in taste, ingredients and nutrients when compared with ready-made foods. In support of this some mothers reported that ready-made foods were more frequently rejected by their children. Another felt that preparing her own fruit purees meant avoiding what she perceived to be high levels of sugar in ready-made purees. For one mother ready-made foods provided more of a contingency plan, stating that they were only used in an emergency. Providing a nutritionally balanced and varied diet emerged as predominant theme of the interviews and this is demonstrated in the frequent use of words such as ‘‘nutritional’’, ‘‘healthy’’ and ‘‘balanced diet’’ (Table 3.5, 2A).

Nutrient quality was also mentioned during discussion around food rejection. When asked what foods mothers were most likely to persist in encouraging their child to eat mothers listed foods that were “healthy” or ‘‘good for them’’ (Table 3.5, 2B), many mentioning fruits and vegetables. In an attempt to encourage consumption of “healthy” foods, many mothers indirectly reported employing the repeated exposure technique. They described a need to persevere in offering those foods which they perceived as less liked and reported not ‘giving up’ when they felt a food should be part of their child’s diet . Similar strategies were adopted by some mothers when confronted with food refusal. Mothers described how they felt it best to approach dealing with food refusal and highlighted a need to minimise the stress of the situation by remaining calm and not making a ‘‘fuss’’.

3.4.5.iii Child eating status

The majority of mothers perceived their feeding strategies to be successful (Table 3.5, 3A) with ten mothers describing their children as being ‘good eaters’. Interestingly only one mother described her child as recently becoming more “fussy”. However, while most mothers seemed satisfied with their child’s current eating habits mothers demonstrated an awareness that, rather than being constant, children’s tastes and preferences can change (Table 3.5, 3B).

Table 3:5: Excerpts from transcripts

Theme		Quotes
1. Vegetables	A - Frequency of vegetable consumption	“well every day. He will have one proper cooked meal with at least two different types of veg – his favourite is broccoli and carrots and cauliflower – he absolutely loves broccoli so yes, he has lots of vegetables” (02). “She will eat vegetables every day and say at dinner time she will probably have broccoli, carrots and one other veg plus a little bit of potato – so every day she’s got varied vegetables” (03). “Chloe has a lot of vegetables really – we’ve always got vegetables in” (09). “she has usually about two pieces of fruit and then at teatime she will have like her three vegetables – she’ll have like carrots, peas, broccoli as these are her three favourites...”(10).
	B - Liking of vegetables	“she doesn't like them a lot now...”(01). “he seems to like his vegetables. I don’t think there is one yet that we have tried to give him that he has not liked.” (04). “They like vegetables a lot... they love it – they love carrots, peas – they love all their vegetables… No I think they like them all...” (05). “And he just loves them – he loves his veg.” (08). “She loves vegetables – absolutely loves them...” (10).
	C - Family diet	“I don’t eat fruit and I don’t eat veg...I have now got myself and my partner eating more healthily because I do a meal in the oven so that she can have it the next day whereas before I wouldn’t have cooked it” (01). “I actually were buying certain vegetables and fruit that we had never had before because it said that’s what he had to have and so we did it.” (05). “It was just things like if we were having a cooked dinner I just put things like potatoes and vegetables to one side ...” (08). “Just by eating what we are eating and making it like a community thing – it’s not just about the food it’s about being together really.” (09).
	D - Vegetables by stealth	“well when I first tried him with this pasta sauce thing that I make he spat the peppers out so then I decided to make it into a smooth one. So rather than the lumps of the pepper and mushrooms I blended it and then put it on his pasta… I blended it all up and then once he got used to the taste of it now he will eat it in big lumps.” (02). “probably either try and hide them in something else if I needed to or make a soup or even something like a jacket potato and then make a pate with vegetables or something...” (03). “Hide it in things – something like making a bolognaise and hide it you know blend it in so they wouldn’t know...” (05). “Cut them up really finely into mince and stuff, put it into fish pie – you know so that he didn’t realise he was eating it....” (07). “Disguise it in sauces and things like that.” (10).

2. Concerns about their child's diet	A - Nutrient quality of foods	"100% salmon, 100% haddock, 100% cod, took the breadcrumbs off to reduce salt intake.., I promised myself that I would ensure that Molly had a varied diet with as much fruit and vegetables as I could..." (01). "I am trying to think of nutritional foods that she will sit and eat all day long..." (01). "even the Cow and Gate baby food for weaning and stuff has still got sugar in it – it's got concentrated ingredients in which contain sugar and stuff and they say that is quite bad for their teeth so they said the best thing to do is just to stew your own fruit and mash this up..." (07). "Liver – We tried it because it's full of iron isn't it." (07). "I'd like to think that she was eating a balanced diet" (09).
	B - Dealing with food rejection and types of foods to promote	"I'd just leave it and try it again a few days later..." (01). "I would try it again – I would keep trying it... So fruit and veg are the things I persist with most really" (02). "So it would really be the foods that are good for him that I would keep trying him over and over..." (04). "I just take it away from him – I don't try and push him if he doesn't like it then he doesn't like it. (05). "I wouldn't bother too much because if you get worked up about it and they get worked up then they are never going to like it" (05). "Yes vegetables and fruit – without a doubt yes. Anything healthy."(08) "I would never give up until he got used to eating it – the things that were good for him anyway." (08). "We try her with it and if she is not eating it then you know we don't make a fuss over..." (09). "I would always keep trying to get any fruit and any vegetables – definitely...I always make sure I keep pushing any healthy food – I don't push chocolate or anything..." (10). "I try to not fuss with it but then try him with it again in a week or so just to see whether he wants it...I tend to persevere." (12). "yes probably healthy eating because I don't tend to persist if he doesn't like chocolate covered raisins then I don't try them again I just think 'well – you know'...You know if he didn't like crisps or snackie things I wouldn't probably try them for a while..." (12)
3. Child's eating status	A - Good versus Bad eater	"She'll eat anything..." (03). "he is a fantastic eater now - Really good he will eat anything" (05). "He's quite good he will eat everything I make for him." (07). "Chloe is quite a good little eater..."(09). "I have to be honest and say she's pretty good...But she is a really good eater – there's not many foods that I have seen her dislike or refuse" (11).
	B - Changes in taste	"But bananas that was a tough one because he liked them at first and then he didn't like them" (05). "he likes fish which he didn't like straight away" (04). "because their tastes change as they get older don't they?" (10). "I know that the taste changes as they get older so I just keep on persisting with her unless I really thought she disliked it." (11). "he did like parsnips when he was younger but he doesn't eat them now" (12).

4. Guidelines vs. Reality	A - Individual Differences	"I think every baby is different and they have all got different needs..." (01). "every baby is different. Not every baby is the same at six months are they?" (01). "I mean I know every baby is different – but I don't particularly think that there's babies that are really more 'hungry babies'." (02). "But with Isaac he were a lot more difficult, he weren't as interested… it was surprising the difference in them two." (05). "I think each baby is different like I did one at four months and he took to it but the other one was six months. I don't think that's got anything to do with the government saying you should wait until six months I just think all babies are different." (05).
	B - Too much focus on Guidelines	"I think everyone is wrapped up with the idea that if you do it earlier you will be frowned upon and if you do it later then do you know anything about your child – it's as though you should have started weaning at six months and one of the Health Visitors when I went to the Clinic said 'have you started weaning her yet?' and I said 'No'. But she said 'she's seven and a half months old'..." (01). "I think there is too much emphasis that it has got to be done at six months... but you always think that you are not doing as well as you can if you are not doing it according to the guidelines. And they are only guidelines and it is up to yourself... I do think Health Visitors can be strict and stringent with certain things especially when it is written all over that it is advised to have exclusive breast feeding for the first six months." (01). "It's everywhere you know it's not just Health Visitors, its books, it's wherever you look – on the television with the adverts it's on there isn't it?" (01). "Yes if it was only slight movability. I wouldn't like to think people would go to extreme movability I mean maybe five or seven months something like that but I wouldn't advise weaning at two months or anything like that you know." (09). "I remember when I used to go in with Georgia they used to say 'no it's six months you really shouldn't wean before' – so you felt as though you were doing something wrong then." (11).
	C - Inconsistency of Guidelines	"Which is what quite a few 'old school' like my mum – she couldn't understand why they were saying six months because back then they did it at three months. So it does change quite a lot – the guidelines do change and that's confusing…" (02). "...because there are so many different foods now that they are not allowed and are allowed. It's so different I mean my oldest one is five now but it is so different from what it was with him she just kept telling me 'no', 'no'." (04). "Because I think when my mum was weaning us that a lot of things have changed – they weaned at four months whereas our guidelines say to wean at six. And things like honey they said don't give them honey until they are five and my mum didn't know that so my mum's information was a bit out of date." (06). "Yes Billie is six now. But he was four months old then and I think that was the guidelines for them at that time." (11)

	D - Advice from Trusted Others	"I did it that way because my mum advised that if you do the root vegetables before the sweeter things they tend not to have a sweet tooth..." (01). "I am so lucky to have my mum – but if I didn't have my mum you know you ask advice and you don't know whether you are getting the best advice…" (01). "I think the information that was most helpful was probably the stuff that was in for example the Tesco magazine with the stories from other mums – you know relatively new mums who had just gone through the process… And then probably other friends that have got children that are not that much older than Erin and so have gone through the process themselves..." (03). "I just did it myself. I didn't go to no weaning classes or anything like that… I asked my sister like because my sister has got three kids and my other sister's got two and my other sister's got five. So I just asked them how they did it and just got advice off them more than anything." (10). "But you know my mum's had us two… she helped me with Billie and so I trusted my mum's advice a lot more that I did the Health Visitors." (11).
	E - Mums know best	"...it is up to yourself – and up to me as a parent to do what I think is best…." (01). "...I just knew that he was telling me that he was ready to try something else." (03). "Well the Health Visitor tried – she really did try but no I knew from having my other two and when you know that they are ready and with knowing all the signs from my other two." (04). "You know when your baby is ready – you really do." (04). "I think you should go for what you think your baby needs." (10).
5. Weaning and Sleep	A - Lack of sleep of parent/infant as a reason to start weaning	"...and waking up in the night for feeds that he had not had before so I decided that I would try him on some solid food..." (02). "I think people try but it's just so they can get them to sleep on a night…" (05). "She was getting up as well through the night so it was another sign that she needed something else really" (09). "If you are giving them as much milk… that's telling me that there is something wrong. She is still hungry."(10). "I think sometimes it's because they want them to sleep through – I think it is laziness on the mum's part." (12).
	B - Sleep as a sign of fullness/ satisfaction	"He was quite a young age as well and so I thought I am going to have to try something different and so I thought I am just going to try him with a bit of baby rice and he liked it and he seemed to have less bottles when I was giving it to him so he was a lot better and I finally managed to get more sleep." (04). "Give them solid foods definitely – it satisfies them more and they sleep more on a night." (13). "So if you introduce solids at an earlier stage then you know it fills them up. Well she slept through… that's what made her better by having that extra for dinner or tea or just before she went to bed." (10). "...and people tend to think if their tummies are full then they will sleep but if they're not going to sleep then they're not going to sleep…" (05). "...and then she started sleeping better as well because she had been waking up and that through the night." (10).

3.4.5.iv Guidelines vs. reality

Mothers were asked how they had initially decided to introduce solid foods to their children and what had shaped their decisions about the foods they had introduced as well as being asked to comment on current weaning guidelines. During discussion around these topics mothers drew contrasts between the advice they had received from health professionals and their own experiences or those of trusted others. Many mothers also pointed out the differences between current guidelines and previous recommendations, which for some had been in place at the time of their first child or when family members or friends had had children. While mothers appeared to have good knowledge of the current recommendations regarding weaning their perceptions of the 'reality' of the process was often very different from these. Mothers were also keen to emphasise that 'every baby is different' (Table 3.5, 4A), sometimes offering examples of these differences which might rationalise where and how they had chosen to deviate from the guidelines. In most cases mothers seemed to view the guidelines as too rigid or to suggest that there was too much of a preoccupation with them, particularly amongst health professionals (Table 3.5, 4B). Consequently mothers reported a sense of obligation or pressure to adhere to the guidelines. This perception of pressure or feeling of accountability meant some mothers attempted to delay or initiate weaning based solely on instructions from their health visitor while others discounted their advice entirely.

The majority of those interviewed had tried to abide by the official guidelines and reported finding them beneficial in navigating the complexities of the weaning process. However, many identified inconsistencies between current recommendations and those which existed previously (Table 3.5, 4C). This was particularly salient for mothers who had other, older children who they had weaned during that time. These mothers reported feeling confused by the changes to guidelines over the years and having to implement the six month recommendation when they had previously and successfully weaned at four months. For some, earlier successful weaning experiences at four months led them to disregard the new guidelines in favour of this previous recommendation.

In addition to mothers' own positive experiences influencing their decisions around weaning many participants reported seeking advice from sources other than health professionals. These included family members, friends and parenting books and magazines (Table 3.5, 4D). Receiving advice from family and friends, or trusted others, was particularly well reported. Some mothers acknowledged that information from those around them could often be outdated; however, others believed this advice was more reliable than what was received from their health visitors. This tended to be the case where mothers knew that those giving the advice had experience of weaning and where they had seen no evidence of negative outcomes. While all mothers reported seeking advice from some external source nearly all agreed that 'mothers know best' when deciding when and how to initiate sold food introduction with their infants (Table 3.5, 4E).

3.4.5.v Weaning and sleep

For many mothers weaning was strongly associated with sleep. A number of mothers described their infants sleeping pattern as being somehow regulated by feeding practices and many reported initiating weaning because of a lack of sleep (Table 3.5, 5A). For these mothers their child's failure to sleep through the night was perceived as a direct consequence of them no longer being satisfied by milk feeds and needing solid foods. In fact many mothers described sated babies as sleeping more, both in terms of frequency and duration (Table 3.5, 5B). It appeared to be generally accepted that full babies sleep. However, while lack of sleep was mentioned by many mothers as a possible trigger for initiating weaning some of these mothers did not feel this was a legitimate motive for introducing solid foods. One mother perceived this strategy as laziness of the mothers' part.

3.5 Discussion

The aims of the current study were to explore maternal feeding practices in relation to the introduction of solid foods as well as to investigate when and how vegetables are first introduced to children and how mothers promote intake beyond the initial stages of weaning. Overall BF rates within this sample of mothers was higher than the national average for 2010 (Health and Social Care Information Centre, 2012), and figures for BF duration and the number of mothers who exclusively BF were also favourable. Much like the national statistics (HSCIC, 2012) the results of the current study show that older mothers and mothers who left school later were more likely to BF. While the mothers in this study tended to introduce solid foods to their children approximately a month earlier than the six month recommendation, a much smaller proportion of this sample (8%) weaned before the four month minimum age recommendation when compared with mothers nationally (30%) (HSCIC, 2012). In addition the foods being introduced earlier than six months tended to be baby cereals, fruits and vegetables with all other foods being introduced, on average, according to the guidelines distributed in that area at the time (adapted from the BDA, 2005) . This is an encouraging finding and follows a national pattern in a reduction in the number of mothers choosing to wean their children before four months. Milk feeding practice was found to effect mothers' decisions about when to introduce solid foods with BF mothers, both those who BF exclusively and in combination with formula, more likely to delay weaning until 22 weeks when compared to purely FF mothers who weaned at around 18 weeks. In fact BF mothers made up 80% of all mothers who weaned at or later than the six month recommendation and none of the BF mothers weaned before sixteen weeks suggesting that BF mothers are more likely to adhere to guidelines around weaning. Although this overall tendency to wean before six months does diverge from recommendations, the EFSA (2009) have stated there is insufficient evidence to suggest that weaning between four and six months is detrimental for children. In addition work by Gillian Harris (1993) has suggested that delayed weaning may miss a "sensitive period" between sixteen and thirty-six weeks when children are more willing to accept new and varied flavours.

In line with previous studies the interviews suggest that decisions about the right time to wean are complex. Mothers reported that advice on weaning came from various sources and felt that the official guidelines were too rigid (Anderson et al., 2001; Cullen, Baranowski, Owens et al., 2003). Some considered there to be too much focus on the guidelines which could be off-putting and to some extent may damage the relationship between mother and health visitor. These guidelines were also often found to conflict with advice given by family and friends and those recommendations made in past guidelines which some mothers followed when weaning previous children (Alder et al., 2004; Cullen et al., 2003). This was a source of confusion and frustration for some mothers. Many of the mothers interviewed had experience of the previous four month recommendation either personally or through witnessing the seemingly successful weaning of a friend or family member's child. Despite the recommendations changing a number of years ago, it seems mothers, having experienced no negative consequences to weaning at four months themselves or in those around them, are reluctant to discount this earlier recommendation altogether. Mothers were keen to stress the individuality of their infants with "every baby is different" becoming a recurring theme. For this reason mothers felt they themselves were best placed to make judgements about their children's readiness to move onto solid foods and this was often given as justification for a decision to wean 'early'.

The variety of vegetables offered by mothers in the current study was comparable to previous findings (Maier, Chabanet, Schaal, Leathwood, & Issanchou, 2007) with mothers offering around 3 different vegetables during the first month of weaning. This number was not affected by whether children had been BF or by how early or late they had been weaned. With the exception of baby cereals, vegetables and fruit were the first foods introduced in all cases, most likely because they are easily mashed or pureed and so easily offered to infants. First foods were almost always introduced to infants using a spoon and the majority of mothers would mix foods together rather than offering them individually. This may cause some disadvantage in terms of initial taste exposure if children are unable to build familiarity with the individual taste or flavour of a food early on and may reduce the likelihood of, or at least delay, preference development for that food. Mothers were also much more likely to offer their children purely home-cooked or a combination of home-cooked and commercially prepared baby foods than they were to offer purely ready-made foods. Again choice of preparation of food for infants was related to milk feeding practice with a much higher proportion of BF mothers (59%) offering purely home cooked foods compared with 24% of FF mothers and a much higher proportion of FF mothers (28%) offering commercially prepared foods only compared with 4% of BF mothers.

Discussion during the interviews suggests that mothers' choices when preparing foods for their children are often based on concerns about providing foods of good nutrient quality. This was highlighted by mothers placing emphasis on the importance of making sure their children's diets were high in a variety of fruits and vegetables but also on keeping salt and sugar intake low and being careful about the produce that they buy. For many these factors were given as explanation for why they choose to offer home-cooked foods over ready-prepared baby foods and preparing their own foods made mothers feel that they had more control over the quality of the food they were offering their children.

The maternal diet has a strong influence over children's diets and as a result the food preferences that they exhibit (Birch, Fisher, & Davison, 2003; Cooke et al., 2004; Faith, Scanlon, Birch, Francis, & Sherry, 2004; Gibson et al., 1998a). Mothers determine what foods are available to children and how they are prepared which in turn determines children's exposure. Mothers and caregivers also impact on their children's eating patterns via modelling (Savage et al., 2007; Wardle & Cooke, 2008). A number of mothers reported that they would use this approach with their children in response to food rejection and has been shown to be effective in several studies (Brown & Ogden, 2004; Gregory, Paxton, & Brozovic, 2011). Increasing the availability of and exposure to vegetables was another strategy mothers used in an attempt to promote intake, often by altering the family's existing eating habits (Baranowski, Cullen, & Baranowski, 1999). Mothers described trying to get their children to eat as many vegetables as possible in an effort to ensure that they maintained a healthy and balanced diet. Offering children a variety of vegetables with each meal has been shown to significantly increase intake when compared with children from families where this does not take place (Jones, Steer, Rogers, & Emmett, 2010). Where mothers felt they might come up against food refusal, many described persisting with offering a food on a number of further occasions in a hope that it may become liked. It was specified by mothers that this tactic was only employed with foods that they felt contributed to a healthy diet, such as vegetables. Repeated exposure has been demonstrated to be effective experimentally (Anzman-Frasca et al., 2012; Maier, Chabanet, Schaal, Issanchou, et al., 2007; O'Sullivan, Alexander, Ferriday, & Brunstrom, 2010; Wardle, Cooke, et al., 2003), suggesting that mothers are already employing effective techniques for promoting intake in the home.

In addition to familiarising children with the taste of a new food, increasing familiarity and liking for the appearance of foods can also promote consumption (Houston-Price, Burton, et al., 2009; Houston-Price, Butler, et al., 2009; Jansen, Mulkens, & Jansen, 2010; Mennella et al., 2008; Roe et al., 2013). Techniques for increasing the visual appeal of vegetables, such as arranging them as faces on the plate, were reported by mothers and have been found to be successful (Jansen et al. 2010). In contrast with familiarising children with the taste and appearance of vegetables many mothers reported offering vegetables by stealth. Incorporating vegetables into meals, sauces and soups so has been endorsed by several popular authors in recent years (Sneaky Chef, Deceptively Delicious) and been shown to be highly effective in increasing children’s vegetable intake (Spill, Birch et al., 2011). However, while this is no doubt beneficial in the short term a lack of exposure to the taste and appearance of vegetables may hinder children’s preference development. To a lesser extent, mothers also reported disguising the pure flavour of vegetables by offering them with dips or sauces. Pairing a vegetable with a liked dip or sauce has the potential to increase liking and intake of the vegetable via associative conditioning. Firstly, through repeated tastings, the child may learn to associate their liking for the dip or sauce with the vegetable, even when then vegetable is eventually presented on its own (FFL). Secondly, the positive post-ingestive consequences of the additional energy provided by the dip/sauce may become associated with the vegetable so the child learns to like the vegetable even when presented without the additional calories. As yet, studies that have investigated the use of associative conditioning in increasing children’s liking and intake of vegetables have shown mixed levels of success (Anzman-Frasca et al. 2010; Havermans & Jansen, 2007; Zeinstra et al. 2009) suggesting that further investigation is required. However, a study by Anzman-Frasca and colleagues

(2012) suggests that the use of dips/sauces may encourage children to taste a vegetable in the first instance. Despite mothers' best efforts to encourage vegetable consumption the results of the family FFQ suggest that on average intake is lower than the five a day recommendation (DOH, 2003) at just under three servings. Since mothers reported frequent and varied consumption this may suggest mothers perceive vegetable intake to be higher than it is. It also raises questions around the effectiveness of the strategies used.

In conclusion, mothers had introduced solid foods to their children by approximately 20 weeks using baby cereals, fruits and vegetables as first foods. By the end of the first month of weaning infants had been offered around 3 different vegetables which, while similar to the number offered in other European countries (Maier et al., 2008), suggests that recommendations around offering variety and daily changes in the vegetables offered may be beneficial for mothers. In addition the common practice of offering first foods mixed rather than individually suggests that guidelines around offering vegetables as single flavours to help preference development may also be helpful to mothers. Overall vegetable consumption in participating families was low, however, mothers demonstrated good awareness of the need for a nutritionally balanced diet and seemed motivated towards encouraging their children to consume a diet high in fruits and vegetables. Many of the strategies they employed to promote intake have a strong basis in the literature and while some require further investigation, the high levels of liking for vegetables that they reported in their children, suggest that the methods they are using are proving successful.

3.5.1 Questions

A number of questions emerge as a result of this study. Mothers reported offering their children, a wide variety of vegetables as well as stating that vegetables are frequently consumed. These descriptions of 'variety' and frequent consumption are based entirely on mothers' perceptions exposing a need to investigate what constitutes variety in relation to vegetable introduction and the type and number of vegetables that children are familiar with. Interestingly the number of vegetables offered in the first month of weaning in the

UK is comparable to the number offered in other European countries (Maier, Chabanet, Schaal, Leathwood, et al., 2007) but evidence suggests that the way vegetables are introduced and levels of intake can vary according to the region in which a child lives (Yngve et al., 2005). This could be as a result of differences in the availability of vegetables, frequency of consumption and how vegetables are prepared suggesting exploration of these issues may be of some benefit. Finally mothers report a number of strategies for promoting vegetable consumption in their children including repeated exposure, incorporating vegetables into meals and offering vegetables with liked dips or sauces. These techniques were perceived to be successful by those mothers that reported using them and, in addition, have all shown some level of success in encouraging intake through experimental studies (Anzman-Frasca et al., 2012; Cooke, Chambers, Añez et al., 2011; Remy, Issanchou, Chabanet, & Nicklaus, 2013; Spill et al., 2011). Of interest is how mothers implement these strategies through their preparation and offering of vegetables and how successful they are when applied through interventions with pre-school children. The following questions will therefore be addressed in the next chapter:

1. How many and what vegetables are introduced in the first years of life?
2. How often do mothers offer vegetables to their young children?
3. Which vegetables are liked and disliked by children in their first years of life?
4. Are there particular vegetables that mothers tend to offer children during these early years and how is this related to liking?
5. How does vegetable introduction vary between different European countries?
6. How do mothers generally prepare vegetables?
7. How are these factors related?

Chapter 4 Vegetable exposure and liking in preschool children

Abstract

Mothers use several different ways to encourage their children to consume vegetables, with more or less success. The relative efficacy of different strategies might depend on the vegetable as much as the strategy employed. It is not clear which vegetables mothers commonly offer their young children and how they would normally serve them. To address this issue preschool children's experience with vegetables across three European countries was examined. A questionnaire for parents was developed specifically for this study to investigate cultural differences, age effects and culinary practices. Mothers of pre-school children (*n* 234) in the UK (*n* 71), Denmark (*n* 93) and France (*n* 70) completed a survey assessing parental and infant familiarity, frequency of intake and liking for a broad range of commonly available vegetables as well as usual preparation techniques. Analyses revealed that children aged 6 to 12 months consumed vegetables more frequently and had a higher reported liking for these vegetables than children aged 25 to 36 months who had been introduced to the greatest number of vegetables. In the UK children's liking was related to frequency of maternal intake and frequency of offering. In Denmark mothers had introduced the greatest number of vegetables and offered vegetables more frequently than both the UK and France. Choice of preparation methods differed between countries while choice of seasonings was similar. Results suggest increasing variety and frequency of vegetable offering between 6 and 12 months, when children are most receptive, may promote vegetable consumption in children.

The author was responsible for the collection of survey data within the UK, including the development of an online version of the postal survey, as well as the analysis of data from all three countries.

4.1 Introduction

Mothers already employ a range of strategies in an attempt to encourage their children to consume vegetables (Chapter 3). Interestingly, the majority of mothers reported that their children had diets that were high in a variety of vegetables and that vegetables were liked, suggesting that the strategies that these mothers are implementing are effective. This result is somewhat surprising when the statistics on UK children's vegetable consumption are considered (see Chapter 1).

Inadequate vegetable consumption is not unique to the UK and low intake among children has been evidenced across other European countries. Studies have suggested that up to 94% of European children are failing to meet recommendations (Klepp et al., 2005, Vereecken, De Henauw et al. 2005; Yngve et al., 2005). In France, like the UK, the official recommendation is to consume 5 portions of fruits and vegetables per day, towards a total intake of 400g (INPES, 2004). However most French consumers fail to meet this target and children's vegetable intake is especially low (Lioret, Touvier, Dubuisson et al., 2009). Where other countries advocate even higher intakes, still intake falls below recommendations. For example in Denmark, where the recommendation for anyone over 10 years old is 600g per day ("6 om dagen"; promoting 6 portions of fruit and vegetables per day), 90% of children aged 11-15 years fail to reach this target (Danish Health Agency, 2008). The potential health risks associated with low fruit and vegetable intake have been well documented in particular revealing links with the development of certain chronic diseases and cancers (Bosetti, Filomeno, Riso et al., 2012; Hung, Joshipura, Jiang et al., 2004). Given that dietary patterns tend to track into later life, current eating habits of most European children present a serious long term health risk.

Reasons for low vegetable intake amongst children are many and complex (see Chapter 1). Children tend to dislike vegetables. Since liking is dependent on the sensory properties of novel foods (Zeinstra, Koelen, et al., 2010), vegetables are disadvantaged by their bitter taste and intense flavour (Rosenstein & Oster, 1988; Schwartz et al., 2009). Efforts to mask bitter flavours are, therefore, likely to be succesful in promoting children's consumption of vegetables. Experience shapes preference and repeated and frequent exposure to new or disliked tastes can reduce rejection and increase acceptance of novel foods (Forestell & Mennella, 2007; Maier, Chabanet, Schaal, Issanchou, et al., 2007; Wardle & Cooke, 2008). The experiences young children have with foods is dependent on what foods are made available to them and this is in turn is influenced by the maternal diet (Fisk, Crozier, Inskip et al., 2010). Mothers offer children foods that they themselves like and avoid offering foods they dislike. Consequently children's vegetable intake is positively correlated with that of the mother (Hart et al., 2010).

Building familiarity through experience provides children with the opportunity to learn about novel foods and develop preferences. However, in the preschool period mothers may be discouraged from offering new foods when their child enters the neophobic phase of their development. In addition to rejecting unfamiliar foods, neophobic children may also refuse foods that were previously consumed, suggesting that, for pre-school age children, previous experience with a food may not be a sufficient predictor of liking. Hiding and masking vegetables within meals may encourage vegetable intake by stealth (Chapter 3) and is an effective strategy for increasing intake (Spill et al., 2011) but offering vegetables in this way may mean that the children do not develop an awareness of their experience with vegetables. This is particularly the case if vegetables are blended so as to be incorporated in to sauces and meals. Since taste and texture of vegetables have been cited as barriers to consumption (Glasson, Chapman, & James, 2011; Krolner, Rasmussen, Brug et al., 2011) hiding them might improve intake whilst not affecting liking, so the use of well liked seasonings to alter taste, or cooking methods which alter texture, may assist in encouraging initital tasting and intake. But it is not known if this influences overall liking of vegetables.

An important aim of the current thesis was to examine the effectiveness of such strategies in promoting consumption of vegetables in young children. Before this was possible it was first necessary to establish which vegetables are commoly offered to children and how frequently. This allowed for the identification of unfamiliar vegetables as potential targets for relevant age groups. The present study sets out to investigate UK children's experience with a broad range of commonly available vegetables and goes on to explore identical data collected in two further European countries; Denmark and France. It examines which vegetables were given to children of different ages and from different countries, how often they were given, how these vegetables were prepared and how much children and their mothers liked these vegetables.

The study set out to test the following questions;

a) Does familiarity (how frequently vegetables were offered to children) predict liking?
b) Are older children more familiar with a greater number of vegetables than younger children, and does this produce greater liking?
c) Are cultural differences in vegetable liking, familiarity and preparation apparent across three EU countries?

4.2 Method

4.2.1 Participants

Mothers of children aged 6 to 36 months were recruited through local child care settings and websites aimed at mothers. Two hundred and seventy seven mothers were recruited across the three countries; UK (*n* 101), Denmark (*n* 98) and France (*n* 78). Informed consent was given as part of the questionnaire prior to inclusion in the study.

4.2.2 Procedure

Questionnaires were distributed to mothers by and returned to their child-care facilities and these were collected by researchers. Others were sent directly to mothers and returned to researchers by post. A proportion of Danish mothers completed the questionnaire by telephone interview and in the UK a sample of mothers completed an online version of the survey. Data was then downloaded directly from the host site.

4.2.3 Questionnaire

4.2.3.i Demographics

Socio-demographic information was collected within each country; for example, gender of the child, the precise age in months and maternal education.

4.2.3.ii Experience with vegetables

Participating mothers completed questionnaires with an identical format and featured a range of culturally appropriate vegetables (UK 54, Denmark 41 and France 52). Thirty six vegetables commonly eaten in all three countries were included on all versions of the questionnaire (Appendix B3). Use of Seasonings was also included.

4.3 Statistical analysis

Data were analysed using SPSS version 20.0 (SPSS Inc., Chicago, IL, USA).

Separate analyses were conducted on the UK data for all 54 vegetables included in the UK survey before comparative analyses were undertaken for the 36 vegetables common to all versions of the questionnaire.

Associations between frequency of maternal intake, how often vegetables were offered to children and mothers' reports of child's liking were evaluated using Spearman's rank order coefficient (UK data only). The same analyses were used to examine the relationship between how frequently children were offered vegetables, the number of vegetables introduced and mother's reports of child's liking on data from all three countries.

Kruskall-Wallis one way analyses of variance were used to explore main effects of nationality and age group of child on maternal and child familiarity, frequency of offering, mothers' reported child liking and frequency of maternal intake (UK only). Mann-Whitney tests were used to make pair-wise comparisons.

The same analysis was undertaken on subsets of participants that completed questions on preparation techniques and seasoning to examine main effects of nationality and age group. The most frequently occurring seasonings and preparation methods were recorded and described before analyses. These data were transformed into a percentage of the total vegetables offered for each participant.

4.4 Results

4.4.1 Sample

Two hundred and seventy seven parents completed questionnaires and of these two hundred and thirty four were completed for children of the correct ages (UK *n* 71, Denmark *n* 93 and France *n* 70). The ages of children ranged from 6 to 36 months with a mean age of 21.17 (±0.59) months and 52.6% were male and 47% female, one mother had omitted her child's gender from the questionnaire. As one of the aims of the study was to investigate age differences in dietary patterns the sample was categorised into three age groups '6-12 months' (*n* 56), '13-24 months' (*n* 101) and '25-36 months' (*n* 77). Of the two hundred and thirty four participants who completed questionnaires, 233 mothers had answered questions on preparation techniques (UK *n* 71, Denmark *n* 93 and France *n* 69) and 177 had responded to questions about seasoning (UK *n* 46, Denmark *n* 78 and France *n* 53). Participant characteristics of the total sample are shown in Table 4.1. A significant age difference was found between the UK and Danish samples with no differences found between France and the other countries.

Table 4:1: Characteristics of participating children by nationality (means ± SEM*) (adapted from Ahern, Caton et al. 2013)

	UK (*n* = 71)	Denmark (*n* = 93)	France (*n* = 70)	*p* value
Age (months)	23.74 ± 1.13 [a]	19.18 ± 0.93 [b]	21.20 ± 0.98 [ab]	0.006
Range	7-36	6-36	7-36	-
Males/Females	37/33	50/43	36/34	0.39

* Means with a different letter (a, b) are significantly different

4.4.2 UK data

Within the UK sample children were aged between 7 and 36 months with a mean age of 23.74 (±1.13) months. Approximately 52% were male and 48% female with one child's gender unspecified. Participant characteristics are shown in Table 4.2.

Table 4:2: Characteristics of participating UK children by age group (means ± SEM) (adapted from Ahern et al. 2013)

	6-12 months (*n* = 13)	13-24 months (*n* = 28)	25-36 months (*n* = 30)	*p*-value
Age (months)	9.42 ± 0.54	20.39 ± 0.68	33.07 ± 0.64	
Range	5	11	11	
Males/Females	8/5	13/15	16/13	0.66
Number of vegetables introduced	25.23 ± 2.40^{a}	30.07 ± 1.40^{ab}	32.13 ± 1.17^{b}	0.05
Frequency of offering[1]	1.99 ± 0.11^{ab}	1.98 ± 0.04^{a}	1.85 ± 0.04^{b}	0.05
Liking[2]	3.41 ± 0.13	3.27 ± 0.08	3.14 ± 0.09	0.19

* Means with a different letter (a, b) are significantly different

[1]Answers on a 4-point scale 1 = <once per month to 4 = every day or almost

[2]Answers on a 5-point scale 1 = strongly dislikes to 5 = strongly likes

4.4.2.i Maternal familiarity with vegetables

UK mothers were familiar with an average of 48 (±0.67, 90.6%) of the 54 vegetables on the UK version of the questionnaire with 14 recognised by all mothers. These were cabbage, carrots, cauliflower, cucumber, green beans, mushrooms, onions, parsnips, peas, pumpkin, red pepper, spinach, sweet corn and tomatoes. Of the seventy-one mothers who completed questionnaires only sixteen mothers were familiar with all 54 vegetables. No effects were found for age or gender of child for maternal familiarity.

4.4.2.ii Variety of vegetables offered to children

None of the children from the UK sample had been offered *all* of the 54 vegetables listed on the questionnaire. On average children had been offered 30 (±0.90, 56.7%) vegetables with a maximum of 46 and a minimum of 4 and broccoli and carrots were found to be the only 2 vegetables that had been offered to all seventy-one children. When the sample was split by age group it emerged that 100% of children aged 13-24 months had also been offered peas and all those in the 25-36 months age group had been introduced to sweet corn and sweet potato. A list of the ten most likely to be introduced vegetables (Table 4.3) reveals that there is very little variation in the types of vegetables offered to each age group.

Table 4:3: Percentage of UK children offered vegetables by age group (adapted from Ahern et al. 2013)

	6 to 12 m (*n* = 13)	13 to 24 m (*n* = 28)	25 to 36 m (*n* = 30)	Total (*n* = 71)
Carrots	100.0	100.0	100.0	100.0
Broccoli	92.3	100.0	100.0	98.6
Peas	84.6	100.0	100.0	97.2
Sweet corn	92.3	96.4	100.0	97.2
Cucumber	92.3	96.4	90.0	93.0
Tomato	84.6	92.9	96.7	93.0
Sweet Potato	92.3	85.7	100.0	93.0
Red Pepper	76.9	96.4	90.0	90.1
Green Beans	84.6	89.3	93.3	90.1
Cauliflower	84.6	92.9	86.7	88.7

A main effect of age group was observed on the number of vegetables introduced, [F (2, 64) = 4.87, p=0.01]. Children in the 25-36 month age group were familiar with significantly more vegetables than those aged 6-12 months (p<.01) and no significant difference was found between the two older age groups. There were no significant gender effects on the number of vegetables introduced to children.

Table 4:4: 15 vegetables most frequently eaten by UK mothers and most frequently offered to UK children (descending order)

	Mothers' intake	Offered to children
1.	Onions	Carrots
2.	Tomato	Tomato
3.	Green Salad	Onions
4.	Carrots	Dried Legumes
5.	Broccoli	Peas
6.	Cucumber	Cucumber
7.	Peas	Broccoli
8.	Red Pepper	Sweet corn
9.	Mushroom	Red Pepper
10.	Sweet corn	Green Salad
11.	Green Pepper	Cauliflower
12.	Yellow/Orange Pepper	Mushroom
13.	Cauliflower	Yellow/Orange Pepper
14.	Green Beans	Green Pepper
15.	Spinach	Green Beans

4.4.2.iii Frequency of offering of vegetables

Kruskall-Wallis one way analyses of variance revealed a significant effect of age group [$\chi^2(2, n = 71) = 6.04$, p=0.05] on the frequency with which vegetables are offered to children. Follow-up tests were conducted to evaluate pairwise differences among the three groups, the results of which indicated a significant difference between the 13-24 month group and the 25 to 36 month group ($p<.05$). The same analyses were repeated with gender as a factor and no significant effect was found.

Correlational analyses revealed a significant positive association between the frequency with which vegetables were offered to a child and the frequency with which they are consumed by the mother [r (71) = .56, $p<.001$]. In fact but one of the 20 vegetables that were most frequently offered to children were also most frequently consumed by mothers (Table 4.4).

4.4.2.iv Maternal reported child liking for vegetables

Children's liking was found to be significantly and positively associated with the frequency with which children were offered vegetables, [r (71)=0.25, $p<.05$]. In addition a child's liking for a vegetable was also found to be positively associated with the frequency of maternal consumption of that vegetable ($p<.05$). No effects of age or gender on maternal reported children's liking for vegetables were found.

4.4.2.v Preparing vegetables for children

In the UK mothers reported both boiling and steaming vegetables or offering them raw (Table 4.5). Mothers described using small amounts of seasoning but prepared 13.3 % of vegetables for their children unseasoned. The seasonings most commonly used were pepper (19.8%), olive oil (16.6%), salt (15.7%) and butter (13.1%).

Age group determined preparation with raw vegetables [χ^2 (2, 71)= 8.39, p=0.02] being more often given to 25-36m age group than younger children and pureed or mashed more often given to younger children [χ^2 (2, 71)= 9.80, p=0.01].

Table 4:5: Most commonly employed preparation techniques of UK mothers by age group (mean percentage of vegetables offered prepared using each method ± SEM) (adapted from Ahern et al. 2013)

	6 to 12 months (*n* = 13)	13 to 24 months (*n* = 28)	25 to 36 months (*n* = 30)	*p* value
Raw	14.9 ± 2.5^{a}	19.9 ± 1.7^{ab}	22.1 ± 1.7^{b}	0.02
Boiled	15.1 ± 4.7	20.8 ± 3.1	28.4 ± 3.1	0.12
Steamed	22.8 ± 4.3	23.3 ± 2.8	18.6 ± 2.8	0.43
Pureed/Mashed	29.0 ± 3.7^{a}	4.3 ± 2.4^{b}	3.2 ± 2.4^{b}	0.01
In a sauce	12.6 ± 3.5	18.4 ± 2.3	12.4 ± 2.3	0.40

4.4.3 Cultural comparisons

4.4.3.i Maternal familiarity with vegetables

On average mothers were familiar with 33 of the 36 vegetables with one mother knowing only five (Figure 4.1). Only 49 mothers were familiar with all 36 vegetables

Nationality influenced the number of vegetables offered to children [χ^2 (2, 234) = 19.34, p=0.001] UK mothers reported familiarity with a greater number of vegetables than French and Danish mothers within the survey. The mean number of vegetables recognised by mothers was similar in each of the three countries, however, with a difference of less than 2 vegetables between UK and Danish mothers (1.8 ±0.63). There were no significant effects of age group of child on the number of vegetables known to mothers.

4.4.3.ii Variety of vegetables offered to children

Overall children had been offered an average of 17 of the 36 vegetables that were common to all questionnaires (range of 2 – 34; see Figure 4.1). None of the mothers had offered all 36 of the vegetables to their child.

Main effects were found for nationality [χ^2 (2, 234) = 23.02, p=0.001] and age group, [χ^2 (2, 234) = 48.26, p=0.001] for the number of vegetables introduced to children. Danish and UK mothers had introduced a significantly greater number of vegetables than those in France (p=0.001). Overall, children in the 6-12 month age group from all three countries had been offered significantly fewer vegetables than both older age groups (p=0.001), this then increased at age 13-24 months and 25-36 months (p<0.05).

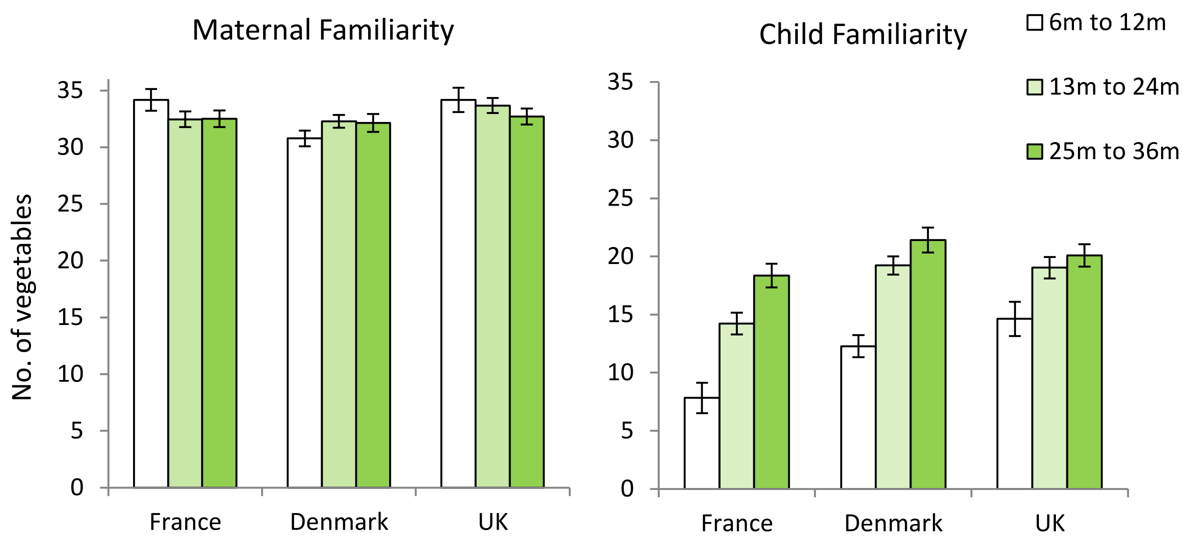

Figure 4:1: Comparisons of number of vegetables known to mothers and number of vegetables introduced to children for each age group by nationality (±SEM) (adapted from Ahern et al. 2013)

4.4.3.iii Frequency of offering of vegetables

Main effects of nationality [χ^2 (2, 233)= 58.25, p<0.01], and age group [χ^2 (2, 233)= 31.88, p<0.001], were observed for frequency. Danish mothers offered vegetables more frequently than those in the UK and France [U=1867.00, Z= -4.76, p<0.01; U=1103.00, Z = -7.13, p<0.001] while UK mothers offered vegetables more frequently than French mothers [U=1622.50, Z= -3.45, p=0.001]. Overall children in the 6-12 month age group were offered vegetables significantly more frequently than both groups of older children. Mean frequency of offering was significantly negatively correlated with age of the child [*r* (234)= -0.29, p<0.001], thus mothers offered vegetables less as children got older. Further correlational analysis revealed a significant negative relationship between the mean frequency with which vegetables were offered and the number of vegetables that had been introduced, [*r* (233)= -0.20, p=0.001].

4.4.3.iv Maternal reported child liking for vegetables

A main effect of age group was found on children's liking for vegetables [χ^2 (2, 234)= 35.32, p=0.001]. Children in aged 6 to 12 months had significantly higher liking scores than children aged 25 to 36 month [U=940.00, Z= -5.54, p=0.001]. Liking scores were negatively associated with the age of the child, [*r* (234)=-0.38, p=0.001], suggesting that children's liking for vegetables reduces with age. In addition liking was negatively related to the number of vegetables that had been introduced [*r* (234)=-0.20, p<0.01]. When individual liking scores were examined it was found that a large proportion of those vegetables that were most liked were also those most frequently offered. Further correlational analysis confirmed a significant positive relationship between a child's liking for a vegetable and the frequency with which it is offered to them [*r* (234)=0.19, p<0.01].

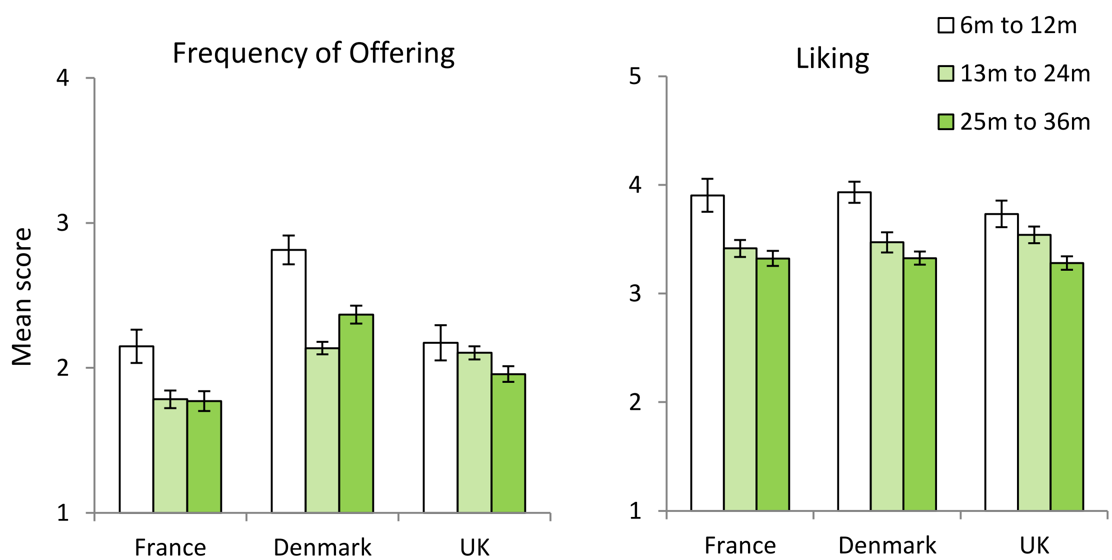

Figure 4:2 Comparisons of mean frequency of vegetable offering and mean maternal reported liking scores for each age group by nationality (± SEM) (adapted from Ahern et al. 2013)

4.4.3.v Preparing vegetables for children

Commonly used preparation methods varied between countries and these differences remained even when age was controlled for. French mothers tended to puree or mash vegetables with steaming and stewing also commonly used. Danish mothers were most likely to boil vegetables or offer them to children in raw form. UK mothers were also more likely to boil vegetables, but also steamed them or offered them raw (Table 4.6). Analysis revealed a main effect of nationality on percentage of vegetables offered using all listed preparation techniques (Table 4.6). Danish mothers offered more vegetables raw and boiled than the other nationalities [U=1372.50, Z= -6.22, p=0.001; U=1521.00, Z = -5.91, p=0.001]. French mothers steamed a higher percentage of vegetables than those in the UK and Denmark [U=11687.50, Z= -3.18, p=0.001; U=1220.50, Z = -6.91, p=0.001] with UK mothers steaming more vegetables than the Danish [U=1832.50, Z= -5.03, p=0.001]. French mothers also prepared more vegetables by stewing [χ^2 (2, 234) = 35.32, p=0.001], and pureeing or mashing [χ^2 (2, 234)= 35.32, p=0.001]. Responses to the open ended questions showed that Danish mothers had reported offering a higher percentage of vegetables fried or stir fried than French mothers and this was also found to be higher than in the UK (Denmark 10.90 ± 2.66; UK 4.53 ± 0.77; France 0.41 ± 0.26). Danish and French mothers were also more likely to report offering vegetables in a soup (Denmark 12.49 ± 2.24; France 5.47 ± 1.66; UK 0.40 ± 0.40). Many Danish mothers offered a high percentage of vegetables in composite meals (13.48 ± 2.37) and mixed with other vegetables (10.82 ± 2.70). These methods were less frequently reported by French and UK mothers (France 0.59 ± 0.24, 5.06 ± 2.04; UK 0.40 ± 0.40, p<0.001).

As with the UK data choice of preparation technique was also affected by the age of the child. Children in the youngest age group were less likely to be offered raw vegetables than older children, [χ^2 (2, 233)= 17.99, p=0.001], but were offered more vegetables that were pureed or mashed, [χ^2 (2, 233)= 18.24, p=0.001]. The 6-12 month age group were also offered fewer vegetables steamed and stewed than those in both other groups [χ^2 (2, 233)= 11.19, p=0.001; χ^2 (2, 234)= 15.45, p=0.001]. Responses to the open-ended questions revealed that mothers of children aged 25-36 months were more likely to fry or stir fry vegetables for their children than mothers with 6-12 month old children, [U=1107.50, Z= -2.69, p=0.001].

Table 4:6: Most commonly employed preparation techniques and seasonings of mothers by nationality (mean percentage of vegetables offered prepared using each method and seasoning ± SEM*)

	France (*n* = 69)	Denmark (*n* = 93)	UK (*n* = 71)	*p* value
Raw	16.9 ± 1.8[a]	33.2 ± 1.6[b]	19.9 ± 1.1[c]	0.00
Boiled	14.2 ± 2.6[a]	48.5 ± 2.5[b]	22.9 ± 2.0[c]	0.00
Steamed	36.5 ± 3.3[a]	9.8 ± 1.5[b]	21.8 ± 1.9[c]	0.00
Stewed	26.6 ± 2.5[a]	6.1 ± 1.1[b]	2.6 ± 0.8[c]	0.00
Pureed/Mashed	42.4 ± 3.8[a]	11.6 ± 2.3[b]	7.8 ± 1.9[b]	0.00
	France (*n* = 53)	Denmark (*n* = 78)	UK (*n* = 45)	*p* value
Unseasoned	11.3 ± 3.2[a]	3.6 ± 1.1[b]	13.3 ± 4.4[a]	0.009
Vinaigrette	9.6 ± 2.0[a]	0.6 ± 0.2[b]	3.7 ± 1.7[b]	0.00
Olive Oil	12.5 ± 2.2[a]	5.5 ± 1.7[b]	16.2 ± 6.0[c]	0.00
Garlic	2.8 ± 0.8	3.5 ± 1.1	4.7 ± 1.8	0.54
Salt	38.6 ± 5.1[a]	13.2 ± 2.6[b]	15.3 ± 4.4[b]	0.00
Pepper	6.8 ± 2.6[a]	5.1 ± 1.6[a]	19.4 ± 5.0[b]	0.01
Butter	21.0 ± 3.5[a]	2.6 ± 0.8[b]	12.8 ± 3.1[c]	0.00
Mixed with other vegetables	5.1 ± 2.0[a]	10.8 ± 2.7[a]	0.0 ± 0.0[b]	0.00

* Means with a different letter (a, b, c) are significantly different

Danish mothers offered fewer unseasoned vegetables to their children than French and UK mothers, [χ^2 (2, 177) = 9.37, p<0.01]. Seasonings commonly used were salt, pepper, butter, olive oil, garlic and vinaigrette or dressing. Mixing with other vegetables was also commonly reported. Choice of seasoning was affected by both nationality (Table 4.6) and age. Children aged 6-12 months were less likely to be offered vegetables seasoned with salt than older children (13-24m, U=1035.00, Z= -3.28, p=0.001; 25-36m, U=713.00, Z= -3.33, p=0.001). This youngest group were also offered fewer vegetables with butter than

13-24 month old children (U=1067.00, Z= -3.25, p=0.001), and those aged 25-36 months (U=745.00, Z= -3.21, p=0.001).

4.5 Discussion

The aim of the current study was to explore children's experience with vegetables in the first three years of life with a view to identifying relationships between children's familiarity with vegetables and vegetable liking. Overall, older children were introduced to a greater number of vegetables while the youngest age group consumed vegetables more frequently and had higher reported liking. Liking for vegetables was related to how often they were offered and, in the UK, how often they were consumed by the mother. Although children's experience with vegetables differed between countries, levels of liking were similar.

UK infants were familiar with a relatively small number of vegetables and the majority of mothers offered a very standard selection; carrots, broccoli, peas and sweet corn. The type and number of vegetables introduced to children in their early years appears to be very similar across these three countries within Europe and while this develops and increases with the age of the child, the number of vegetables that are regularly offered remains limited. Those vegetables that are offered to children tend to be ones that mothers perceive to be well liked and for UK and Danish children liking was significantly related to how often a vegetable was offered. A relationship between children's preferences for vegetables and how often those vegetables are served is consistent with existing research demonstrating the success of repeated exposure in promoting children's liking for vegetables (Anzman-Frasca et al., 2012; Howard, Mallan, Byrne, Magarey, & Daniels, 2012; Lakkakula et al., 2010). However, it is important to interpret this finding cautiously as it may instead be indicative of mothers opting to serve vegetables they are confident will be consumed. Mothers' perceptions of a child's liking for a vegetable is an important factor in how often it is offered (Carruth, Ziegler, Gordon, & Hendricks, 2004). In addition mothers are more likely to offer vegetables that are liked by their children, reducing the probability of rejection (Cooke & Wardle, 2005).

As previously discussed, maternal dietary choices will influence in utero exposure to flavour, will serve as a role model and will determine what is offered within the context of a family diet (Beauchamp & Mennella, 2009; Forestell & Mennella, 2007; Hausner et al., 2010; Maier, Chabanet, et al., 2008; Mennella et al., 2001). Therefore, mothers might be a better target of healthy eating interventions than children and influencing maternal dietary choice will affect infant dietary choice both directly (via exposure) and indirectly (via modelling). Inverse relationships were found for liking and frequency of offering and liking and age. Given that the neophobic response to food is at its height between two and six years (Birch et al., 1987; Dovey et al., 2008) a decline in perceived liking for vegetables among children in this age group is expected. As food neophobia sets in, instances of food refusal increase, including familiar and previously liked foods as well as those which are new to the child (Carruth, Skinner, Houck et al., 1998). In view of this mothers will offer vegetables less frequently in response to consistent rejection, believing vegetables to be disliked. That mothers are inclined to stop offering foods which are disliked may be counterproductive. Evidence has suggested that the neophobic response to food can be modified through experience (Loewen & Pliner, 1999) and more specifically that repeated exposure can reduce rejection (Birch et al., 1987). Interestingly liking for those vegetables that were most frequently offered was found to persist amongst children in all three age groups and countries adding further support to the idea that repeated exposure promotes liking and intake of vegetables, even amongst neophobic children. This interpretation, however, rests on the assumption that frequency of offering equates to frequency of consumption. The survey used in this study did not measure how often a vegetable was eaten by children but it is reasonable to assume that each 'offering' would involve some degree of taste exposure. Nonetheless, mothers were not asked to report on the amounts of vegetables eaten by their child nor how often vegetables were rejected and so the extent to which offering equates to intake remains unclear. In addition, the inverse relationship identified between the numbers of vegetables offered and frequency of offering may provide an alternative explanation for this pattern of results. As a child gets older mothers introduce a wider variety of vegetables and it follows that each vegetable will be offered less frequently to accommodate each new vegetable that is introduced, if it is accepted that vegetable intake is relatively stable part of the diet. Mothers of younger children, who are offered a smaller number of vegetables, are likely to offer them more frequently.

The inverse relationship between a child's liking for vegetables and the number of vegetables introduced is also an interesting finding. Offering children variety early on can benefit later eating behaviours by increasing variety seeking (Nicklaus, Boggio, et al., 2005a). In addition early experience with a variety of vegetables can improve acceptance of novel vegetables and increase subsequent intake (Krolner et al., 2011; Maier, Chabanet, et al., 2008; Mennella et al., 2008). The results of this study suggest that variety may have a negative effect on liking and that this effect is particularly pertinent for children aged six to twelve months. Again this finding should be interpreted with care. Measures of liking in this study related to mothers' perceptions of how much their child enjoys each individual vegetable and not how much they like vegetables generally. It is possible that a child's liking for individual vegetables may change with the introduction of variety. However, a child who consumes a wide array of vegetables could be said to have a greater overall liking for them.

Cultural variation in vegetable introduction and offering is consistent with existing evidence that children's vegetable intake differs significantly between European countries (Yngve et al., 2005). Danish children had been introduced to the greatest number of vegetables and were offered them most frequently. This reflects a higher national recommendation for daily fruit and vegetable intake. Liking for vegetables did not differ between the three countries and while frequency of offering was related to liking in UK and Danish children, this was not the case for the French sample. While this data offers insight into children's earliest experiences with vegetables, this cannot be linked to intake patterns.

As hypothesised, cultural differences were also identified in the techniques mothers used when preparing vegetables for their children. Weaning is strongly influenced by cultural traditions (Brownlee, 1990; Negayama, Norimatsu, Barratt, & Bouville, 2012). As children develop and move onto table foods they are introduced to traditional dishes and foods consistent with the cultural and familial diet. Thus preparation methods chosen by mothers and the frequency with which they are used will differ by country. Mothers use sauces and incorporate vegetables into soups and composite meals to optimise acceptance (Chapter 3), this was most apparent within the Danish sample. Preparation methods were also related to child age in accordance with their ability to consume these foods. A limitation of the study is that it does not address the extent to which vegetable type influences preparation methods. That is to say that certain vegetables can be offered raw while others need to be cooked, so mothers' choices of vegetables can determine preparation method. However, a large proportion of the most offered vegetables were the same across all three countries. It is likely that preparation methods are a result of vegetable type, cultural traditions and age of the child.

Seasonings were similar across countries to enhance flavours and increase palatability (Nicklaus, 2011; Schwartz, Chabanet, Lange, Issanchou, & Nicklaus, 2011). Whilst this may be effective in improving children's vegetable intake (Beauchamp, Cowart, Mennella, & Marsh, 1994; Schwartz et al., 2009) perhaps by conditioning flavour preferences (Havermans & Jansen, 2007; Johnson, McPhee, & Birch, 1991), this also means that children become accustomed to eating seasoned vegetables. For example, adding salt and butter on children's food intake was examined by Bouhlal, Issanchou, and Nicklaus (2010) who found increased green bean intake with the level of salt, and no effect of adding butter. But removing or reducing salt from green beans reduced intake compared to a moderate level of salt (Bouhlal, Chabanet, Issanchou, & Nicklaus, 2013). If children are exposed to salted foods, their preference is for that pairing and so foods paired with salt will be rejected or intake reduced when not salted. The effectiveness of such pairings is therefore dependent of children's previous experiences with these foods and flavours as they can become valued or devalued as a result of pre-exposure (Blair, Blundell, Galtress, Hall, & Killcross, 2003; Blair & Hall, 2003).

While adding salt promotes children's vegetable intake, it conflicts with current recommendations to reduce salt consumption. Within the UK guidelines (Food Standards

Agency), for instance, distinctions are made between daily recommendations for children under twelve months (up to one gram) and those aged between one and three years (up to two grams) and these appear to be reflected in the UK results. Nevertheless, reluctance to season might reduce the infant's willingness to accept new foods and pairing with salt might reduce the infant's willingness to consume unsalted foods. Systematic studies on alternatives to salt are necessary to improve the flavour of vegetables in line with government guidelines to reduce salt intake.

The youngest age group received most vegetables unseasoned or simply mixed with other vegetables. Zeinstra et al. (2009) have suggested that pure vegetable flavours are too intense for young children, who are likely to find them aversive. The results of the current study suggest this might not be the case. While the youngest children were most likely to receive pure vegetable flavours they were also reported to have greatest liking for vegetables and were offered vegetables most often. This finding confirms the observation that infants of this age are generally more willing to try new foods and flavours (Northstone, Emmett, Nethersole, & team, 2001) prior to entering the neophobic stage.

Consistent with the literature, findings suggest low vegetable intake amongst European children. Mothers tend to offer a narrow selection of vegetables and few are offered regularly. Children's experience with vegetables during the first three years of life seems limited and results suggest that some may not be reaching national recommendations for intake. However, as children's experience with fruit was not explored it is possible that low vegetable consumption may be offset by higher levels of fruit intake. In addition frequency of offering rather than consumption was measured and so conclusions around levels of vegetable intake for the three countries cannot be made. By collecting information relating to intake, such as rates of acceptance and rejection, future studies could offer a more complete account of vegetable consumption in these countries.

4.5.1 Questions

Children's liking of vegetables was related to how frequently they were offered suggesting that repeated exposure plays an important role in encouraging vegetable intake in young children. The extent to which this relationship reflects the success of repeated exposure is unclear as it may also point to mothers' inclination towards offering well liked vegetables. The use of simple repeated exposure appears to be quite widespread amongst mothers of children aged six to twelve months and seems effective with liking for vegetables high in this age group. However, questions are raised as to whether it is a sufficient strategy for older children. Children's acceptance of vegetables is dependent on their appearance, taste and texture and these properties are all influenced by the way in which vegetables are prepared. Methods of preparation appear to be chosen on the basis of being age appropriate with mothers of older children more likely to add things like butter and salt. Of interest is whether seasoning vegetables in this way offers any additional advantage in promoting vegetable consumption beyond repeated taste exposure. The following questions will therefore be addressed in the next chapter:

1. Is repeated exposure sufficient as a strategy to increase vegetable liking and intake in preschool children?
2. Is flavour nutrient conditioning, by pairing vegetables with fat, an effective technique for increasing liking and intake?
3. Is flavour flavour conditioning, by pairing vegetables with an already liked flavour, an effective technique for increasing liking and intake?
4. How do these strategies compare?

Chapter 5 Repeated exposure promotes vegetable intake in preschool children: a comparison of learning

Abstract

Despite parents' efforts to encourage their children to eat vegetables, liking and intake remain low. Familiarity is an important factor in preference development but vegetables are unlikely to be offered to children in an unadulterated form. Pairing vegetables with additional energy (FNL) or an already liked flavour (FFL) could be effective methods for promoting vegetable intake in preschool children and are techniques already employed by mothers. The present study set out to examine the relative effectiveness of these strategies when compared to a simple repeated exposure (RE) method. Children aged 9 to 38m (*n* 72) were assigned to one of three conditions (RE, FFL or FNL) and offered ten exposures to their respective version of a novel vegetable puree (artichoke). Pre and post-intervention intake measures of a plain version and a familiar control (carrot) were taken to assess change in intake. Baseline carrot intake was significantly higher than artichoke and intake of both vegetables had significantly increased post-intervention. Analyses revealed that change in intake was significantly greater for artichoke than carrot. Artichoke intake increased to a similar extent in all three conditions and a significant increase was observed by the fifth exposure. Intake remained higher than baseline 5 weeks post-intervention suggesting the effects of all three learning strategies remained stable over this period. Results suggest that repeated exposure to a novel vegetable is sufficient to increase intake of this vegetable, regardless of preparation method.

The author was responsible for the recruitment of the nurseries and children that participated in the study as well as the collection of data and assisted in each stage of the analysis.

5.1 Introduction

Children exhibit low levels of liking for vegetables, particularly for those infrequently offered (Chapter 4). The relationship between children's liking for a vegetable and how often it is given, suggests repeated exposure may play an important role in developing and maintaining preferences for vegetables. Repeated offering is a method mothers already use in order to promote intake (Chapter 3), however, the preparation techniques employed by mothers mean that vegetables are not always offered in their pure form. Vegetables are commonly prepared using seasonings and condiments (Chapter 4) which may enhance flavour or provide additional energy. Given that mothers are keen to maximise children's intake (Chapter 3), it is crucial that their approaches to vegetable introduction facilitate acceptance and consumption. Establishing the effectiveness of these methods experimentally will therefore assist in offering parents guidance in how best to tackle children's dislike for vegetables.

Familiarity is an important factor in determining children's acceptance and rejection of foods (Cooke, Haworth, & Wardle, 2007). While parents and caregivers are chiefly responsible for what foods children are offered (Birch & Davison, 2001; Patrick et al., 2005; Savage et al., 2007), it is children's responses to those foods that dictate whether or not they are consumed. Zajonc (1968) demonstrated that individuals exhibit preferences for stimuli with which they are familiar and that familiarity can be reached through repeated exposure. This mere exposure effect is achieved when experiences with a stimulus occur in the absence of negative affect which could potentially hinder preference development by inducing negative associations (Zajonc et al., 1974). In terms of food preference development exposure facilitates 'learned safety' (Rozin & Kalat, 1971). Again contingent on a lack of a negative outcome, experiences with new foods help children to trust that they are safe to consume. Thus, familiarity with a food, or other similar foods, allow children to apply previous knowledge in their appraisal of its appearance and taste and ultimately form judgments regarding its suitability to eat. In addition, children's liking for vegetables has been shown to be related to the frequency with which they are offered and children display clear preferences for those vegetables to which they are frequently exposed (Chapter 4). To date repeated exposure interventions have proven highly successful in increasing children's acceptance of new foods including a number of studies which have demonstrated significant improvements in both liking and consumption of vegetables (Birch, McPhee, et al., 1987; Forestell & Mennella, 2007; Lakkakula et al., 2010; Loewen & Pliner, 1999; Noradilah & Zahara, 2012; Wardle, Cooke, et al., 2003; Wardle, Herrera, et al., 2003).

Associative conditioning can also play an important role in the development of food preferences (Brunstrom, 2005), allowing children to learn about the properties of different foods and shaping choices regarding what foods to consume. Much of the research into associative conditioning has focussed on flavour-nutrient learning (FNL) where associations are formed between the flavour of a food and its post-ingestive consequences. Ingestion of foods that lead to positive outcomes, such as feeling satiated, result in an increase in the hedonic value of those foods and acceptance of those flavours. A large proportion of the evidence of FNL comes from animal research (Chapter 1) and studies examining its effectiveness in humans have shown varying levels of success (Brunstrom, 2005). This is demonstrated by Zeinstra and colleagues (2009) who failed to increase children's liking for vegetable flavours using FNL. In their experiment primary school children (mean age 7.5 years) were given seven conditioning trials to a vegetable juice paired with maltodextrin for added energy and a further seven to a plain, low energy vegetable juice. Interestingly, Zeinstra suggests that low intake throughout the experiment meant children did not consume enough of the vegetable flavours for learning to take place and this is explained by children's inherent aversion to intense vegetable flavours. However, during their intervention children were also offered water and small pieces of gingerbread, which may have competed with the vegetable juices and offer an alternative explanation for such low consumption. Moreover the children rated the taste of the vegetable juice in this experiment as very intense, therefore, the intensity o the pure form of a vegetable juice may be both unfamiliar and unappetising.

In addition to forming associations between foods and their post-ingestive consequences, preferences can also be conditioned via flavour-flavour learning (FFL). Associations are produced by pairing an unfamiliar food or flavour with another, already liked flavour resulting in a positive shift in liking for the previously novel food. Again much of the evidence for FFL comes from animal research and findings have varied, however, FFL has been successfully demonstrated in both adult and child participants (Brunstrom & Fletcher, 2008; Havermans & Jansen, 2007; Mobini et al., 2007). Most notably, Havermans and Jansen (2007) succesfully increased children's liking for vegetable flavours that were repeatedly paired with dextrose, when compared with those that had been offered unsweetened. Associative conditioning may also offer an advantage to repeated exposure in that associations can be formed quickly (Ackroff et al., 2009). While between eight and fifteen exposures may be necessary to significantly enhance preference for a target food (Birch & Marlin, 1982; Birch et al., 1987; Sullivan & Birch, 1990), Havermans and Jansen (2007) were able to increase liking after just six conditioning trials.

There is growing evidence that repeated exposure offers an effective strategy for promoting vegetable intake in young children, however, associative conditioning may facilitate preference development by reducing the number of times that a vegetable must be offered. To date few studies have examined the effectiveness of associative conditioning in improving vegetable consumption. Thus the current study aimed to establish the relative effectiveness of all three techniques in increasing intake of a novel vegetable in preschool children; RE, FNL and FFL.

5.2 Method

5.2.1 Participants

Parents of children aged 9 to 38 m were invited to participate in the study. In total 108 children were recruited through five nurseries and pre-schools in the West and South Yorkshire areas (Bradford, Leeds, Wakefield and Barnsley). Using a question on parental consent forms participants were screened for food allergies. The study was approved by the Institute of Psychological Sciences (University of Leeds) ethics committee (10 189-02).

5.2.2 Study foods

Using the results of the vegetable survey conducted in Chapter 4, artichoke was identified as a suitable target vegetable as it was unfamiliar to the majority of UK pre-school children. Only 17% of that sample of children had ever been introduced to artichoke and those that had tended not to be offered it more than once per month. Additionally artichoke puree is not widely available in the UK as commercially prepared baby food. Carrot was selected as a suitable control vegetable as it was familiar to almost 100% of pre-school children, frequently offered and well liked.

5.2.3 Procedure

A summary of the study procedure can be seen in Figure 5.1. Children were randomly assigned to one of the three conditions; repeated exposure (RE), flavour flavour learning (FFL) and flavour nutrient learning (FNL). Prior to the intervention baseline measures of intake were taken of the RE version of the artichoke puree and a carrot puree. On one day children were offered 100g of artichoke at their usual snack time and asked to consume as much or as little as they wanted. If they finished all of the first pot they were offered a second 100g portion. On a separate day this was repeated using 130g portions of the carrot puree. Purees were offered to the children by nursery staff or experimenters. Where children needed assistance with feeding, they were fed by a familiar member of nursery staff. Nursery staff had been instructed to approach feeding the children in their usual manner, only using methods of encouragements they would normally employ. Staff were reminded not to pressure children into consuming the purees and to allow children as much time as they needed to consume the snacks.

The conditioning phase of the intervention started 2 to 5 days after baseline. Children were given 10 exposures, 2 to 3 per week, to the relevant variant of artichoke puree; RE, FFL or FNL. No exposures were given to the carrot puree. Children’s intake was measured after each exposure. Post-intervention intake measures of the RE version of the artichoke puree and the carrot puree were taken on two separate days 2 to 5 days after the end of the conditioning phase. Further intake measures were taken 3, 4 and 5 weeks post-intervention.

Week	1			2		3		4		5		6			7			10	11	12	
Day	1	2	2-5 days	3	4	5	6	7	8	9	10	11	12	2-5 days	13	14	2 weeks	15	16	17	18
Condition	Pre-test			Conditioning Phase											Post-test			Follow Up			
				1	2	3	4	5	6	7	8	9	10					3w	4w	5w	
RE (n=34)	RE Artichoke	Carrot		RE	RE	RE	RE	RE	RE	RE	RE	RE	RE		RE Artichoke	Carrot		RE Artichoke	RE Artichoke	RE Artichoke	Carrot
FFL (n=30)				FFL	FFL	FFL	FFL	FFL	FFL	FFL	FFL	FFL	FFL								
FNL (n=30)				FNL	FNL	FNL	FNL	FNL	FNL	FNL	FNL	FNL	FNL								

Figure 5:1 Summary of study procedure. RE, repeated exposure; FFL, flavour flavour learning; FNL, flavour nutrient learning

5.2.4 Questionnaires

Questionnaires were distributed to parents of participating children through their nurseries. These included a number of demographic questions, questions regarding infant feeding practices, a parental Food Frequency Questionnaire (FFQ) and a parental measure of food neophobia (Food Neophobia Scale (FNS)). A child FFQ and the Child Food Neophobia Scale (CFNS) were also included along with a measure of child temperament (EAS), the Child Feeding Questionnaire (CFQ), the Caregivers Feeding Style Questionnaire (CFSQ) and the Child Eating Behaviour Questionnaire (CEBQ).

5.2.5 Anthropometric measures

Where parental consent had been granted participating children had their heights and weights measured. Measurements were taken by trained researchers using Seca digital scales and a Leicester SMSSE portable stadiometer. BMI z-scores were calculated using the WHO anthropometric calculator (http://www.who.int/childgrowth/software/en/).

5.3 Statistical analysis

Data were analyzed using SPSS version 20.0 (SPSS Inc., Chicago, IL, USA). All children who completed the intervention were included in the analyses.

Repeated measures ANOVA were performed on intake data, both absolute and change in intake, with vegetable (artichoke; carrot) and time (pre-intervention, post-intervention and 5 weeks post-intervention) as within-subject factors. Condition (RE; FFL; FNL) and age group (≤24 m and ≥25 m) were included as between-subjects factors. In an attempt to control for the difference in carrot and artichoke intake at baseline ANCOVA was conducted with the same factors and baseline carrot intake as the covariate. To examine changes in intake across the conditioning period further ANCOVA were conducted with exposures as with-in subject factor and condition and age group as between-subjects factors. Change in carrot intake from pre to post-intervention was included as the covariate. Pearson's correlation was used to investigate relationships between intake pre and post-intervention in the three conditions and both vegetables.

To examine the effect of condition assignment on post-intervention intake, ANOVA was carried out with time (exposure 10; post-intervention) as within-subject factor and condition as the between-subject factor. Sphericity was not assumed and so the Greenhaus–Geisser correction was applied. Further ANOVA and Pearson's correlational analyses were used to examine individual differences.

5.4 Results

Of the 108 children recruited, 3 were excluded due to food allergies and 11 were outside of the specified age range. Ninety-four children took part in the study with 72 children completing the full intervention having been present for all 10 exposures and all pre and post measurements (Table 5.1).

Table 5:1: Characteristics of participating children by condition (means ± SEM)

	Condition			
	RE (*n* = 22)	FFL (*n* = 25)	FNL (*n* = 25)	*p* value
Age (m)	23.55 ± 1.49	23.44 ± 1.17	23.75 ± 1.81	0.99
Age Range	10-35	11-38	9-35	-
Males/Females	10/12	13/12	9/16	0.94
	(*n* = 15)	(*n* = 17)	(*n* = 15)	
BMI z-score	1.08 ± 0.20	1.17 ± 0.16	1.15 ± 0.21	0.52

RE, repeated exposure; FFL, flavour flavour learning; FNL, flavour nutrient learning

5.4.1 Intake pre and post intervention

Overall, baseline intake of carrot was significantly higher than artichoke (p=0.05): Artichoke 38.7±6.5g; Carrot was 64.2±9.8g. Baseline intake of neither vegetable differed by condition (p=0.6): Artichoke: RE 25.4±6.3g; FFL 53.0±14.5g; FNL 37.1±10.8g Carrot: RE 69.2±18.2g; FFL 72.2±15.3g; FNL 54.2±15.4g. A significant main effect of time was found on intake with a significant increase from pre to post intervention for both vegetable purees [F (1, 66) =52.1, p<0.001] (Figure 5.2).

5.4.2 Changes in intake

When changes in intake were calculated artichoke increased significantly more than carrot [69.0±8.7g vs. 29.0±7.2g; F (1, 66) =30.3, p<0.001). No main effect of condition was found nor a vegetable x condition interaction change in intake suggesting that all three methods were equally effective in increasing children's vegetable intake (Figure 5.3). Due to elevated levels of pre-intervention carrot intake, this measure was included as a covariate. The main effect of vegetable persisted [F (1, 65) =10.0, p<0.01) with magnitude of change greater for artichoke than for carrot (p<0.001). A significant interaction was identified between vegetable and baseline carrot intake [F (5.6, 371.4) =10.3, p<0.05) although no main effect of baseline carrot intake was found. No effect of condition revealed that increase in intake was greater for artichoke even when baseline carrot intake was controlled for.

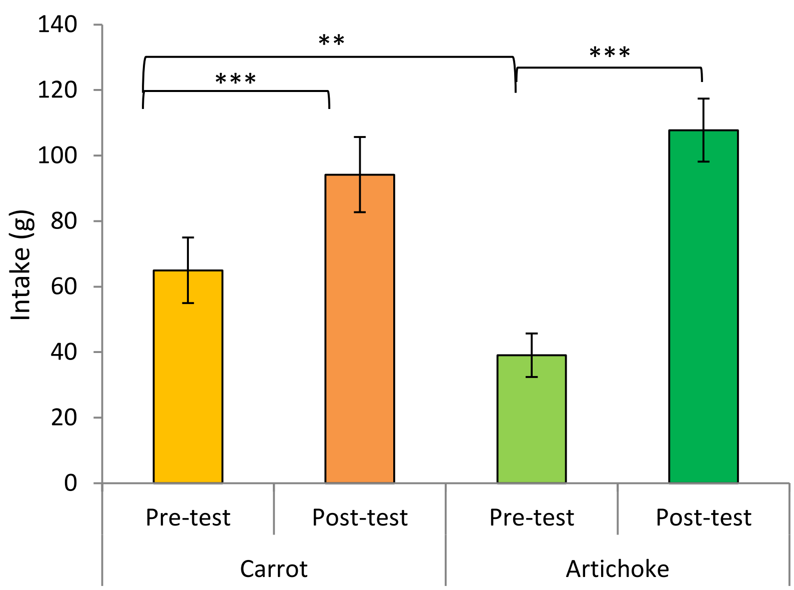

Figure 5:2: Mean intake pre and post-intervention by vegetable (± SEM, n=72) (adapted from Caton et al. 2012)

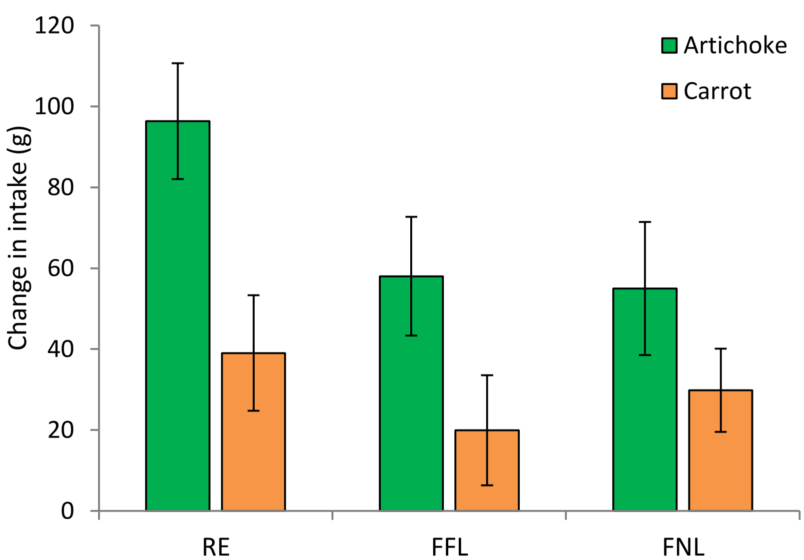

Figure 5:3 Mean change in intake by vegetable and condition (± SEM, n=72) (adapted from Caton et al. 2012)

5.4.3 Intake across exposures

In order to establish the number of exposures needed to effectively increase consumption, intake at each exposure was analysed. A significant main effect of the number of exposures was observed [F (5.6, 371.4) =10.3, p<0.001] with a significant increase in intake achieved by exposure 5 (p<0.01). Intake across exposures 6 to 10 remained significantly higher than at first exposure with no further significant increase found after exposure 5 (p=1.0). No effect of condition was found.

When change in carrot intake was included in the model as a covariate it was found to have a significant main effect [F (1, 65) =7.0, p=0.01]. In addition a significant interaction between exposures and change in carrot intake was observed [F (5.6, 363.9) =2.4, p<0.05], demonstrating that artichoke intake across the exposure period was related to change in carrot intake. The main effect of exposures remained [F (5.6, 363.9) =7.5, p<0.001] and still no effect of condition on intake across exposures was found: RE 65·3± 7·4g; FFL 60·9±6·9g; FNL 52·2± 6·9g. Changes in artichoke and carrot intake were found to be positively associated [r (70) =0.42, p<0.001].

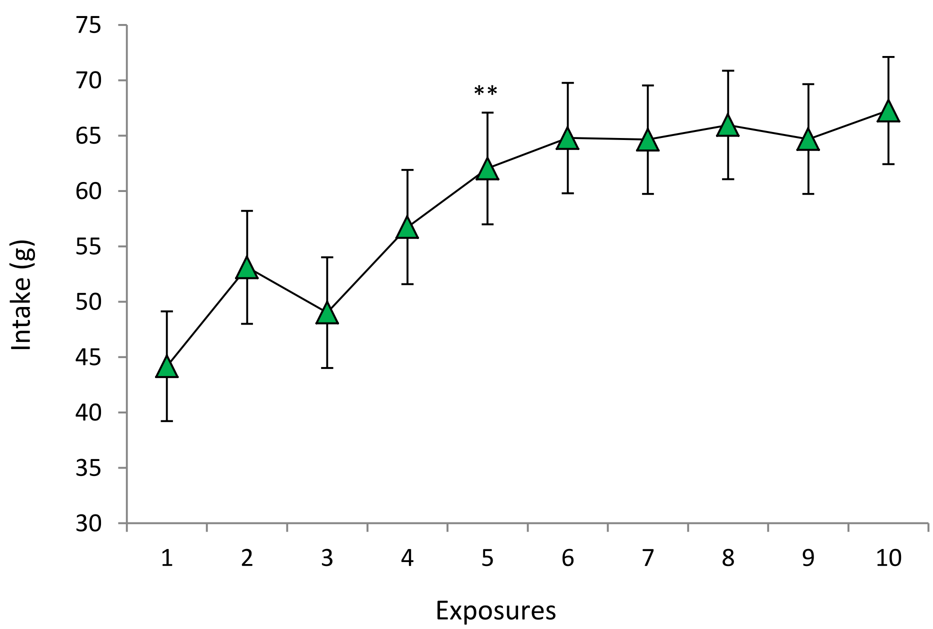

Figure 5:4 Mean intake (g) across exposures (±SEM, n=72) (adapted from Caton et al. 2012)

5.4.4 Intake at last exposure and post intervention

Artichoke intake at exposure 10 and post-test was examined to establish if children in the RE condition consumed more post intervention as a result of exposure to the RE version of the artichoke puree during the intervention. A main effect of time was observed [F (1, 66) =44.0, $p<0.001$), with post-intervention intake being higher than intake at exposure 10 (102.9±4.1g vs. 64.6± 8.6g). No main effects or interactions of condition were found, suggesting that condition did not influence post-intervention intake of the RE recipe artichoke when intake at the last exposure was taken into account.

5.4.5 Intake at follow up

Of the 72 children that completed the intervention 45 completed follow up intake measures (RE *n* 16, FFL *n* 15 and FNL *n* 14). Children's artichoke intake increased significantly from pre-intervention when compared to intake immediately post-intervention and 3, 4 and 5 weeks post-intervention ($p<0.001$). Intake did not differ significantly between post-intervention time points. A significant time by condition interaction was found [F (8, 156) =3.2, $p<0.01$] with artichoke intake greater at post-test and follow up in the RE condition (Figure 5.5). When artichoke intake was compared with intake of the carrot control a significant interaction between time and vegetable was observed [F (1.9, 70.4) =7.4 $p<0.01$]. Carrot intake was greater than artichoke at baseline, however, artichoke intake was greater than carrot immediately post-intervention (124.5±11.6g vs. 114.0±15.5g) and at 5 week follow up (136.2±15.9g vs. 112.9±15.2g).

When change in intake from baseline to follow up was analysed, a main effect of vegetable was found [F (1, 39) =20, $p<0.001$] with increase in artichoke intake greater than carrot intake: Artichoke 95·0±11·29g; Carrot 46·9±13·3g. In addition a significant vegetable x condition interaction was found ($p<0.05$).

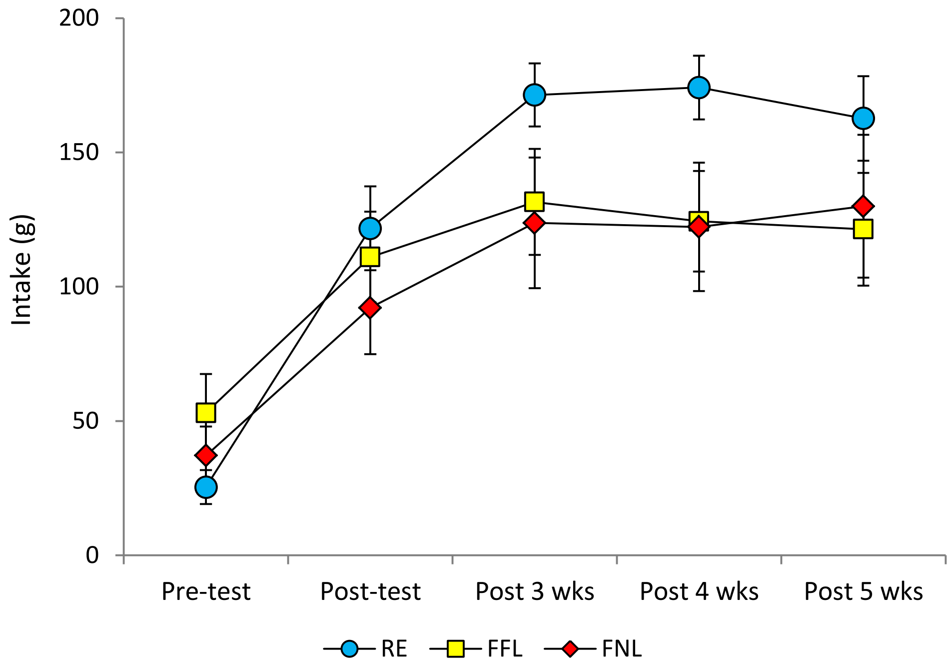

Figure 5:5 Mean intake across the intervention by condition (±SEM, n=45) (adapted from Caton et al. 2012)

5.4.6 Intake with age as a factor

Baseline intake of the artichoke and carrot purees did not differ by age group (p=0.2: Artichoke ≤24m=47.7±9.4g; ≥25m=28.3±8.9g; Carrot ≤24m=77.5±13.8g; ≥25m=49.3±14.0g) and no interactions between age and condition or vegetable were found.

A significant main effect of time was observed with children in both age groups significantly increasing their intake from pre to post-intervention, [F (1, 56) =52.1, p<0.001]. In addition a main effect of age group (p<0.01) and a time by age group interaction (p<0.01) revealed a significantly greater increase in intake in the ≤24 m age group. No effects of condition or interactions involving age group or condition were found. When change in intake was calculated, main effects of vegetable [F (1, 66) =19.3, p<0.001] and age group [F (1, 66) =10.0, p<0.01] were observed confirming that change in intake was greater for artichoke than carrot and overall change in intake was greater in the ≤24 m age group than for those aged ≥25 m (67·5±8·6g vs. 26·4±9·6g).

A main effect of age group was found on intake across the exposure period (p<0.001) and an exposure by age group interaction (p<0.05) revealed that children in the younger age group consistently ate more artichoke across the intervention and increased their intake to a greater extent than the older children (Figure 5.6). No effect of condition or condition by age group interaction was found indicating that children in both age groups responded similarly to all three conditions.

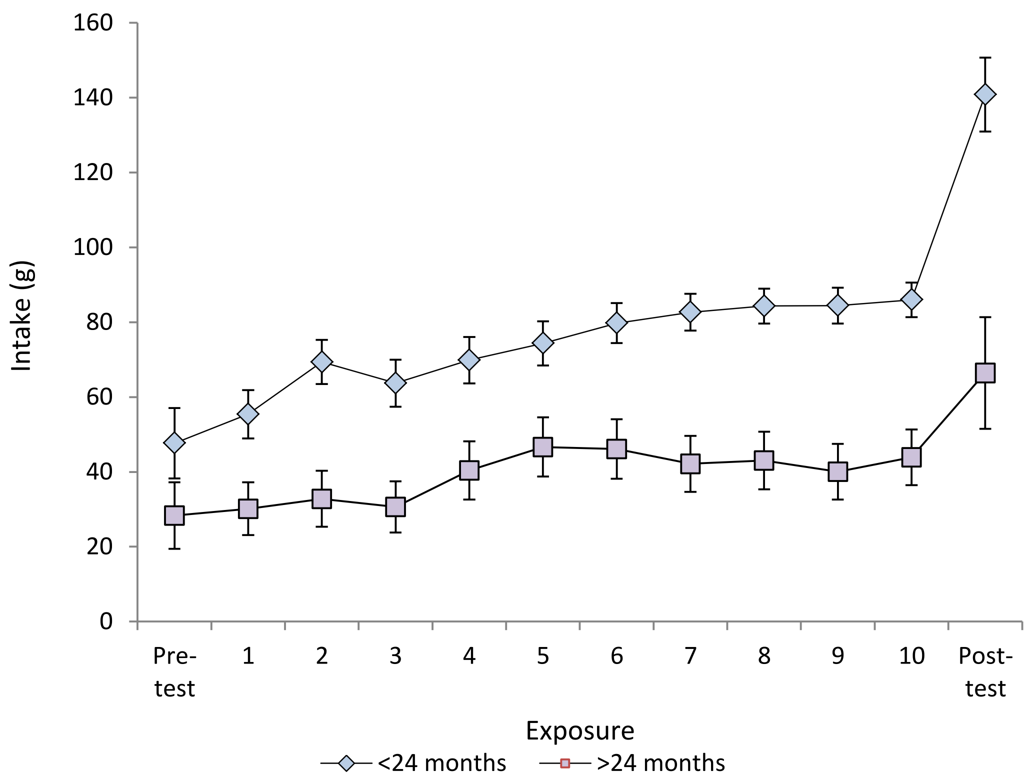

Figure 5:6 Mean intake (g) across the intervention by age group (± SEM, n=72)

5.4.7 Individual differences

5.4.7.i Categorisation of eaters

To assist in the investigation into individual differences in children's responses to the intervention, children were categorised into three types of eaters. Children were identified as regular eaters, non-eaters and plate clearers based on their pattern of intake throughout the intervention. Regular eaters showed a linear increase in intake over time, non-eaters consistently consumed less than 10g (10 %) of a portion over the exposure period and plate clearers consumed an average of 90g (90%) or more over the exposure period. Preliminary analysis which removed non eaters and plate clearers, found no impact of eating category on the results. Of the 72 children that completed the study 34 were categorised as regular eaters, 22 as plate clearers and 16 as non-eaters. The majority of non-eaters (73%) were from the older age group. Plate clearers were evenly distributed across the two age groups. All categories of eaters were split equally across the conditions.

5.4.7.ii Questionnaire data

A total of 36 mothers completed and returned questionnaires. Mothers were aged between 26 and 44 years (mean 34.93±0.83 years) with a healthy BMI (23.56±0.79kg/m2). The majority were of White British origin (91.7%). 85.7% of mothers had breast-fed (*n* 30) either exclusively or alongside the use of formula feeding. Mothers that BF did so for an average of 7.1m and children had been introduced to solid foods between 2 and 7m (mean 5.11±0.17m). Mothers tended to introduce vegetables between 4 and 7 m of age (mean 5.46±0.15m) and fruits between 3 and 7 m (5.62±0.14m). FFQ scores for each of the vegetable food types were summed in order to provide an indication of how often both mothers and children consumed vegetables in an average week. An average was then taken to give number of times per day. On average both mothers and children consumed some kind of vegetable twice a day.

<u>Factors influencing vegetable intake</u>

Analysis of variance determined frequency of vegetable consumption at home differed significantly between age groups with children aged over two years eating vegetables less often than younger children [F (1, 34)=5.3, p<0.05]. This was not the case for eating category, with all three consuming vegetables with similar frequency. Vegetable intake during the intervention and at home did not differ between breastfed and formula fed children as a result of caregivers feeding style. Correlational analysis found no relationship between children's temperament as measured by the EAS and vegetable intake during the intervention, however, frequency of vegetable intake at home was negatively related to emotionality [r (33)=-0.41, p<0.05] and sociability [r (33)=-0.35, p<0.05]. Neither vegetable intake during the intervention or at home was related to factors included in the CFQ.

Baseline intake of artichoke was positively associated with the frequency with which a child consumed fruit per week [r (32) =0.39, p<0.05] and negatively associated with the age at which they had been introduced to solid foods [r (32) =-0.35, p<0.05] while baseline intake of carrot was not associated with any of the factors included in the questionnaire. Post-intervention intake of artichoke was positively related to frequency of fruit consumption [r (32) =0.42, p=0.01] while intake of carrot was associated with enjoyment of food (EF) as measured by the CEBQ; [r (32) =0.35, p<0.05]. Both were negatively associated with the CEBQ factors of food responsiveness [FR; r (33) =-0.35, p<0.05; r (33) =-0.33, p=0.05)].

Change in intake of artichoke was positively related to the frequency with which children normally consumed vegetables at home [r (32) =0.39, p<0.05] while increase in carrot intake was associated with EF [r (32) =0.38, p<0.05] and children BMI z-scores [r (47) =0.30, p<0.05]. Change in the level of carrot intake was negatively associated with children's food neophobia (CFN) scores [r (32) =0.38, p<0.05] and scores for food fussiness (FF) while increase in artichoke was negatively associated with mothers' scores for food neophobia. The age of the children was negatively associated with post-intervention intake of artichoke, change in artichoke intake and children's average intake of puree across exposures. Mean intake across exposures was also negatively associated with children's scores for food neophobia [r (32) =-0.34, p<0.05].

CFN scores differed significantly by eating category, with non-eaters having significantly higher scores than both other types of eater who did not differ. CFN scores were negatively related to how frequently children consumed vegetables at home [r (33) =-0.34, p<0.05]. Frequency of vegetable consumption was also related to how frequently mothers ate vegetables [r (33) =0.39, p<0.05].

5.5 Discussion

The results of the current study demonstrate that repeated experiences with a novel vegetable can successfully increase children's intake, irrespective of preparation method. Children consumed significantly more of the carrot control than artichoke target at baseline indicating a preference for carrot prior to the intervention. Despite this, post-intervention intake of the artichoke was significantly higher than carrot in all three conditions, demonstrating an overall shift in preference. An increase in intake of the plain artichoke puree post-intervention in the flavour nutrient learning and flavour flavour learning conditions indicates that associative conditioning had occurred. Children assigned to the repeated exposure condition tended to consume more artichoke immediately post-intervention and at follow up, however, change in intake was not found to differ significantly between conditions. Intake across the exposure period was also similar in each condition, suggesting all three recipes were equally palatable and a significant increase in artichoke consumption was observed after just five exposures. Following the intervention, intake of the target vegetable rose from 39g to approximately 108g, representing an increase of more than one child's portion of vegetables (40g). Findings suggest that all three techniques are equally effective in promoting children's vegetable consumption.

In agreement with current literature RE appears to provide an effective method for improving vegetable liking and intake in young children (Birch, McPhee, et al., 1987; Forestell & Mennella, 2007; Lakkakula et al., 2010; Loewen & Pliner, 1999; Noradilah & Zahara, 2012; Wardle, Cooke, et al., 2003; Wardle, Herrera, et al., 2003) supporting the assumption that it is how often a vegetable is offered that predicts how well it is liked (Chapter 4). The study also offers support for the addition of energy or other already liked flavours as a means of promoting vegetable intake but the additional effort involved in these strategies offered no benefit for consumption. Both forms of associative conditioning appear to have been successful with preference for the target vegetable remaining even when offered without the additional energy or sweet taste. While the success of these two techniques could be a result of children's increased preference for high energy dense foods (Birch, McPhee, Steinberg, & Sullivan, 1990; Johnson et al., 1991; Kern, McPhee, Fisher, Johnson, & Birch, 1993) and sweet tastes (Steiner, 1979; Ventura & Mennella, 2011) it may also demonstrate the generalising effects of mere exposure (Gordon & Holyoak, 1983). That is to say that repeated exposure to the sweetened or energy dense version of the artichoke puree meant that the plain version offered post-intervention was not perceived to be entirely unfamiliar. To date support for the use of associative conditioning as a means of increasing children's vegetable consumption is limited. Zeinstra et al. (2009) failed to demonstrate FNL in primary school children, citing low intake as a constraint on learning. However, a study by Bouhlal et al. (2010), which offered children green beans with different levels of fat, sugar or salt was unable to demonstrate any preference for the vegetable with additional fat – in this case butter. It is important to consider, however, that while butter provides additional energy it also may also influence the taste and texture of the green beans, which in turn may have influenced acceptance. In terms of FFL, Havermans and Jansen (2007) demonstrated an increase in children's preference for vegetable flavours that had previously been paired with a sweet taste. However, their intervention did not investigate how this increase in preference translated to intake. In addition, Bouhlal et al. (2010) found no effect of sweetening green beans on how much children consumed.

While the results of the present study suggest that associative conditioning can play a role in developing children's preference for vegetables, they also suggest that neither method offers any additional advantage over repeated exposure, which is consistent with other studies (Anzman-Frasca et al., 2012; Hausner, Olsen, & Moller, 2012; Remy et al., 2013). A tendency for children in the repeated exposure group to consume more of the target vegetable at post-test suggests it is a more effective method. However, it could also indicate that children in the FFL and FNL expected to receive the version of artichoke puree to which they had become accustomed and as a result ate less. Given that no significant differences in artichoke intake were found between conditions, it is important that this finding is interpreted cautiously. When consumption across the exposure period was examined by energy intake rather than weight, children in the FNL were found to consume significantly more energy when compared with both other conditions (data not shown). Thus, reduced puree consumption in this group may be evidence of children adjusting their intake as a result of conditioned satiety (Birch & Deysher, 1985). Further research which looks to examine the possible limiting effects of FNL on intake via conditioned satiety may help to determine its effectiveness as a strategy for improving vegetable consumption.

Repeated exposure to all three versions of the artichoke puree significantly increased children's intake and this was observed after just five exposures. Early research into the effects of repeated exposure had previously demonstrated that as many as fifteen taste exposures were required to increase children's acceptance and intake of novel foods (Birch et al., 1982; Birch, McPhee, et al., 1987). Thus, this current finding is a promising one and is consistent with other studies that have demonstrated enhanced preference for vegetables after fewer than ten exposures (Hausner et al., 2012; Wardle, Cooke, et al., 2003). However, the extent to which the effects of five exposures persist, in the absence of the subsequent exposures, cannot be established from the results of the current study. While optimal intake was achieved after five exposures, children's consumption of artichoke after this point remained the same, ruling out possible monotony effects on intake (Hetherington et al., 2000; Hetherington et al., 2002). It is likely that the potential for monotony effects was reduced as a result of the frequency of exposures that children received. Offering children two to three exposures a week, rather than ten consecutive daily exposures, allowed children 'rest' days from both the study foods and the study procedure. High levels of intake five weeks post-intervention also suggest that the effects of all three strategies remained stable over this period, despite no further opportunity to consume artichoke puree. However, further follow ups would have helped to establish whether or not preference for artichoke puree endured.

Baseline intake of artichoke was relatively low at around a third of the overall portion offered. The amount consumed at baseline was not found to differ between age groups suggesting all children exhibited a general reluctance to consume the unfamiliar target vegetable prior to the intervention (and included intakes from “non-eaters”). This idea is supported by significantly higher baseline intake of the carrot control, selected as a highly familiar and liked vegetable (Chapter 4). Across the intervention participants over two years of age ate substantially less artichoke than those in the younger age group. In addition, their intake of the puree increased to a lesser extent. There are two possible explanations for this finding. The first is the use of puree as experimental foods. Given its similarity to ‘baby food’, older children who were accustomed to receiving solid foods at snack times may have been resistant to eating the puree. Alternatively, lower consumption in this age group may be evidence of a heightened neophobic response to unfamiliar foods, known to peak between two and six years (Addessi, Galloway, Visalberghi, & Birch, 2005; Cooke et al., 2003; Dovey et al., 2008; Nicklaus, 2009). CFN scores were found to increase with age offering further support for this idea. Food neophobia is associated with lower levels of vegetable intake (Cooke et al., 2004; Galloway, Lee, & Birch, 2003) and this is consistent with the reduced vegetable consumption exhibited by the older age group both at home and throughout this intervention. Greater vegetable intake in the younger children is also consistent with an increased acceptance and willingness to consume unfamiliar foods (Nicklaus, 2009) before the onset of food neophobia. This suggests that exposure as a technique for developing preferences for vegetables could be employed early on in childhood in order exploit this willingness to taste new foods. However, it is important to consider that while the older age group ate consistently less vegetable puree their intake of both vegetables had significantly increased post-intervention. Repeated exposure may therefore offer a successful method of maximising vegetable consumption even children considered to be at the peak of the neophobic stage. It is possible that older children may require a greater number of exposures to achieve similar increases in intake.

While artichoke intake increased to a greater degree than carrot, change in intake of both vegetables was positively related. This is an interesting finding and might indicate a general propensity for vegetable acceptance and consumption amongst children who were receptive to the intervention. Regular experience with a variety of vegetables has been shown to improve children's acceptance and intake of other novel vegetables (Krolner et al., 2011; Maier, Chabanet, et al., 2008; Mennella et al., 2008). In view of this, the positive relationship between change in artichoke intake and the frequency with which vegetables are consumed at home might indicate that this propensity is a product of frequent exposure to vegetables within a child's diet. However, it is important to consider the direction of this relationship. Namely whether greater habitual intake of vegetables promotes further consumption or whether it merely reflects a general positive behavioural tendency towards vegetable intake.

A low response rate to parental questionnaires makes it difficult to examine the individual differences which might determine children's susceptibility to this intervention and limits what conclusions can be drawn from the relationships found. CFN scores were one of very few questionnaire measures found to be related to vegetable intake during the intervention. CFN was inversely related to both vegetable intake across the exposure period and how often vegetables were eaten at home. In an attempt to explore differences in children's responses to the intervention, eating categories were applied which were based on individual patterns of intake across the study period. However, the criteria used for this categorisation were very basic and it is important to consider that children, particularly those labelled non-eaters, may have responded differently to repeated exposure under different circumstances. The size of the portions used for this intervention may have been overwhelming for some children, causing them to reject the purees. Had smaller portions been used those same children may have been more likely to consume the foods offered to them. Similarly the experimental procedure may have been an important influential factor for some children. The social atmosphere of nursery snack time may have provided too many distractions for young children while others may have found the presence of researchers off-putting. It is possible that the same children may have responded very differently to repeated exposure had the vegetable been offered in a different setting. The context of eating situations can therefore have a strong influence on the eating behaviours exhibited by children and this should always be considered when conducting interventions of this type. Despite this the results of the parental questionnaires did offer some support of the eating categories employed during analysis. As expected, children who were categorised as non-eaters, who did not respond to the intervention, scored significantly higher for food neophobia than both regular eaters and plate clearers, who did not differ. However, children in the three eating categories were not found to differ in terms of how often they ate vegetables at home. This highlights the complexity of children's individual differences and how this can influence of eating behaviours. Thus, future research might benefit from focusing on food neophobia as a potential barrier to both learning and vegetable consumption on the whole.

Overall the results of this experiment show that RE exposure to any variant of a novel vegetable is sufficient to promote intake for up to 5 weeks post intervention and that five exposures might be sufficient to increase intake (and liking). Substantial differences in vegetable intake between age groups suggest a possible "sensitive" stage for the introduction of novel vegetables, with young children (<24 m) being more receptive than older children (>24 m). Observed increases in intake at post-intervention were not found to be a result of condition assignment but lower intake in FNL condition could be evidence of conditioned satiety. Individual differences in sensitivity to flavour-based learning (Yeomans, 2010) and repeated exposure may help to explain differences in response to the intervention but this requires further investigation.

5.5.1 Next steps

Repeated exposure to a novel vegetable appears to promote acceptance and intake. While pairing vegetables with increased energy may limit intake due to conditioned satiety, research suggests FFL via the addition of a sweet taste may be an effective strategy for increasing liking and intake, particularly in younger children (Remy et al., 2013). However, the use of sugar as a pre-liked flavour is unlikely to be attractive to parents because of concerns around sugar consumption. Of interest is whether FFL can be successful in increasing children's vegetable intake when something other than sugar or an artificial sweetener is used as the unconditioned stimulus. In, addition, the use of a familiar vegetable as a control in the current intervention meant it was difficult to account for the increase in intake observed post-intervention. Children were likely to regularly consume carrots during testing period (Chapter 4), however increase in carrot intake may also be a result of the generalisation of the repeated exposure effects. This could not be established in the present study and employing novel vegetables as both the target and control vegetable is likely to be of benefit. The next chapter will therefore address the following questions:

5. Do the effects of RE generalise to other novel vegetables?
6. Can successful FFL occur when a natural sweetener, such as a fruit puree is used as the additional sweet taste?
7. Are fewer than ten exposures to a novel vegetable sufficient in enhancing intake and liking?

Chapter 6 Increasing preschool children's liking for a novel vegetable: Repeated exposure vs. flavour flavour learning

Abstract

Mothers commonly offer children vegetables that are seasoned or served with dips or sauces in an effort to promote consumption. Pairing vegetables with already liked flavours has been found to increase intake (Chapter 5) but to date successful experimental studies have focussed on the addition of sugar and artificial sweeteners. The current study aimed to investigate the effectiveness of flavour-flavour learning (FFL) as a strategy for increasing vegetable intake in pre-school children, using a pure fruit puree for added sweetness. Preschool children (*n* 29, mean age 34m) received between 6 and 8 exposures to a root vegetable puree with added apple puree (FFL) alternating with 6-8 exposures to another with nothing added (RE). A third puree acted as a control. Intake of unadulterated versions of all three vegetable purees was measured pre and post-intervention to establish change in intake. Further intake measures took place 1 month (*n* 28) and 6 months (*n* 10) post-intervention. Children consumed significantly more of all three purees post intervention when compared with baseline intake. Magnitude of change was smaller for the control puree but no effect of condition was found. Intake at 1 month and 6 month follow ups remained significantly higher than baseline for all conditions. Children in the older age group (>24m) consumed less puree across the intervention compared to younger children and neither age group showed any difference in response to the three conditions. Results suggest that flavour flavour learning can effectively increase vegetable intake in young children but offers no added benefit to a simple RE method. In addition the effects of mere exposure appear to generalise to other, similar vegetables.

The author was responsible for the design of the study recruitment of the nurseries and children that participated as well as the collection of data and all of the analysis.

6.1 Introduction

Pairing vegetables with flavours that are liked by children is a strategy UK mothers already employ in an effort to promote consumption (Chapters 3 and 4). Mothers report the addition of seasonings such as salt as well as offering vegetables with dips and sauces, but it is yet to be established whether such strategies assist children in developing preferences for vegetables. For example, the use of salt has been found to increase vegetable consumption amongst infants when compared with intake of unsalted vegetables (Bouhlal et al., 2010). However, it has been suggested that repeated exposure to salty foods reinforces children's preference for salt (Harris & Booth, 1987) indicating that children may learn to prefer vegetables that are seasoned in this way. Similarly, offering liked dips with vegetables appears to promote initial tasting in young children but has not been shown to offer any advantage in improving liking and consumption over and above simple RE (Anzman-Frasca et al., 2012).

Nonetheless, pairing unfamiliar or disliked flavours with those that are already well liked has been found to induce conditioned preferences in both adult and child participants via flavour flavour learning (FFL) (Appleton, Gentry, & Shepherd, 2006; Brunstrom & Fletcher, 2008; Hausner et al., 2012; Havermans & Jansen, 2007; Johnston, Palcic, Tyler et al., 2011; Mobini et al., 2007; Remy et al., 2013). As previously described, learnt associations between the two flavours result in an increase in liking and intake of the target flavour even when it is presented on its own. This method has proven effective in producing increases in both liking and intake of vegetables amongst young children. In Havermans and Jansen's (2007) study primary school children (average age of 5 years) received six pairs of conditioning trials to sweetened and unsweetened vegetable juices. Results demonstrated a significant increase in children's preference for those juices which had been paired with the sweet taste when subsequently presented unsweetened. Interestingly, Havermans and Jansen did not observe any change in preference for the unsweetened juices to which children were also repeatedly exposed. It is worth noting, however, that no measure of intake of the vegetable juices was taken during this intervention so it is difficult to draw conclusions about how this increase in preference might impact on consumption. Several recent studies have shown FFL to be an effective method of increasing vegetable intake in preschool aged children (Caton, Ahern, Remy et al., 2013; Hausner et al., 2012; Remy et al., 2013). Using similar designs and the same artichoke puree target, these three studies compared the relative effectiveness of FFL, RE, and FNL (see Chapter 5 for procedure). Following ten exposures to a sweetened version of the puree, children in the FFL condition of all three studies demonstrated a significant increase in intake of an unsweetened version given post-intervention. However, none of the studies were able to demonstrate any advantage of sweetening the artichoke puree when FFL was compared with repeated exposure to the plain artichoke.

Collectively these interventions offer promising results however, their success seems dependent on the use of a sweet taste as the unconditioned stimulus. Sweet tastes are associated with positive affect (Booth, Higgs, Schneider, & Klinkenberg, 2010) and are particularly enjoyed by children who exhibit an innate preference for sweet tastes (Steiner, 1979; Ventura & Mennella, 2011). Thus offering children vegetables paired with a sweet taste is likely to boost intake by establishing liking. However, in much the same way that mothers are being advised to reduce children's salt intake, they are also being encouraged to cut down on added sugars (Department of Health, 2013). For this reason using naturally sweet ingredients such as fruit or pureed fruits might be effective and attractive to parents.

While evidence for the use of RE to promote children's vegetable consumption appears strong (Anzman-Frasca et al., 2012; Caton, Ahern, et al., 2013; Hausner et al., 2012; Lakkakula et al., 2010; Maier, Chabanet, Schaal, Issanchou, et al., 2007; Remy et al., 2013), research in support of FFL is limited suggesting further investigation is needed. The addition of a familiar, already liked flavour may facilitate preference development by encouraging initial acceptance of a vegetable (Anzman-Frasca et al., 2012). That is to say that diluting the intense or bitter vegetable flavour with the addition of a well-liked sweet taste may encourage initial consumption, increasing the opportunity for taste exposure and this may be particularly effective for food fussy children.

The current study set out to establish whether pairing a novel target vegetable with the added sweetness of a fruit puree would successfully induce a conditioned preference for that target compared to RE. It was predicted that both RE and FFL would produce an increase in vegetable intake relative to the control. It was also expected that the addition of the sweet fruit puree would produce greater initial intake of the FFL puree than RE puree (at exposure 1) and that fewer exposures would be needed to the sweet FFL puree than RE puree to produce a significant shift in intake.

In order to effectively test these hypotheses it was first necessary to establish that the addition of a fruit puree would effectively increase the sweetness of the target vegetables. For this reason this chapter will begin by describing the sensory analysis employed to select the target vegetables and to determine the concentration of fruit puree to be used during the intervention before describing the intervention itself.

6.2 Vegetable selection and sensory analysis

Four root vegetables were selected as potential targets using the results of the vegetable survey (Chapter 4). Beetroot, celeriac, swede and turnip were all identified as having been introduced to less than 60% of pre-school children. On average all four were offered to children between 1-3 times per month and less than once a month and were neutrally liked by those children who had been offered them (see Table 2.2). Three vegetables were needed for the final experiment. Sensory profiling was conducted on all four vegetable purees in order to establish if any excessive differences existed between them which may influence children's response to them as target vegetables. Given children's innate preference for sweet tastes and aversion to bitter tastes (Schwartz et al., 2009; Steiner, 1979; Ventura & Mennella, 2011) it was considered important that the final three vegetables not differ significantly for intensity of these two tastes. It was also desirable that significant differences were not found between the levels of salty and sour taste. For the purpose of this study it was necessary that the vegetables not differ significantly in terms of rated liking. The final three targets were to be selected based on these measures.

The sensory analysis also aimed to validate the use of a fruit puree as a natural sweetener and to identify suitable concentrations of the FFL recipe purees.

6.2.1 Procedure

Sensory analysis was performed by an untrained panel of twenty adults recruited from the student and staff population at the Institute of Psychological Sciences at the University of Leeds. Participants were aged between 20 and 35 years and were asked to taste three versions of each vegetable puree presented at room temperature; 0% apple puree, 13% apple puree and 18% apple puree. Tasting sessions lasted between 30 minutes and an hour and participants were asked to rate the overall flavour intensity as well as the sweetness, bitterness, saltiness, and sourness of the purees. Scores were given using a 9-point scale, anchored from ‘not at all’ (0) to ‘extremely’ (9). Participants were also asked to report how much they liked each of the purees using the same 9-point scale anchored from ‘dislike extremely’ (0) to ‘like extremely’ (9). The puree samples were presented in 35g portions according to a Latin square design and four replications were performed.

Participants were instructed to taste every sample before answering each question and to rinse their mouths with water between samples. To assist participants in effectively recognising the four basic tastes, twenty reference samples were available to participants throughout the tasting sessions (five identical samples for each taste). These consisted of sweet (0.7% sugar), bitter (0.02% caffeine), salty (0.1% salt) and sour (0.02% citric acid) aqueous solutions.

6.2.2 Statistical analysis

Repeated measures ANOVA were performed on taste rating, liking and intensity scores, with vegetable (beetroot; celeriac; swede; turnip) and apple concentration (0%; 13%; 18%) as fixed factors. Bonferoni post-hoc tests were used to identify differences.

6.2.3 Results

6.2.3.i 100% vegetable purees

When compared, beetroot was found to be significantly sweeter than the other vegetables, with no other differences in sweetness found (Table 6.1). Celeriac was significantly more bitter than beetroot ($p<0.01$) but not the other vegetables. No differences were observed in the saltiness or sourness of the four vegetable purees in their pure form. The flavour of beetroot was found to be significantly more intense than swede and turnip, but not celeriac and was also significantly more liked than the three other vegetables.

Table.6:1: Mean rating scores (± SEM) for pure vegetable purees (0% apple puree)

	Beetroot	Celeriac	Swede	Turnip	*p* value
Intensity	7.16 ± 0.35^{a}	6.05 ± 0.49^{ab}	4.65 ± 0.44^{b}	4.15 ± 0.48^{b}	0.00
Sweet	5.50 ± 0.56^{a}	2.30 ± 0.41^{b}	2.75 ± 0.38^{b}	2.80 ± 0.42^{b}	0.00
Bitter	3.85 ± 0.39^{a}	5.45 ± 0.53^{b}	4.50 ± 0.51^{ab}	4.10 ± 0.54^{ab}	0.06
Sour	3.65 ± 0.36	3.50 ± 0.48	2.85 ± 0.39	2.70 ± 0.38	0.79
Salty	2.90 ± 0.42	2.80 ± 0.43	2.75 ± 0.35	2.30 ± 0.33	0.48
Liking	5.00 ± 0.50	3.50 ± 0.49	2.68 ± 0.34	2.90 ± 0.29	0.00

* Means with a different letter (a, b) are significantly different

6.2.3.ii All recipes

Overall main effects of vegetable were found on the flavour intensity [$F\ (3, 54) = 14.1$, $p<0.001$], sweetness [$F\ (3, 54) = 9.9$, $p<0.001$] and saltiness [$F\ (3, 54) = 5.4$, $p<0.01$] of the vegetable purees. Beetroot was perceived to be significantly more intense than all of the other vegetables as well as significantly sweeter than celeriac and swede and saltier than turnip. Celeriac was also found to be significantly saltier than turnip ($p<0.05$). No effect of apple concentration was found on flavour intensity but significant effects were found on the sweetness [$F\ (2, 36)= 20.8$, $p<0.001$] and bitterness [$F\ (1.5, 26.5)= 7.6$, $p<0.01$] of the vegetable purees. Vegetable purees containing 13% and 18% apple were found to be significantly sweeter than the unadulterated purees ($p<0.01$; $p<0.001$). In addition the 18% apple purees were found to be significantly less bitter than both the 0% and 13% purees ($p<0.05$). A significant interaction was found between vegetable and apple puree concentration [F (6, 108)=3.5, $p<0.01$] revealing that the sweetness of all the vegetable purees increased incrementally with apple puree with the exception of beetroot (Figure 6.1). The sweetness of the beetroot did not change with the addition of apple puree. The same interaction was observed in relation to the saltiness of the purees [F (6, 108) = 3.1, $p<0.01$]. Saltiness was found to increase from the 0% apple puree to the 13% puree for beetroot and celeriac and from the 13% to the 18% puree for beetroot. No effect of vegetable was found on how sour the purees were perceived to be but a main effect of apple concentration was found [F (2, 36) = 6.4, $p<0.01$] with the 18% apple purees reported as significantly more sour than those not containing apple.

6.2.3.iii Liking

Liking was significantly affected by both vegetable [F (3, 51) = 5.1, $p<0.01$] and apple concentration [F (2, 34) = 9.2, $p=0.001$]. On average beetroot was liked more than all three of the other vegetables (Table 6.1) but this was only significant for swede ($p<0.05$). None of the other vegetables differed for liking. Mean liking scores increased with the apple concentration of the purees and the 18% purees were significantly more liked than the 0% apple versions ($p<0.01$).

A significant interaction was observed between vegetable and apple concentration. Liking was found to increase for each vegetable puree as apple concentration increased with the exception of beetroot. Liking for beetroot puree did not differ as a result of the apple content.

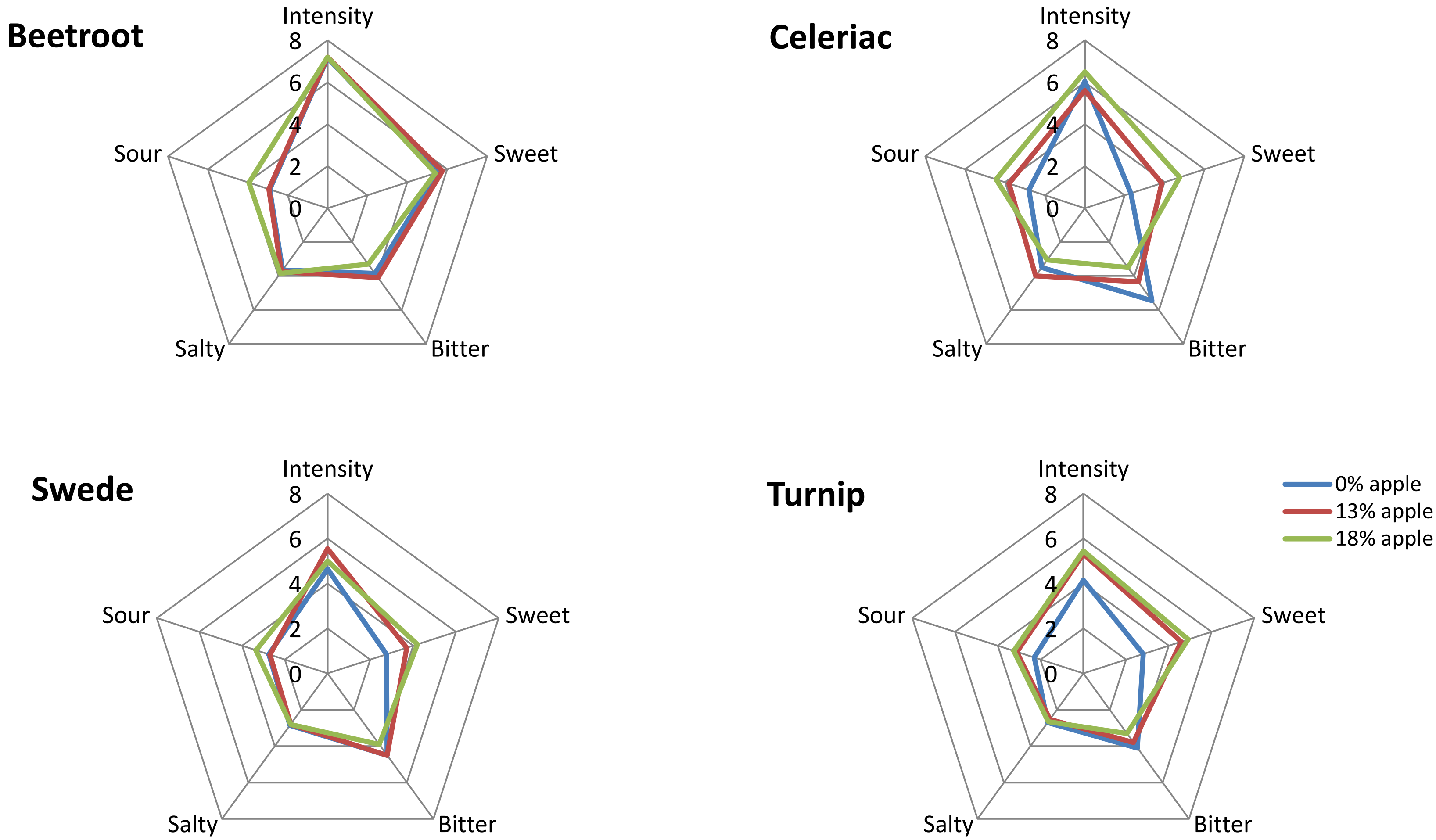

Figure 6:1: Sensory profiles of root vegetable purees

6.2.4 Discussion

The results of the sensory analysis provide simple yet clear taste profiles of each of the potential target vegetable purees. Distinct differences were identified between beetroot and the three other vegetables, eliminating it as a target vegetable for the intervention. The beetroot puree was perceived to have a more intense flavour than the other vegetables. Previous work by Zeinstra and colleagues (2010) has suggested that intense vegetable flavours may be unsuitable to offer young children for whom they can become aversive after minimal intake. The authors suggest that highly intense flavours may induce early sensory specific satiety and as a result early termination of consumption. Beetroot was also found to be sweeter than each of the other vegetables and significantly sweeter than swede and celeriac. Offering beetroot alongside other vegetables that are perceived to be considerably less sweet could potentially skew data with children displaying a clear preference for beetroot puree. The fact that both the sweetness and liking of beetroot were unaffected by the addition of an apple puree also suggests it may be an unsuitable target. In order for FFL to be successful an association must be formed between the novel flavour and an already liked taste- in this case the sweetness of the apple puree. Adding apple puree to beetroot did not increase perceived sweetness, thus removing the potential for associative conditioning to occur.

Celeriac, swede and turnip were similar in their taste attributes and liking. Most importantly the sweetness of these three vegetables was significantly increased with the addition of apple puree and liking for all three was found to improve with the increase of apple concentrations. For this reason, celeriac, swede and turnip were selected as the final target vegetables. Vegetable purees containing 18% apple were found to be significantly sweeter and less bitter than the unadulterated versions demonstrating that the CS sweet taste is detectable in these purees. Additionally the 18% apple vegetable purees were found to be significantly more liked than the pure vegetable versions. As a result 18% apple was selected as the concentration of purees to be used in the FFL condition.

6.3 Flavour flavour learning intervention

6.3.1 Participants

Parents of children aged 12 to 60 months were invited to participate in the study. In total 42 children aged 15 to 56 months were recruited through local nurseries and pre-schools (Leeds, West Yorkshire, UK). Participants were screened for food allergies (as reported by parents) and inclusion in the study required children to attend nursery for at least 2 days per week. The study was approved by the Institute of Psychological Sciences (University of Leeds) ethics committee (12-0018).

6.3.2 Procedure

Three target vegetables were selected; celeriac, swede and turnip. To eliminate any possible order effects these vegetables were counterbalanced across conditions and then counterbalanced across participants. A summary of the study procedure is shown in Figure 2.

Week	1		2	3	4	5	6	7	8	9		10		15		36
	Pre-test		Conditioning Phase									Post-test		Follow Up 1		Follow Up 2
n=42	Day 1	2-5 days	Day 4	Day 6	Day 8	Day 10	Day 12	Day 14	Day 16	Day 18	2-5 days	Day 20	1 month	Day 23	5 months	Day 26
	Veg 1		FFL (1)	FFL (2)	FFL (3)	FFL (4)	FFL (5)	FFL (6)	FFL (7)	FFL (8)		Veg 1		Veg 1		Veg 1
	Day 2		Day 5	Day 7	Day 9	Day 11	Day 13	Day 15	Day 17	Day 19		Day 21		Day 24		Day 27
	Veg 2		RE (1)	RE (2)	RE (3)	RE (4)	RE (5)	RE (6)	RE (7)	RE (8)		Veg 2		Veg 2		Veg 2
	Day 3		No exposures									Day 22		Day 25		Day 28
	Veg 3											Veg 3		Veg 3		Veg 3

Figure 6:2 Summary of study procedure, exposure number shown in ().

Prior to the intervention baseline measures of intake were taken of the RE (unaltered) versions of all three vegetable purees. Children were offered up to 200g of each vegetable on three separate days at their usual snack time. Initially children were given a single 100g pot of puree and were asked to consume as much or as little as they would like. On completion of the first pot children were then offered a second 100g pot. Purees were offered to the children by nursery staff or experimenters. Nursery staff had been instructed to approach feeding the children in the same way as they normally would and children were given as much time as they needed to consume the puree snacks.

The intervention started 2 to 5 days after baseline with the conditioning phase. Children were given between 6 and 8 exposures to a FFL variant of one of the vegetable purees alternated with 6 to 8 exposures to a RE variant of another of the vegetable purees. No exposures were given to the third vegetable which acted as the control. Researchers weighed the pots of vegetables before and after each exposure to measure intake. Following conditioning post-intervention measures of intake were taken. Children were again offered the RE variants of all three purees on three separate days. These post-intervention measures were taken two to five days after the conditioning phase and at 1 and 6 months after the intervention.

6.3.3 Questionnaires

Questionnaires were distributed to parents of participating children through their nurseries. These included a number of demographic questions, questions regarding infant feeding practices, a parental Food Frequency Questionnaire (FFQ; Hammond et al., 1993) and a parental measure of food neophobia (FNS; Pliner & Hobden, 1992). A child FFQ, the Child Food Neophobia Scale (CFNS; Pliner, 1994) and the Child Eating Behaviour Questionnaire (CEBQ; Wardle et al. 2001) were also included (see Chapter 2).

6.3.4 Anthropometric measures

Where parental consent had been granted participating children had their heights and weights measured. Measurements were taken by trained researchers using Seca digital scales and a Leicester SMSSE portable stadiometer. BMI z-scores were calculated using the WHO anthropometric calculator (http://www.who.int/childgrowth/software/en/).

6.4 Statistical analysis

Data were analyzed using SPSS version 20.0 (SPSS Inc., Chicago, IL, USA). All children who completed the intervention were included in the analyses.

Repeated measures ANOVA were performed on intake data, both absolute and change in intake, with condition (FFL; RE; Control), vegetable (Celeriac; Swede; Turnip) and time (pre-intervention, post-intervention and 1 and 6 months post-intervention) as within-subject factors. Vegetable to condition assignment and age group (≤24 months and ≥25 months) were included as between-subjects factors. The same analysis was then repeated with time representing first and last exposures. To examine changes in intake across the conditioning period further ANOVA were conducted with exposures and condition as with-in subject factors and vegetable assignment and age group as between-subjects factors. Pearson's correlation was used to investigate relationships between intake pre and post-intervention in the three conditions and the three vegetables. Bonferoni post-hoc tests were used to identify differences.

6.5 Results

In total 29 children completed the full intervention having been present for at least 6 exposures to both the FFL and RE purees. Of these, 17 were male and 12 female. Children had a mean age of 34.0±2.3 months and a mean BMI z-score of 0.7±0.2.

6.5.1 Intake pre and post intervention

Baseline intakes did not differ by condition; p=0.7, RE 6.6±2.9g; FFL 6.2±2.2g; Control 9.5±3.4g. A significant main effect of time was found on intake of purees in all conditions with a significant increase from pre to post intervention (p<0.001, Figure 6.2). No effect of condition or any condition by time interaction was found on intake.

Baseline intake was similar for each vegetable (p=0.1; Celeriac 3.8±0.9g; Swede 11.7±4.2g; Turnip 6.9±2.3g), however, an overall main effect of vegetable showed that children consumed more swede and turnip than celeriac over the course of the study [*F* (2, 56) =8.7, p<0.001]. A main effect of time demonstrated greater intake across condition for all vegetables pre to post-intervention. A marginally significant interaction between time and vegetable was also identified (p=0.06).

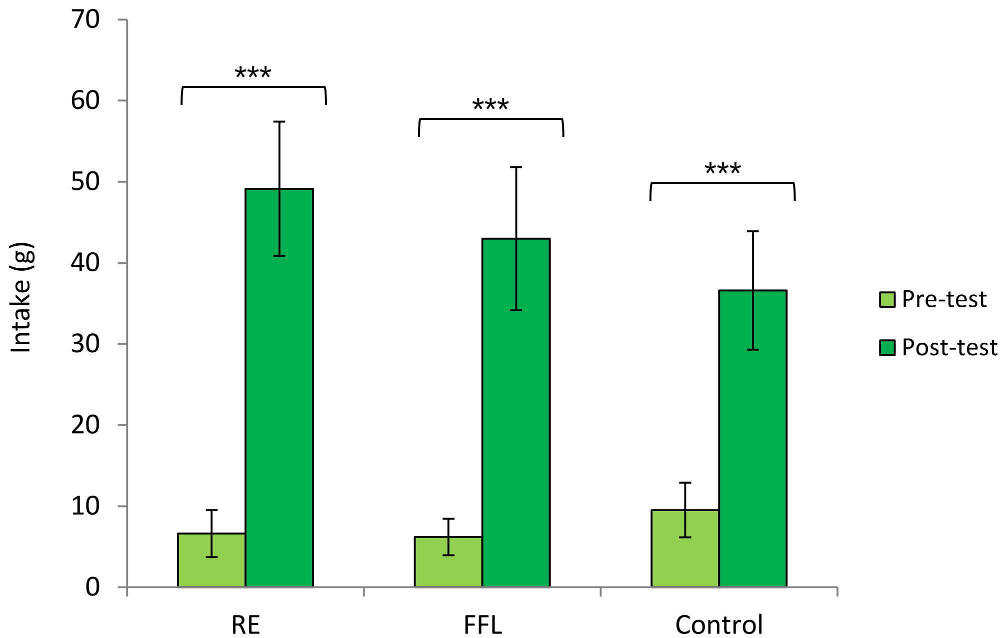

Figure 6:3 Pre and post intervention intake (g) by condition (± SEM, n=29)

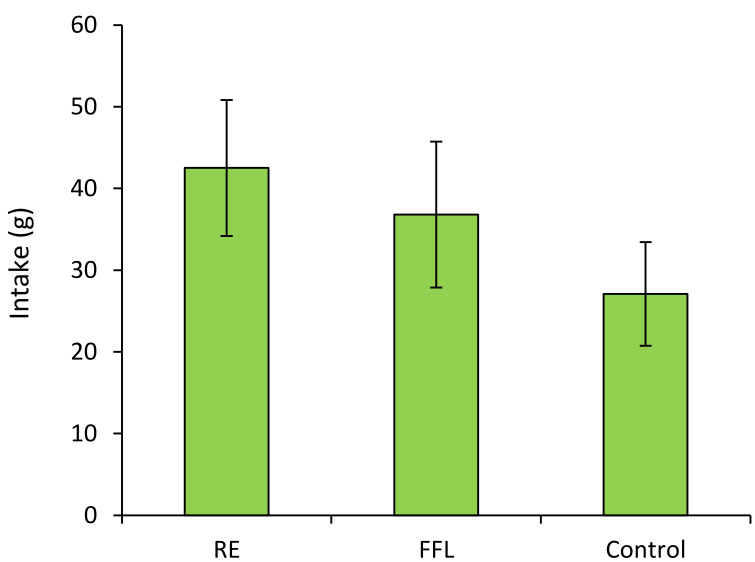

Figure 6:4: Change in intake (g) from pre to post-intervention by condition (± SEM, n=29)

6.5.2 Changes in intake

No main effect of condition was observed for change in intake although magnitude of change was found to be smallest in the control condition (Figure 6.2). Similarly vegetable to condition assignment was not found to have an effect on change in intake; however, the increase in intake of swede and turnip was marginally greater than for celeriac (Celeriac 25.1±6.7g; Swede 39.8±8.3g; Turnip 41.5±8.6g).

6.5.3 Intake across exposures

Due to the total number of exposures varying between children, intake was compared from first to last exposure. Analysis revealed a significant main effect of time with intake increasing from the start to the end of the conditioning phase [F (1, 28) = 25.5, $p<0.001$]. No effect of condition was found (Figure 6.4). A significant main effect of the number of exposures was observed [F (5, 140) =7.2, $p<0.001$] and a significant increase in intake had been achieved by exposure 3 ($p<0.05$). Intake at exposures 4, 5 and 6 remained significantly higher than at first exposure with no further significant increase found after the third exposure. No effects of vegetable assignment were found.

6.5.4 Intake at Follow Up

Of the 29 children that completed the intervention 28 completed follow up intake measures 1 month later. Ten of these children also completed measures of intake 6 month post-intervention. Children's vegetable intake increased significantly from pre-intervention when compared to intake immediately post-intervention ($p<0.01$) and 1 and 6 months post-intervention ($p=0.001$; $p<0.05$). No effect of condition or condition by time interaction was found. For those children who completed the 6 month follow up intake of the vegetable purees continued to increase (Figure 6.5), however, no significant change in intake occurred between post-intervention measures.

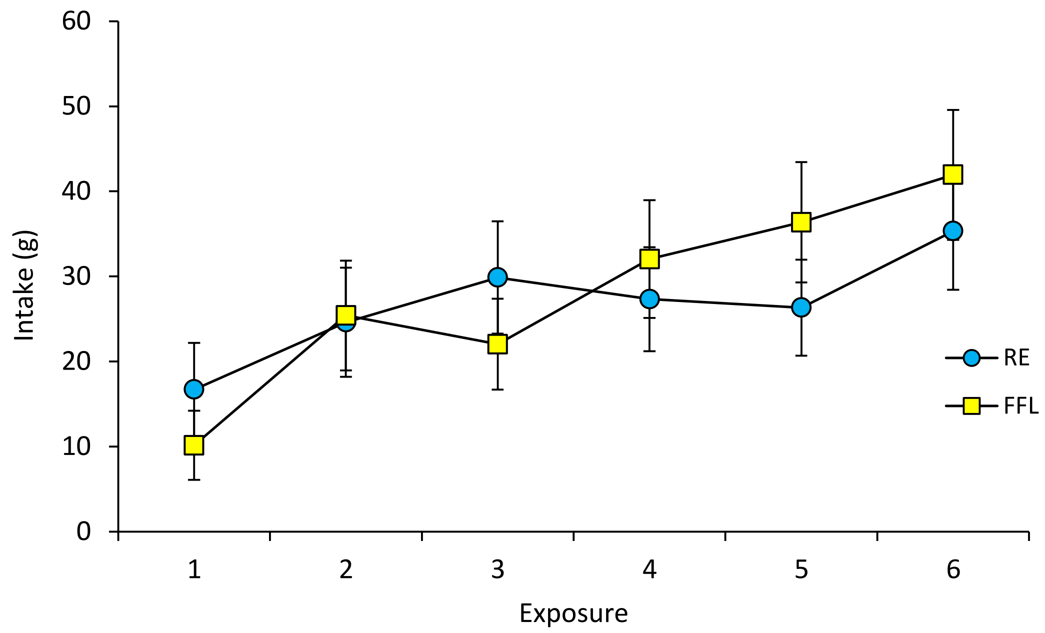

Figure 6:5 Intake (g) per exposure by condition (± SEM, n=29)

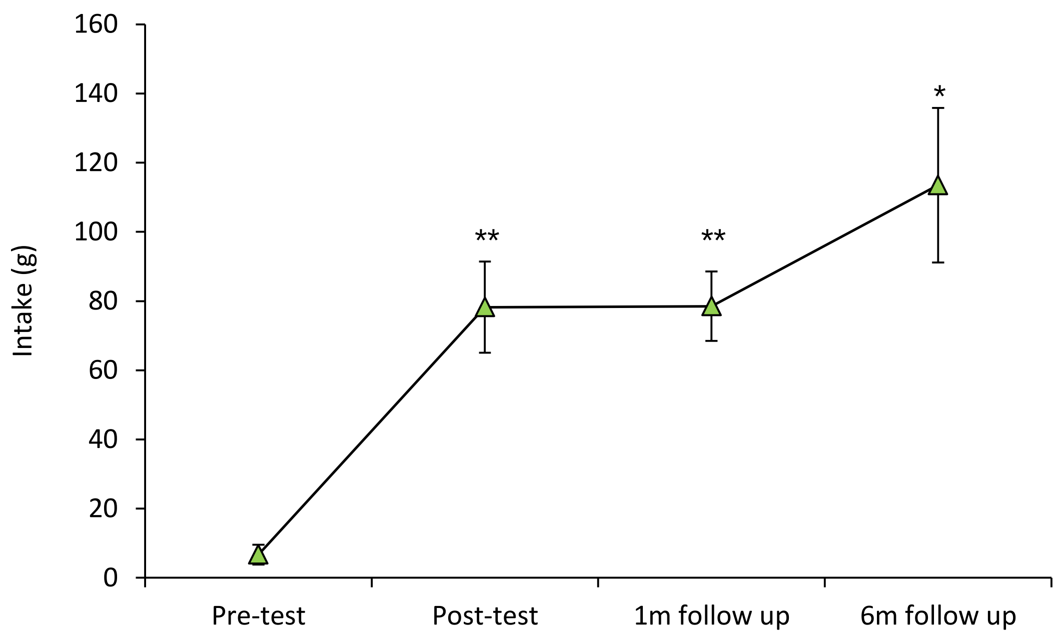

Figure 6:6 Mean overall puree intake (g) at pre-intervention, post-intervention, 1 month follow up and 6 month follow up (± SEM, n=10)

Intake of each of the vegetables had significantly increased at each time point post-intervention when compared with baseline intake ($p<0.001$). Analysis revealed a main effect of vegetable [F (2, 18) = 7.0, $p<0.01$]. Pairwise comparisons revealed that the children ate significantly less celeriac than the other two vegetables immediately post-intervention and at one month follow up. By the 6 month post-intervention measure this difference was only found to be significant between celeriac and turnip.

6.5.5 Intake with age as a factor

Baseline intake of the vegetable purees did not differ by age group; $p=0.2$; ≤24m= 4.1±1.1g; ≥25m= 9.2±2.6g. A significant main effect of time was observed with children in both age groups significantly increasing their intake from pre to post-intervention [F (1, 27) =56.0, $p<0.001$]. In addition a main effect of age group ($p<0.001$) and a time by age group interaction ($p<0.001$) revealed a significantly greater increase in intake in the younger age group. No main effect of condition and no condition by age group interaction were found. When change in intake was calculated, further analysis confirmed that magnitude of change was significantly greater in the younger age group [F (1, 28) =28.2, $p<0.001$] (Figure 6.6).

Intake of vegetable puree across the exposure period was also significantly affected by age group ($p<0.05$). An exposure by age group interaction ($p<0.01$) showed that younger children consistently ate more vegetable puree across the intervention and that their intake increased to a greater extent across exposures. No effect of condition or condition by age group interaction was found suggesting there were no differences in response to conditions between age groups.

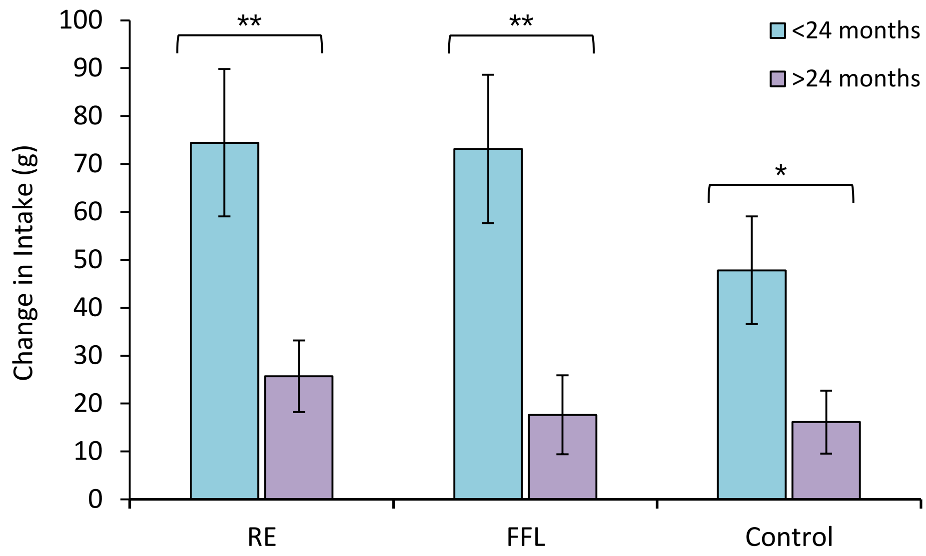

Figure 6:7 Change in intake (g) from pre to post-intervention by condition and age group (±SE mean, n=29)

6.5.6 Correlations

Significant positive correlations were found between post-intervention intake in all three conditions [RE and FFL: *r* (27) =0.63, p<0.001, RE and Control: *r* (27) =0.65, p<0.001, FFL and Control: *r* (27) =0.64, p<0.001]. This was also the case for change in intake [RE and FFL: *r* (27) =0.51, p<0.01, RE and Control: *r* (27) =0.47, p<0.01, FFL and Control: *r* (27) =0.76, p<0.001] suggesting that a child who increased their vegetable intake in one condition was likely to eat more in all conditions. Similarly post-intervention intake of all three vegetables were positively related [celeriac and swede: *r* (27) =0.49, p<0.01, celeriac and turnip: *r* (27) =0.65, p<0.001; swede and turnip: *r* (27) =0.88, p<0.001].

6.5.7 Individual differences

6.5.7.i Categorisation of eaters

To assist in the investigation into individual differences in children's responses to the intervention, children were categorised into three types of eaters (see section 5.4.7 for criteria). Of the 29 children that completed the study 18 were categorised as regular eaters and 11 as non-eaters. No children were identified as plate clearers. All non-eaters were over 22 months of age. Regular eaters were evenly distributed across the two age groups.

Baseline intake did not differ significantly between non-eaters and regular eaters [RE: non-eaters 5.5±2.1g; regular eaters 7.4±4.6g; FFL: non-eaters 4.5±1.2g; regular eaters 4.1±1.7g], however, intake across the intervention and post-test was significantly lower [non-eaters 3.9±0.9g; regular eaters 41.1±4.9g]. This suggests initial reluctance to consume a new food does not differ between the two groups, but that non-eaters are less responsive to the intervention.

6.5.7.ii Questionnaire data

A total of 31 mothers completed and returned questionnaires and 15 of these pertained to children who had completed all stages of the intervention. Mothers were aged between 25 and 46 years (mean 36.4±1.5 years) with a healthy BMI (23.0±0.8kg/m2). Most mothers were of White British origin (93.3%) and the majority had breastfed (80%). Mothers that had BF did so for an average for 8.5m and children had been introduced to solid foods between 4 and 6 months (mean 5.2±0.2m). Children had been introduced to vegetables between 4 and 6 months of age (mean 5.3±0.2m) and fruits between 4 and 8 months (5.5±0.3m). An overall score for frequency of vegetable consumption per week was calculated by summing scores for each vegetable category included in the FFQ. Results showed that mothers consumed vegetables an average of 11.3 times per week with a minimum of 7 times and a maximum of 21. Fruit was consumed less frequently with an average of 8.3 times per week. The minimum was 0.5 times and the maximum was 14. Mothers reported that their children consumed both fruits and vegetables more frequently than they did themselves. Children consumed vegetables an average of 12.0 times per week (minimum 1.3; maximum 23) and fruits 10.1 times per week (minimum 0; maximum 21).

Factors influencing vegetable intake

Both post-intervention intake and change in intake of the FFL puree were positively correlated with the age at which children had been introduced to solid foods [r(15)=0.59, p=0.022; r(15)=0.58, p=0.023]. Post-intervention intake of the RE puree was negatively associated with children's scores for food neophobia [r(15)=-0.54, p=0.037] and positively related to the CEBQ factor desire to drink [DD; r(15)=0.65, p=0.009]. DD was also positively associated with post-intervention intake and change in intake of the control puree [r(15)=0.69, p=0.004; r(15)=0.73, p=0.002]. Mean intake across the conditioning phase was positively related to the frequency with which children consumed fruit at home [r(13)=0.66, p=0.015]. No effects of breastfeeding or choice of weaning food were found on vegetable intake during the intervention or frequency of intake at home.

A negative correlation observed between children's food neophobia scores and frequency of vegetable consumption at home demonstrated that children with higher CFNS tended to eat vegetables less frequently at home [r(14)=-0.60, p=0.024]. No significant differences were found between neophobia or food fussiness scores for eating categories, nor were they found to differ in levels of vegetable intake at home.

6.6 Discussion

In agreement with previous findings the results of this study demonstrate that RE is an effective strategy for increasing children's intake of a novel vegetable (Chapter 5; de Wild de Graaf, & Jager, 2013; Hausner et al., 2012; Remy et al., 2013). The increase in intake observed post-intervention in the FFL condition suggests that associative learning has occurred as intake of the target remains high even when offered without the added apple puree. FFL has been found to successfully increase pre-school children's vegetable intake and liking (Chapter 5; Hausner et. al., 2012; Havermens & Jansen, 2007; Remy et al., 2013), however, current findings suggest it offers no additional advantage over a simple repeated exposure technique (Chapter 5). Following the intervention vegetable intake had increased by approximately one child portion of vegetables (40g) and a significant shift in intake was evident after only three exposures. This finding lends further weight to the suggestion that very few exposures are necessary to increase intake of vegetables in preschool children (Chapter 5).

No significant effects of condition were found on intake, and intake of the control puree had also significantly increased by the end of the intervention. This is an interesting finding and could suggest that overall changes in intake were the result of developmental changes in the children. However, given that the intervention lasted around seven weeks, this is extremely unlikely and it is much more probable that repeated experiences with both experimental purees influenced children's intake of a third, different vegetable puree. Alternatively the results might demonstrate generalisation of the effects of repeated exposure. The positive affect for a stimulus induced via mere exposure results from increased familiarity (Zajonc, 1968) and can generalize to other previously novel stimuli where these stimuli are sufficiently similar (Gordon & Holyoak, 1983). It has been suggested stimuli which are similar to the exposed stimulus are not perceived by participants to be entirely unfamiliar. When these 'novel' but similar stimuli are presented in a way with which participants have previous experience, structural mere exposure can occur (Zizak & Reber, 2004). The assertion that children's previous experiences with the experimental purees stimulated intake of the control finds further support in Kalat and Rozin's (1973) 'learned safety' hypothesis. Within the current study children received at least twelve exposures to similar vegetable purees which were uniformly presented. Thus repeated experiences with these purees, without any negative outcome, may have taught children to trust that the foods they were offered were safe to consume.

Elevated levels of vegetable intake were still present one month post-intervention indicating that the effects of the experimental conditions remained stable during this time despite no further exposure to experimental purees. However, it is possible that children received exposure to the target vegetables in some form at home. Despite not being commonly offered to preschool children (Chapter 4) parents of children that participated in the current study were not asked to report on whether these vegetables were ever offered. Similarly researchers were unable to ensure that these vegetables were not introduced in the time between the end of the intervention and the follow up measures.

Due to the timing of the intervention and the age of participating children only a third of the original sample took part in the six month follow up and most were under two years of age at the time of the intervention. This subsample of participants continued to increase their intake, consuming an average of 114g of vegetable puree six months post-intervention. This represents an overall increase from baseline of more than two child portions of vegetables. Although increases in intake observed after the first follow up were not significant they are encouraging and suggest that repeated exposure may induce preferences that persist later in childhood.

Children over two years of age ate considerably less vegetable puree across the intervention when compared with the younger age group (Chapter 5). This is consistent with a peak in the neophobic response observed in children of this age (Addessi et al., 2005; Cooke et al., 2003; Dovey et al., 2008; Nicklaus, 2009). However, it may also indicate reluctance amongst older children to consume pureed vegetables, which they might associate with 'baby food'. Although children in the older age group ate consistently less than their younger counterparts, they did demonstrate a significant increase in intake following the intervention. This finding offers support to the observation that repeated exposure can successfully increase acceptance and intake of new foods in neophobic children (Birch, McPhee, et al., 1987). Frequency of exposure has been found to be positively associated with children's liking for vegetables (Chapter 4) and is particularly important when introducing vegetables later in childhood (Coulthard et al., 2010). It is possible, therefore, that increasing the frequency and/or number of exposures given to children in the older age group would eventually induce comparable levels of intake. This is yet to be investigated and it is just as possible that the effects of repeated exposure will remain limited until children leave the neophobic phase.

Repeated exposure has been shown to successfully increase children's vegetable consumption following a small number of exposures (Chapter 5; Chapter 6; Wardle, Herrera, Cooke & Gibson, 2003) and it is important to highlight the practical significance of this finding. In the UK, parents are advised to encourage acceptance of new foods by offering them 'lots of times' with some guidance suggesting up to 15 exposures (NHS, 2013). Such a high recommendation may seem unrealistic to parents (Birch, McPhee, et al., 1987; Wardle, Cooke, et al., 2003) particularly when faced with initial rejection and meagre levels of intake. Maier et al. (2007) observed that parents often stop offering new foods following the third rejection having judged them to be disliked. Reducing the recommendation or offering guidance on a pattern of food introduction, such as offering two or three similar vegetable purees on alternate days, may seem more achievable and help motivate parents to persevere (Maier, Chabanet, et al., 2008; Nicklaus, 2009). Within the current study, three exposures were sufficient to significantly increase vegetable intake, however, this finding should be interpreted carefully. As a result of employing a within subject design, the third exposure to either condition was in fact children's fifth or sixth overall exposure to a vegetable puree. This represents an important limitation of the study. While a within subjects design offered reduced variability, it is possible that a between subjects design may not have produced a significant increase in intake until the fifth exposure (Chapter 5).

A further limitation of the study is the use of vegetable purees. For the purpose of this study, offering the target vegetables as a puree reflects common practice in the UK (Chapter 4). However, the findings offer no insight into whether familiarity with a pureed vegetable will generalise to the same vegetable prepared and offered differently. It has been argued that a newly acquired flavour preference is specific to the context in which it is first experienced and takes time to generalise to other contexts (Mennella et al., 2006). Thus, future studies might look to investigate this by including post-intervention intake measures of target vegetables offered in solid form.

Overall results confirm that repeated exposure is a successful method of enhancing vegetable intake in young children. Within the current study FFL appears equally as effective, producing a similar shift in intake. However, in agreement with findings reported in Chapter 5, the addition of a sweet taste failed to enhance intake to any greater extent than repeated exposure. Given that positive changes were observed after very few offerings, a repeated exposure approach could provide parents with a simple yet effective technique for improving vegetable consumption.

6.6.1 Next steps

Repeated exposure significantly increases preschool children's intake of novel vegetable purees after relatively few presentations. In addition the effects appear to generalise to other similar purees. The extent to which this is true for vegetables which are offered in other forms is yet to be examined. Interestingly, children over the age of two years have consistently shown lower levels of intake across interventions when compared with younger children (Chapter 5 and 6). While this may be an effect of an increase in the neophobic response, it may also point towards a reluctance to consume pureed vegetables perceived to be 'baby food'. Of interest, therefore, is whether repeated exposure to none pureed vegetables can successfully promote vegetable intake, particularly in children less accustomed to being offered purees. Research into the effects of offering variety has suggested that frequent experiences with a range of vegetables can promote children's acceptance of novel vegetables and increase subsequent intake (Mennella et al., 2008; Nicklaus, Boggio, et al., 2005a; Nicklaus, Issanchou, & Boggio, 2004). In addition offering children variety in the vegetables presented as part of a meal or snack can work to increase overall vegetable consumption (Roe et al., 2013; Rohlfs Domínguez, Gámiz, Gil et al., 2013). In summary there is an indication that offering children repeated and frequent exposure to a mix of vegetables may encourage increased intake in children. Furthermore, snack time at child care settings may present an opportunity for increased exposure to vegetables. The following questions will therefore be addressed in the next chapter:

1. Is repeated exposure as effective for solid, raw vegetable targets?
2. Will the effects of RE generalise to other vegetables?
3. Can offering variety increase acceptance of similar foods?
4. Can offering a variety of vegetables as a snack increase overall intake?
5. Given appropriate guidance, can caregivers effectively implement an intervention to increase vegetable intake in young children?

Chapter 7 Repeated exposure and the variety effect

Abstract

Offering children repeated experiences with vegetables can promote liking and intake. Studies suggest that providing variety and choice in what is offered can also encourage acceptance and intake of vegetables. The present study set out to examine the effectiveness of offering variety as a strategy for increasing preschool children's vegetable consumption and to establish whether variety offers any advantage over simple repeated exposure. Children (*n* 95) aged 24 to 55m were assigned to a variety or repeated exposure condition and given a minimum of 5 (maximium 6) exposures to a snack of 5 mixed vegetables (variety) or a single vegetable snack (repeated exposure). Pre and post-intervention intake measures of both the single and 5 vegetable snacks were taken for each child. Follow up measures took place 1 month post-intervention (*n* 40). Vegetable intake increased significantly from pre to post intervention for snacks congruent to the condition to which children were assigned. Magnitude of change was smaller for the 5 vegetable snack. Follow up data revealed that snack intake remained significantly higher than baseline 1 month post-intervention. Results confirms that repeated exposure is effective in promoting children's vegetable intake and suggest an advantage to introducing children to new vegetables alone rather than mixed with other vegetables.

The author was responsible for the design of the study, the recruitment of the nurseries and children that participated as well as the collection of data and all analysis.

7.1 Introduction

Variety offered early in life benefits acceptance and consumption of a variety of foods later in life (Forestell & Mennella, 2007; Maier, Chabanet, Schaal, Issanchou, et al., 2007; Mennella et al., 2008). Variety in the foods and flavours offered within meals stimulates food intake in both adults (Hetherington et al., 2006) and young children (Gerrish & Mennella, 2001; Mennella et al., 2008). Conversely, a lack of variety suppresses intake (Hetherington et al., 2000; Sørensen et al., 2003). This effect of variety on food consumption can be explained in part by the drive to meet needs for a variety of nutrients for optimal health and the process of sensory specific satiety (SSS). SSS is generally defined as a gradual decline in the experienced pleasantness of an eaten food, when compared to other uneaten foods which remain pleasant and which are eaten if offered (Rolls et al., 1981). Offering a series of different foods stimulates intake compared to offering a series of the same foods (Nolan & Hetherington, 2009; Rolls et al., 1981)(Rolls, 1981; Nolan and Hetherington reference). Variety may slow SSS and interest in foods may be sustained for a longer period than if only one food is presented (Havermans, Janssen, Giesen, Roefs, & Jansen, 2009).

Offering a variety of foods simultaneously within a single course and successively, using multiple courses, have both been found to result in increased overall consumption (Berry, Beatty, & Klesges, 1985; Rolls, Van Duijvenvoorde, & Rolls, 1984). In their review Sørenson and colleagues (2003) have suggested that variety may increase intake and lead to overeating, perhaps with consequences for positive energy balance. However, this is obviously dependent on the types of foods being consumed. For example vegetables are low in energy density but high in nutrient density thus promoting intake of this food promotes health. Meengs et al. (2012) presented adults with meals which included half a plate (600g) of a single vegetable or the same amount of three different vegetables (200g of each). Intake of vegetables increased when offered three different vegetables than when offered a single vegetable. Similarly Roe and colleagues (2013) found that offering preschool children a variety of vegetables at snack time increased intake when compared to offering a single vegetable for snack. However, given that offering variety in this way also provides children with a degree of choice as to what they consume it is difficult to conclude that this is purely an effect of variety, or more specifically a delay in sensory specific satiety.

The role of choice in children's food intake, and particularly vegetable intake, has been highlighted in several studies which have focussed on parental feeding practices (Blissett, 2011; Patrick et al., 2005; Scaglioni et al., 2008). These studies have suggested that excluding children from the decisions about the foods they consume may lead to the development of unfavourable dietary habits in the long-term. However, eating habits are not improved *per se* when choice is offered (Crombie et al., 2009; Patrick et al., 2005).

Self-determination theory proposes that allowing a sense of choice or personal control increases an individual's intrinsic motivation (Deci & Ryan, 1985) and this has been found to be especially pertinent for children (Lepper, Sethi, Dialdin, & Drake, 1997). A controlling environment where there is an absence of choice reduces motivation and produces resistance. Taken together, self-determination theory and evidence from parental feeding practices suggest giving children some choice in food decisions will encourage vegetable intake (Hoerr, Utech, & Ruth, 2005; Patrick et al., 2005).

An intervention to examine the role of choice within a school meal setting found that a choice of new fruits and vegetables given to four and five year old children increased intake relative to four other 'teacher actions' of reward for consuming the foods, insisting that the children try the foods, modelling consumption and simple exposure (Hendy, 1999). A later study by Hendy and colleagues (2005) found that offering choice to slightly older children (aged between six and ten years) also produced increased consumption of and preference for fruits and vegetables. However, the longevity of these effects is unclear as preferences had returned to baseline 7 months post-intervention. Zeinstra et al. (2010) offered children a pre-meal or at-meal choice of two vegetables but this failed to enhance liking or intake. Zeinstra noted that children nonetheless enjoyed being able to choose their vegetables but perhaps the single exposure was insufficient to produce any positive effect on children's preferences. It is also important to note that since the experiment was conducted in a restaurant setting, unfamiliar to participating children using a more familiar setting might improve the effectiveness of a choice condition (Zeinstra et al. 2010).

Rohlfs Domínguez et al. (2013) examined the effect of providing primary school children with choice on their vegetable intake at school meal times. How choice was presented to the children varied across conditions. Children were either offered a choice of vegetables at the beginning of the meal or were exposed to a variety of vegetables within the meal so that they were able to choose throughout the meal which vegetables to consume. This was compared with a no-choice condition in which children were offered only one type of vegetable. Both choice conditions led to an increase in vegetable consumption when compared with offering a single vegetable (approximately 20g). Of particular interest is the fact that there was no significant difference between the two choice conditions suggesting that offering children choice by presenting them with variety can be just as successful in promoting vegetable intake as explicitly giving children a choice in what foods they wish to consume before a meal. However, it is important to note that the interchangeable nature of offering variety and providing choice can only exist where children are permitted to eat as much or as little as they like of a meal or snack. According to self-determination theory it is the sense of choice that is important in increasing an individual's motivation (Deci & Ryan, 1985). Therefore, offering children a variety of vegetables in a situation where they are asked to consume all of what is offered, or where they perceive pressure to consume every vegetable on offer is unlikely to produce the same effects.

Whilst repeated exposure is successful in significantly increasing preschool children's intake of unfamiliar vegetables (Chapters 3-6), the use of variety and choice could further enhance vegetable intake. Moreover, offering choice within a variety condition over time allows comparison of the relative effect of exposure versus choice. The present study set out to test the relative effect of repeated exposure to a single target vegetable included within a variety snack with repeated exposure to a target vegetable offered alone.

The hypothesis under investigation was that vegetable consumption would be greater for a 5 vegetable variety compared to a single liked vegetable at baseline, across exposures and post-intervention. It was predicted that repeated exposure to a vegetable snack (whether single or mixed) would increase intake of that snack from pre to post-intervention. Given that children would receive repeated exposure to their target vegetable in both the single and 5 vegetable snacks it was also predicted that intake of the target would increase in both conditions. Finally it was predicted that intake of the 5 vegetable snack would only increase in the variety condition.

7.2 Method

7.2.1 Participants

184 children aged two to five years old were recruited through local nurseries (Bradford, West Yorkshire, UK). A total of 182 children took part in the intervention as two children had left the nurseries prior to the intervention taking place. In order to optimise recruitment consent was obtained using an opt-out system which was entirely accepted by nurseries. Parents were given comprehensive information forms and asked to inform their nursery, or researchers directly, if they did not wish for their children to take part.

7.2.2 Design

The study was a between subjects design where children were assigned to one of two conditions; repeated exposure (RE) or variety (V) and this determined which snack they would receive throughout the intervention. The RE group were exposed to a single vegetable snack at test sessions and the V group would be offered the same weight of snack made up of 5 vegetables. Given that children in each class would be consuming snacks together during snack time, cluster randomisation was used for condition and vegetable assignment. This meant all children within the same class were offered the same snack. All procedures were approved by the Institute of Psychological Sciences (University of Leeds) ethics committee (12-0240).

7.2.3 Study foods

Based on the results of the vegetable survey (Chapter 4) target vegetables were selected as having similar scores for child liking and frequency of offering (see Chapter 2). These were baby sweet corn, celery and red pepper. Vegetable snacks were offered in 100g portions in clear freezer bags each labelled with the child's name. For the single (RE) vegetable snack this consisted of 100g of one of the three vegetables and for the variety snack this was 20g of each of these five vegetables with another 20g each of two further vegetables, green pepper and radish, which were selected using the same criteria.

7.2.4 Procedure

In order to minimise disruption to the usual routine of participating children snack sessions were run by the individual nurseries. Prior to the start of the study, booklets were prepared for each of the nurseries explaining its purpose, giving detailed instructions for staff and providing sheets on which participating children's attendance during the intervention could be recorded (Appendix D). Researchers met with the managers of each nursery and the staff member/s that would be responsible for overseeing the intervention and the booklets were introduced and discussed thoroughly allowing opportunity for questions and concerns to be raised. Several meetings were held to ensure that the protocol was wholly understood and where it was requested further sessions were held with other staff members who would be present during the intervention sessions.

Test sessions were held at children's usual morning or afternoon snack time and this was kept consistent throughout the experiment. Children were seated in small groups (5 to 10 children) along with one of the staff study leaders. The snacks were introduced to the children and they were told that they could try the snacks and eat as much or as little as they wanted. Where nursery staff usually sit and consume snack with the children, extra bags of snack were provided.

Children's baseline intakes of both snacks were measured before the intervention. They received 100g of the variety snack on one day and 100g of a single vegetable snack on another day at their usual snack time. Nursery staff had been instructed through the booklet to encourage children to eat in the same way as they normally would. Written guidance was provided stating the importance of avoiding pressure to eat and allowing children as much time as they needed to consume the snacks. The exposure period began 2 to 5 days after baseline. Participants received 5 or 6 exposures to either a variety vegetable snack or a single vegetable snack according to their condition assignment. All children in one class were offered the same snacks to avoid children asking for different vegetables. Intake of each vegetable was measured after each exposure. For the variety snack this meant intake of the whole snack was measured and of each of the constituent vegetables. Post-intervention measures of intake of both snacks took place 2 to 5 days later. A follow up measure of the single vegetable snack and variety snack took place a month post-intervention. A summary of the study procedure can be seen in Figure 7.1.

<table>
<tr><td>Week</td><td colspan="2">1</td><td rowspan="6">2-5 days</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td rowspan="6">2-5 days</td><td colspan="2">5</td><td rowspan="6">2-5 days</td><td colspan="2">10</td></tr>
<tr><td>Day</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td></tr>
<tr><td rowspan="2">Condition</td><td colspan="2" rowspan="2">Pre-test</td><td colspan="6">Exposures</td><td colspan="2" rowspan="2">Post-test</td><td colspan="2" rowspan="2">Follow Up</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td>RE (n=87)</td><td rowspan="2">1 veg</td><td rowspan="2">5 veg</td><td>1 veg</td><td>1 veg</td><td>1 veg</td><td>1 veg</td><td>1 veg</td><td>1 veg</td><td rowspan="2">1 veg</td><td rowspan="2">5 veg</td><td rowspan="2">1 veg</td><td rowspan="2">5 veg</td></tr>
<tr><td>Variety (n=97)</td><td>5 veg</td><td>5 veg</td><td>5 veg</td><td>5 veg</td><td>5 veg</td><td>5 veg</td></tr>
</table>

Figure 7:1: Summary of study procedure.

7.2.5 Questionnaires

Questionnaires were distributed to parents of participating children through their nurseries. These included a number of demographic questions, questions regarding milk feeding and weaning, a parental Food Frequency Questionnaire (FFQ) and a parental measure of food neophobia (Food Neophobia Scale (FNS)). A child FFQ, the Child Food Neophobia Scale (CFNS) and the Child Eating Behaviour Questionnaire were also included (see Chapter 2).

7.2.6 Anthropometric measures

Where parental consent had been granted participating children had their heights and weights measured. Measurements were taken by trained researchers using Seca digital scales and a Leicester SMSSE portable stadiometer. BMI z-scores were calculated using the WHO anthropometric calculator (http://www.who.int/childgrowth/software/en/).

7.3 Statistical analysis

Data were analysed using SPSS version 19.0 (SPSS Inc., Chicago, IL, USA). Children who consumed one child portion or more (≥40g) of their target vegetable at pre-test were excluded from the analysis on the basis that this demonstrated existing preference for this vegetable. All remaining children who completed the intervention were included in the analyses.

One way analysis of variance and chi-square tests were conducted to identify any differences in age, BMI and gender between the two condition groups. Repeated measures ANCOVA were performed on intake data (both absolute and delta). Snack type (1-veg and 5-veg) and time (pre-intervention, post-intervention and 1 month post-intervention) were included as within-subject factors and condition and target vegetable were included as between-subjects factors. These analyses was then repeated with time (first and last exposures) as the within subjects factor. Within group contrasts of intake were tested using paired t-tests. Further ANCOVAs were run to explore patterns of intake across the exposure period with exposures and condition as fixed factors. Consumption of the 5-item snack was also considered in more detail by including measures of intake of the 5 individual vegetables in the data analysis. Pearson's correlation was used to investigate relationships between intake pre and post-intervention for the two conditions and snack types.

Associations between factors measured within the questionnaires and intake measures taken throughout the intervention were examined using Pearson's correlation coefficient. Independent groups t-tests and one-way analysis of variance were used to explore effects of milk feeding practice and types of weaning foods used on vegetable consumption during the intervention.

7.4 Results

In all, 115 children were present for at least 5 of the 6 exposures and all pre-intervention and post-intervention measures. Ten children consumed ≥40g of the target vegetable at baseline and so were excluded from analysis.

Significant differences were found between the ages and BMI z-scores of the children in the two conditions. Removal of outliers for BMI z-score did not eliminate the difference between conditions and so these participants were retained in the analysis. The age variable was recalculated to be mean-centred and age and BMI-zscore were then included in the analyses as covariates.

Table 7:1: Participant characteristics (mean ± SEM)

		Condition		
	Total (*n* = 95)	Variety (*n* = 37)	RE (*n* = 58)	p-value
Age (months)	43.44 ± 0.87	40.00 ± 1.51	45.64 ± 0.94	0.001
Range (months)	25-55	25-54	25-55	-
Male/Female	53/42	21/16	32/26	0.53
BMI z-score	0.85 ± 0.15 (*n* = 75)	1.25 ± 0.14 (*n* = 32)	0.55 ± 0.24 (*n* = 43)	0.02

7.4.1 Intake pre and post intervention

7.4.1.i Total sample

Across groups intake at baseline did not differ by snack type (5-veg 8.1±1.3g; 1-veg 6.1±0.9g, p=0.16), and seemed very low at less than 10% of the snack offered. More of the single red pepper snack was consumed at baseline than the other single vegetable snacks (red pepper: 8.5±1.8g; baby sweet corn: 4.8±1.2g; celery: 4.2±1.3g) suggesting a pre intervention preference for red pepper. However, intake was not found to differ significantly by vegetable assignment (p=0.09; Figure 7.2). In contrast when baseline intake of the 5 vegetable snack was examined, baby sweet corn was eaten more than all other vegetables except radish (Figure 7.2).

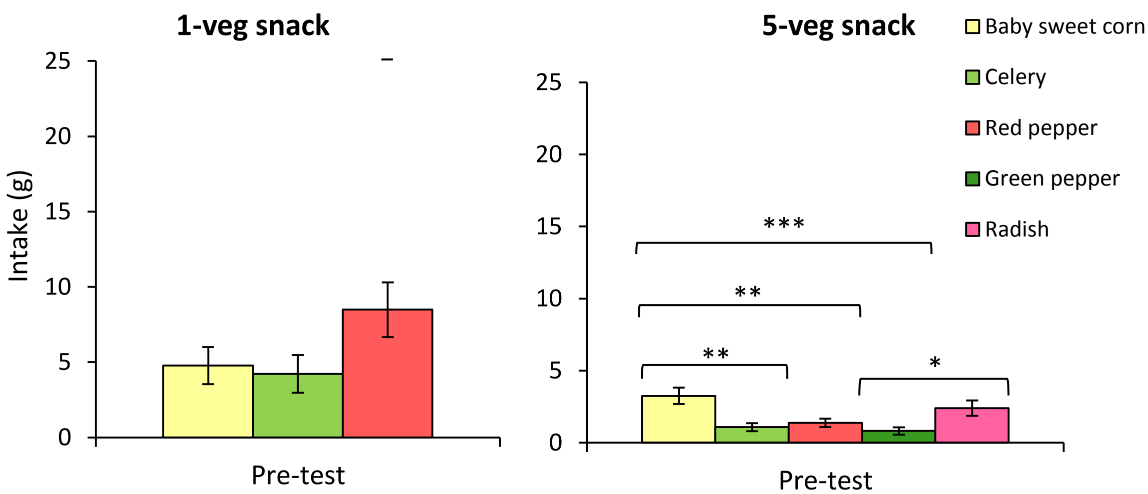

Figure 7:2: Mean pre-intervention intake of vegetables by snack type across conditions (±SEM)

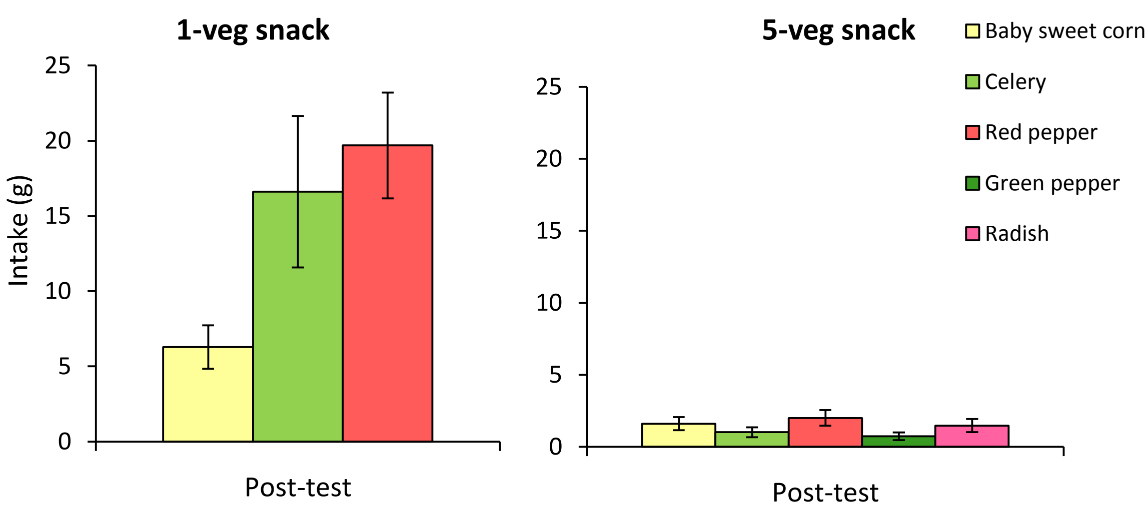

Figure 7:3: Mean post-intervention intake of vegetables by snack type across conditions (±SEM)

Post-intervention snack intake was significantly greater for the single vegetable snack (15.2±2.3g) than the 5-item snack (8.6±1.6g); [t (94) = -2.43, $p<0.05$]. Intake of the three vegetables offered as single snacks was similar and no significant differences in post-intervention intake of any of the component vegetables was found for the 5-item snack (Figure 7.3)

Analysis of covariance revealed a main effect of time with overall snack intake increasing significantly from baseline to post-intervention [F (1, 71) = 9.84, p<0.01]. Across groups the magnitude of change in intake was significantly greater for the single snack than for the 5-item snack [t (94) = -2.80, p<0.01]. Within the 5-item snack, intake did not increase of any single vegetable from pre to post intervention.

7.4.1.ii Within groups contrasts

Within group contrasts found no difference in baseline intake between snacks for the variety condition while the RE group ate significantly more of the 5-item vegetable snack at pre-test than the single vegetable snack (p<0.01). When analysis was repeated for post-intervention intake the RE group ate more of the single snack than the 5-item snack [5-item 6.6±1.4g; 1-item 18.9±3.5g, p=0.001] but no difference was found for the variety group (p=0.58).

<u>Intake by condition assignment</u>

Although no main effects of snack type or condition were found, a significant snack type x time x condition interaction was observed [F (1, 71) = 9.26, p<0.01]. Intake of the 5-item snack increased significantly over time in the variety group [t (36) = -2.60, p<0.05] but decreased slightly in the RE group (p=0.08). Similarly intake of the single vegetable snack increased significantly in the RE group [t (57) = -4.18, p<0.001] but no change was found for the variety group (p=0.17; Figure 7.4). No main effects or interactions involving age or BMI z-scores were identified. Change in intake for each snack differed significantly between conditions [Delta Variety F (1, 93) = 9.81, p<0.01; Delta Single F (1, 93) = 8.01, p<0.01]. Further investigation showed that change in intake only differed significantly between snack type for the RE group [t (57) = -4.05, p<0.01] and not the variety group (p=0.13).

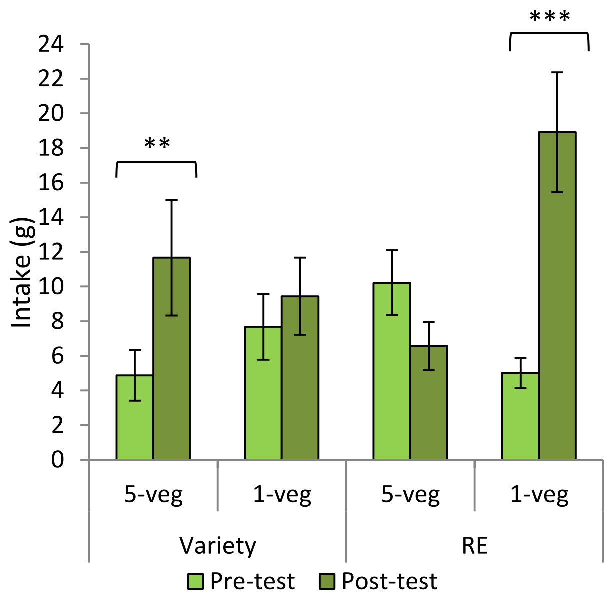

Figure.7:4: Comparisons of mean snack intake (5 veg/1 veg) by condition (± SEM)

<u>Intake by target vegetable assignment</u>

Baseline consumption of the two snack types (1-item and 5-item) did not differ for those assigned to the red pepper or baby sweet corn target vegetable groups, however, intake of the 5-item snack was significantly greater than single snack intake in the group who were given celery as their target vegetable [*t* (32) = -2.92, p<0.01]. Post-intervention intake of the two snack types did not differ for the baby sweet corn or celery groups but single snack intake was significantly higher than intake of the 5-item snack for the red pepper group [*t* (37) = -4.06, p<0.001].

Analysis of covariance revealed a main effect of time (p<0.01) with no main effects of snack type or target vegetable found. A significant snack type x target vegetable interaction was found [*F* (2, 70) = 7.04, p<0.01]. Within group contrasts showed that intake did not change for either snack in the baby sweet corn group. A significant increase in intake of the single snack from pre to post intervention was found for both the celery group [*t* (32) = -2.57, p<0.05] and the red pepper group [*t* (37) = -3.53, p=0.001] with no change found for the 5-item snack in either group. Change in intake of each snack did not differ by target vegetable assignment. The magnitude of change in intake did not differ between snack type for the baby sweet corn or celery group but was significantly greater for the single snack in the red pepper group [t (37) = -2.88, p<0.01].

7.4.2 Intake across exposures

Since some children missed some exposure sessions, intake was compared from first to last exposure. A significant main effect of time was observed with intake increasing significantly from the start to the end of the exposure period [F (1, 93) = 9.16, p<0.01]. No effects of condition or target vegetable were found. Overall mean intake across the exposure phase did not differ by condition or target vegetable assignment. Analysis of covariance revealed a significant main effect of the number of exposures [F (4.64, 308.04) = 3.90, p<0.01] with a significant increase in intake identified by exposure 3 (p<0.05) but no further significant increase after this (Figure 7.5). Within the 5-item snack only red pepper consumption increased from first to last exposure.

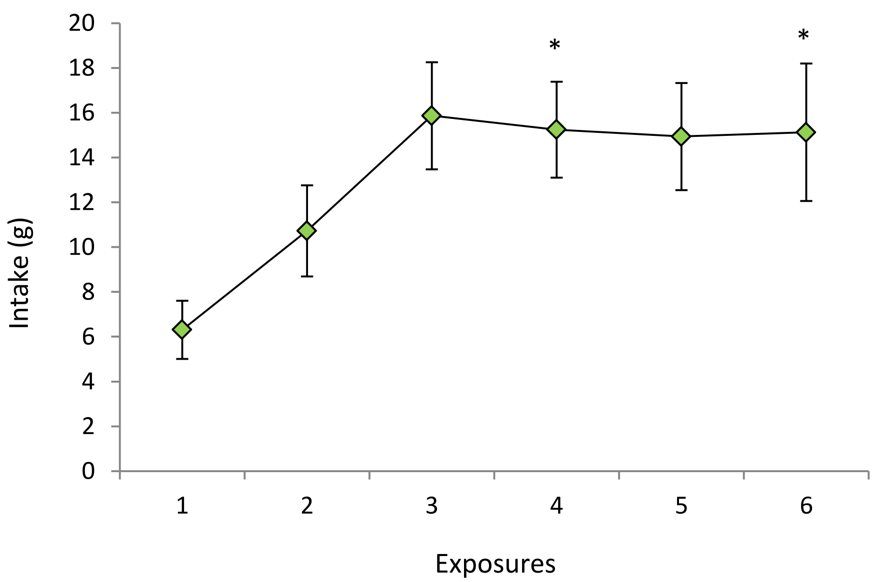

Figure.7:5: Mean snack intake across the exposure period (±SEM)

7.4.3 Intake at follow up

Of the 95 children who completed the intervention, 40 completed the 1 month follow-up. Snack intake increased significantly from pre-intervention to immediately post-intervention (p=0.001) and 1 month after post-intervention (p=0.001). No effect of condition or condition by time interaction was found. The effect of snack type on intake approached significance (p=0.06) with more single vegetable snack being consumed than the 5 vegetable snack. Intake increased significantly further between post-intervention and 1 month follow up (p<0.05). Further investigation revealed that while intake of the two snack types did not differ at any of the time points for the variety condition, intake of the single vegetable snack was significantly higher than the 5-item snack at both post-intervention time points for the RE group (Figure 7.6). No effects of age or BMI z-score were found.

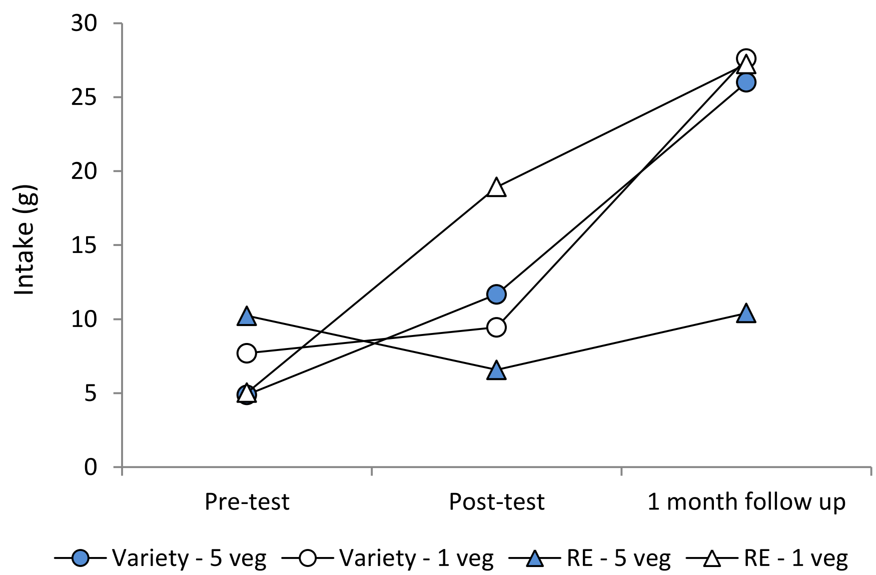

Figure.7:6: Mean snack intake at baseline, immediately post-intervention and 1 month after intervention by condition (Variety/RE) and snack type (1 veg/5veg)

7.4.4 Correlations

Pre-intervention intake of the 5-item snack was positively associated with post-intervention intake of both snack types: [5-item r (93) =0.31, p<0.01; 1-item r (93) =0.38, p<0.001]. However, baseline intake of the single snack was only associated with single snack intake post-intervention [r (93) =0.36, p<0.001]. No relationship was found between post-intervention intake of the two snacks, however, a significant negative correlation was observed between change in intake of the 5 vegetable snack and change in intake of the single snack [r (93)=-0.30, p<0.01], suggesting children who increased their intake of one of the snacks decreased consumption of the other.

7.4.5 Individual differences

22 parents of participating children completed and returned questionnaires, all of whom were mothers. Mothers were aged between 22 and 38 years (mean 30.12±1.37 years) with a healthy BMI (24.27±0.99kg/m2). The majority were of South Asian origin (59.0%) with white British mothers accounting for 31.8% of the sample. Mothers who breast-fed (BF) made up 81.0% (*n* 17) of respondents, including both those who exclusively breast-fed (*n* 11) or breast-fed alongside the use of formula feeding (FF, *n* 6). On average mothers that BF did so for 8.6 months. Children had been introduced to solid foods between 3 and 9 months (mean 5.8±0.3 months) with vegetables being introduced between 3 and 18 months of age (mean 7.8±0.8 months). Fruits had been introduced slightly earlier (6.8±0.6 months). 44.4% of parents used only home-cooked foods during weaning while 22.2% used only commercially prepared foods. The remaining parents used a combination of the two foods. In order to give an indication of frequency of vegetable intake for mothers and children FFQ scores for green vegetables, other vegetables and salad were summed. On average mothers consumed vegetables 13.5 times per week and fruits 7.3 times per week. Children consumed vegetables 9.9 times per week and fruits 7.4 times per week.

None of factors measured via parental questionnaires were related to vegetable intake during the intervention or at home.

7.5 Discussion

Offering preschool children a vegetable snack, whether comprising of a variety of vegetables or a single vegetable, significantly increased intake of vegetables. This result confirms the findings of previous literature which have shown repeated exposure to be a successful strategy for promoting young children's vegetable acceptance and consumption (Caton, Ahern, et al., 2013; de Wild et al., 2013; Hausner et al., 2012; Wardle, Cooke, et al., 2003). Interestingly the results of this study suggest that exposure to a target vegetable within a 5-item snack may limit the effects of repeated exposure, at least in the short term, when compared with exposure to the target vegetable offered singularly. Conversely, repeated exposure to a single vegetable snack appears to reduce acceptance and intake of a snack containing a variety of vegetables. Snack intake in both conditions increased significantly after just three exposures. However, the change in intake following this intervention was relatively low, representing only an increase of around one quarter of the recommended 40g child portion. This contrasts with previous studies described in Chapters 5 and 6 that have induced greater increases in consumption of 40g or more. However using raw vegetables in this study rather than puree means that texture and the additional effort involved in consuming the snack will produce smaller intakes.

In contrast to the variety experiments described earlier (Roe et al., 2013; Rohlfs Domínguez et al., 2013), this study found no difference in initial levels of intake between a variety and single vegetable snack. Intake of the 5-item snack was lower than for the single vegetable by the end of the exposure period. This could be explained, in part, by the allocation of vegetables from survey data and not personalised preferences. All of the vegetables which made up the 5-item snack were found in the survey to be reasonably similar in frequency of offering and liking scores for preschool children suggesting they were not highly familiar and were neutrally liked. In addition children were only offered these kinds of salad vegetables around three times per week and intake at home was not related to vegetable intake during the intervention (data not shown). Nonetheless, these measures were not taken specifically for participating children.

Cashdan (1998) suggested that children's reluctance to consume unfamiliar foods when presented mixed with other foods may be adaptive. She suggests that animals may prefer to consume new foods individually so that any negative post-ingestive consequences can easily be attributed and these foods can be avoided in the future, thus facilitating dietary learning. However, if this were the case it would be expected that baseline intake of the two snacks would differ, with intake of the 5-item vegetable snack being lower than the single snack. In addition, while these vegetables were not found to be frequently offered to children of this age group, it cannot be verified that all the vegetables contained within the 5-item snack were unfamiliar to the children. A recent study by Brown and colleagues (2012) found that young children's liking for foods can be influenced by the other foods with which they are presented. Highly disliked foods can act as a contaminant, reducing liking ratings for a previously acceptable or even liked food merely by having contact with them. In the current study 5-item snacks were presented to the children in small bags with all the vegetables mixed together. Contamination effects therefore offer a credible explanation for why children in the RE condition, who increased their intake of their target vegetable, failed to eat any more of that target when it was offered as part of the variety snack post-intervention. Brown's study found that the contamination effect was most pertinent for the younger children in their experiment, aged 4 years, who like the participant sample in the current study, would be considered to be at the peak of the neophobic phase of their development (Addessi et al., 2005; Cashdan, 1994; Dovey et al., 2008).

In line with our initial hypothesis, children in the RE condition, who were not repeatedly exposed to the 5-item snack, did not increase their intake of that snack at any point during the intervention. As discussed in previous chapters it is suggested that as well as building familiarity with novel foods, repeated exposure allows children to learn that unfamiliar foods are safe to consume (Kalat & Rozin, 1973). Therefore children who only received repeated exposure to a single vegetable target did not have opportunity to become familiar with the 5-item snack or to develop 'learned safety' for the four other vegetables contained within it. As a result consumption did not increase. While this result was anticipated, a lack of increase in intake for the single vegetable snack by children in the 5-item condition was surprising. It had been hypothesised that children given a variety of vegetables would not only increase their intake of that snack but also their target vegetable when offered this on its own. This is because children's target vegetable was included within these five, although in smaller quantities, meaning that repeated exposure to the variety snack also involved the opportunity to become familiar with the target. The fact that this increase in consumption was not observed suggests that frequently offering children a number of vegetables at one time may somehow inhibit the effects of simple repeated exposure. A possible explanation for this is that providing children with a variety of vegetables, and therefore a level of choice as to what they eat, means that the vegetables effectively compete to be consumed. Children in both conditions ate a similar amount of vegetables across the exposure period. However, for children in the RE group this meant between 5 and 20g of their target while for the variety condition intake was made up of up to five different vegetables with an average intake of 1 to 5g. This low intake may mean that children did not consume enough of the vegetables within the variety snack to experience the effects of repeated exposure.

Only a few exposures are needed to produce the mere exposure effect for novel foods (Caton, Ahern, et al., 2013; Wardle, Herrera, et al., 2003). The best effects have been noted for vegetable soups and purees showing quite dramatic increases in intake (Caton, Ahern, et al., 2013; de Wild et al., 2013; Hausner et al., 2012; Remy et al., 2013). Experiments that have employed solid vegetables, however, have had less consistent and sizeable effects. A recent study by O'Connell, Henderson, Luedicke, and Schwartz (2012) failed to demonstrate any increase in children's consumption of raw vegetable snacks while another study by Anzman-Frasca and colleagues (2012) found increases in liking but not intake. Despite this other studies that have repeatedly exposed children to raw vegetable targets have successfully increased their intake, but in congruence with the current study, these increases in intake tend to be relatively small (Remington, Anez, Croker, Wardle, & Cooke, 2012; Wardle, Cooke, et al., 2003).

Differences in intake levels between vegetable purees or soups and raw vegetable snacks are to be expected. Recent research has demonstrated that the texture of a food is highly influential in terms of the speed with which it is eaten and how much of it is consumed (de Graaf and Kok, 2010). Foods that can be consumed quickly result in greater intake and low satiating effects resulting from the low oral exposure involved their consumption. It follows that raw vegetables which require more chewing will be consumed more slowly and in smaller quantities than a vegetable puree. While the positive shift in vegetable consumption observed in this study is relatively small, it does represent an increase of around two or three pieces of a vegetable and this result is promising. Current guidance does suggest that parents may need to offer a new food 10-15 times before it becomes liked (NHS, 2013), many more than the minimum of 5 exposures used during this intervention. It may well be that when the new foods that are offered present potentially challenging textures in addition to a novel taste, a greater number of exposures are needed before that food becomes liked. Further research focused on repeated exposure to solid vegetables would assist in determining how many exposures are sufficient in producing equivalent increases in consumption.

Although limited by the lack of personalised information about preference or familiarity, this study has shown that variety involving vegetables which are not liked, might limit the repeated exposure effect. This might be particularly true of children at this age as they enter the period of highest neophobia. The use of cluster randomisation also presents a limitation of this study, particularly given that the intervention was implemented by the staff teams of each individual nursery rather than a research team. Despite staff being provided with detailed instructions and advice on how to approach the study, the absence of researchers in the classroom means it is impossible to ascertain whether snack sessions were consistently managed on each test day both within that classroom and between nurseries. Slight differences in the way the study protocol was implemented by the different staff teams, and individuals within those teams, may have had some influence on the effectiveness of the intervention and how much of the snacks were consumed. This method may therefore have produced a biased estimate of effect. In addition the use of cluster groups also accounts for the significant difference in age between condition groups.

Overall the current study offers further support to the growing body of evidence of the effectiveness of repeated exposure. In agreement with previous work, the results of this study show that repeated exposure can be used to successfully increase preschool children's vegetable consumption and demonstrate that it presents an effective strategy over and above variety, even for parents whose children may be entering the food fussy or neophobic phase of their development.

Chapter 8 General Discussion

Children's vegetable intake falls well below recommendations across many European countries. There are many explanations for low levels of consumption; however, prominent amongst them is children's general dislike for vegetables which serves as a major barrier to intake. Research has demonstrated a number of effective strategies for promoting vegetable intake in young children but few have been consistently successful. Consequently the research described within this thesis aimed to further explore food preference development in young children with a specific focus on increasing vegetable consumption within the early years of life. The current chapter aims to provide a synthesis of the research findings and discusses them within the context of current literature. The implications of this work are then considered along with potential directions for future research.

8.1 Synthesis of findings

The main findings of this thesis are summarised in Figure 8.1. Three key areas for consideration emerged from the research: maternal perception and experience; exposure and vegetable intake; age and individual differences.

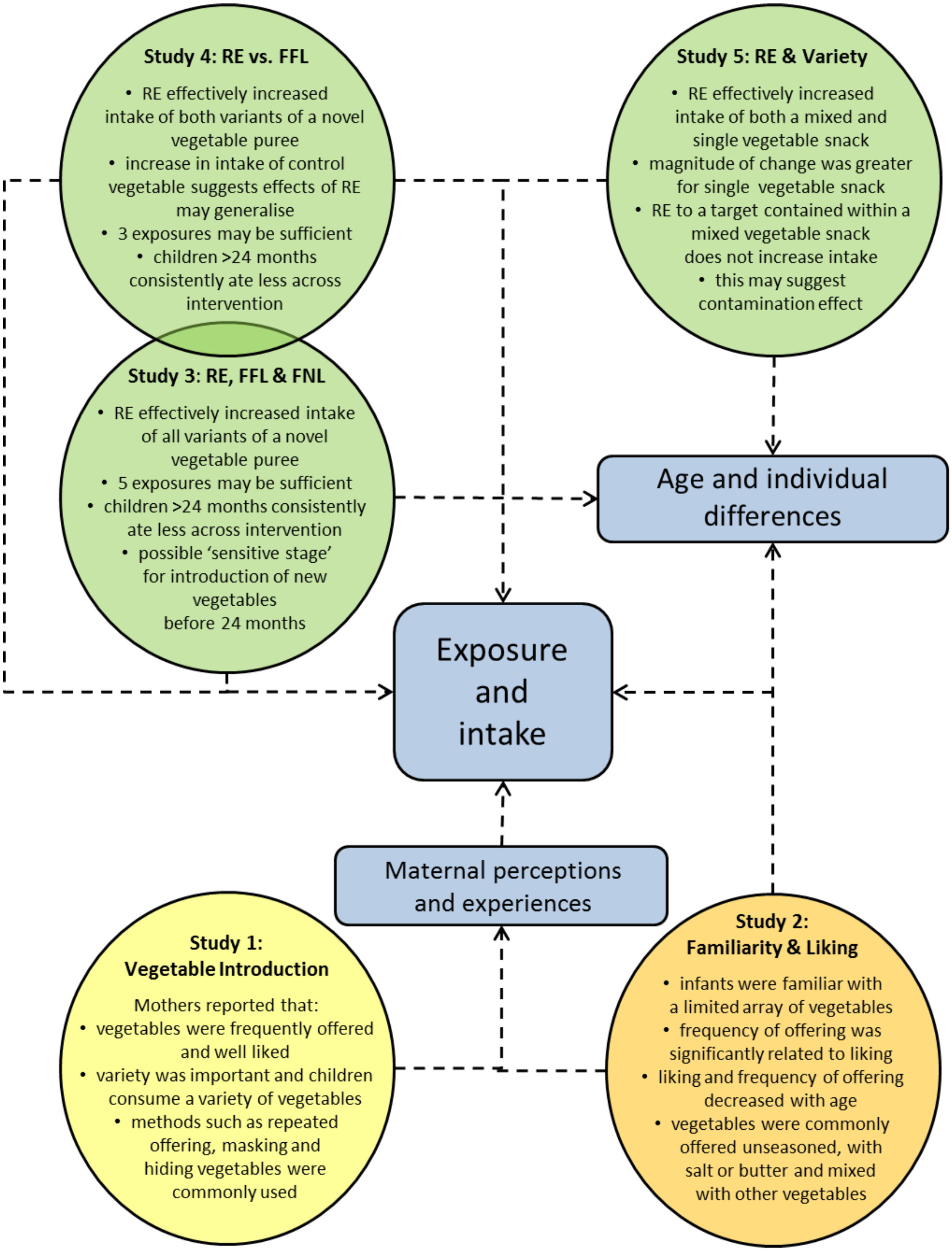

Figure 8:1: Overview of main findings and emerging themes

8.1.1 Maternal experiences and perceptions

The initial aim of the thesis was to examine children's experience with vegetables during the first three years of life in an attempt to build a comprehensive picture of how mothers approach vegetable introduction. This was achieved by asking mothers to report on when and how they introduced vegetables, their preparation techniques and their child's intake and liking (Chapter 3 and 4) as well as how frequently vegetables were consumed as part of the familial diet (Chapters 3, 5, 6 and 7), thus mothers' experiences and perceptions were central to the findings of this thesis. Furthermore, this in turn undoubtedly influences mothers' subsequent behaviours, both in terms of how they approach their children's vegetable consumption and how they report it.

8.1.1.i Maternal experience of vegetable introduction

Mothers reported that their children had been introduced to approximately three vegetables during the first month of weaning, comparable to the number previously found to be offered by German and French mothers (Chapter3; Maier et al., 2008). By the age of twelve months this had increased to an average of twenty-five vegetables, however, only a very small number were offered regularly (Chapter 4). Interestingly Study 2 revealed that between the ages of 12 and 36 months very few vegetables were introduced to UK children's diets and this result was replicated within the Danish sample. This suggests that children in both countries become familiar with the largest proportion of the vegetables in their diets within the first six to eight months of solid food introduction when compared with the subsequent two years. Mothers' tendency to acquaint their children with a range of vegetables early on is consistent with children's willingness to accept and consume new foods before twelve months of age. Within the literature this early stage of food introduction is often referred to as a 'critical period' or 'window of opportunity' during which children are particularly receptive of the foods being offered (Cashdan, 1994; Harris, 1993). It is suggested that this opportunity should be exploited by parents in order to promote early preference development for healthy foods (Cooke, 2007; Coulthard et al., 2009; Coulthard et al., 2010; Harris, 2008). The findings from Study 2 appear to suggest that mothers *are* introducing the broadest range vegetables, in this first six months of weaning (Chapter 4). However, as current UK guidance around weaning gives little mention of this ‘window of opportunity’ it is most likely that mothers are responding to the behaviours they observe in their children, rather than to official recommendations. That is to say that mothers whose children exhibit a willingness to try vegetables when offered will in turn continue introducing them.

After 12 months the number of new vegetables that were offered to try decreased along with how often children were offered vegetables (Chapter 4). These findings reflect a broadening of children’s diets with age. The diversity of a child’s diet is likely to increase after twelve months of age as they are introduced to a wider range of foods. Similarly the inverse relationship between the amounts of vegetables a child has been introduced to and how often they are offered suggests that vegetables may be offered less frequently to accommodate increased variety of other foods in the child’s diet (Chapter 4). However, this explanation fails to take into account the fact that mothers are introducing the greatest number of new vegetables before twelve months. It seems more likely that the decline in offering is a direct consequence of the decrease in vegetable liking that mothers report across the same period (Chapter 4), as the neophobic response to food sets in (Birch, McPhee, et al., 1987; Dovey et al., 2008). Faced with consistent rejection mothers’ perceptions of their children’s liking for vegetables will decline and mothers will offer vegetables less frequently. Equally mothers may be less inclined to introduce new vegetables with children less receptive to new foods generally. This highlights the extent to which mothers’ perceptions of children’s liking for foods can dictate if and how frequently they are offered (Carruth, Ziegler, Gordon, & Barr, 2004; Savage et al., 2007). Research suggests that reducing vegetable introduction and offering in response to an increase in food refusal is likely to be counterproductive. Repeated experiences with foods can reduce rejection in neophobic children (Birch, McPhee, et al., 1987) and Study 2 demonstrated that those vegetables that remained frequently offered were still liked by children whose overall liking for vegetables was found to decrease (Chapter 4).

8.1.1.ii Interpreting maternal reports: perceptions and reality

Overall results in these studies indicate low levels of vegetable intake amongst UK children, consistent with current national statistics. However, there is some inconsistency between the quantitative and qualitative data relating to vegetable consumption (Chapter 3, 4, 5, 6 and 7). In interviews mothers reported regularly offering children a variety of vegetables and suggested that vegetables were well liked and frequently consumed (Chapter 3). The suggestion that children are eating vegetables frequently was not supported by the results of FFQs. This may point toward some level of discrepancy between mothers' perceptions of their children's vegetable consumption and actual levels of intake. More specifically it may indicate that while mothers are aware of what their children are consuming, they perceive overall intake to be higher than it is. The use of entirely self-report measures makes this issue difficult to resolve as it also emphasises the limitations of these methods.

While maternal perceptions of the quality of their children's diets are an important determinant of food intake, they are not always accurate (Kourlaba, Kondaki, Grammatikaki, Roma-Giannikou, & Manios, 2009). Mothers have a tendency to overestimate children's healthy eating behaviours, such as vegetable intake, and to underestimate those that may be considered unhealthy (Kourlaba et al. 2009; Vereecken & Maes, 2010). This raises questions around the reliability of maternal reports of children's vegetable consumption. In addition to relying on the perceptions of respondents, self-report is open to a number of biases such as a respondent's desire to appear favourably to researchers and inaccurate recall (Fadnes, Taube, & Tylleskär, 2008; Hebert, Clemow, Pbert, Ockene, & Ockene, 1995). Both of these have been found to be particularly pertinent to research investigating health related behaviours (Coughlin, 1990; Newell, Girgis, Sanson-Fisher, & Savolainen, 1999; Prince, Adamo, Hamel et al., 2008). Social desirability bias predicts that mothers with a tendency to engage in socially desirable responding were more likely to overestimate frequency of vegetable intake in their families when completing questionnaires (Chapter 4, 5, 6 and 7). It also offers an explanation for mothers' reports of high levels of vegetable intake when they came face to face with the researcher in interviews (Chapter 3). That is to say mothers may experience a greater desire to respond favourably when responding directly to a researcher in an interview situation, than when responding to a questionnaire which they will return by post. In the same way those mothers more susceptible to errors of memory may well have *underestimated* intake as might those who failed to take into account their child's meals and snacks within child-care settings. Studies have shown that while parents are reasonably accurate in reporting children's diets at home, they may have less awareness of what is consumed outside of the home (Baranowski, Sprague, Baranowski, & Harrison, 1991; Livingstone & Robson, 2000). However, a study by Parrish and colleagues (2003) demonstrated that parents of preschool age children remained accurate in their reports of children's diets even when children regularly consumed meals in their child-care setting. This reflects both the practice of mothers bringing meals to nurseries and having a record from nursery staff about what was eaten there . In several studies, parents reported their own and their children's dietary habits within a single questionnaire (Chapter 5, Chapter 7) which may have exaggerated correlations between parent and child vegetable intake. This suggestion is further supported by the results of Study 4 (Chapter 6). As part of this study, parents completed FFQs relating to their own diet and their child's diet separately at two different time points and no relationship was found between levels of vegetable intake.

Although relying on parental report measures of dietary preferences and behaviours may present a limitation of this thesis, these measures were selected as being most appropriate for the studies in which they were included. Clearly, given the age of participating children and differing levels of cognitive development, it would not have been possible to rely on children's reports of their own vegetable intake and liking. Similarly, the scale of the studies included within this thesis meant the use of observational measures of consumption or measures of biological markers were not feasible. The FFQ is a validated and commonly used dietary measure and previous comparisons with observational and biomarker measures have shown that parents are able to use it to accurately indicate fruit and vegetable intake in young children (Byers, Trieber, Gunter et al., 1993; Linneman, Hessler, Nanney et al., 2004). In addition studies have demonstrated that mothers are reliable judges of their children's like and dislike for foods (Skinner, Ruth Carruth, Moran Iii et al., 1998; Skinner, Carruth, Bounds, & Ziegler, 2002). Mothers' perceptions of their child's liking for foods are the result of a number of verbal and non-verbal indicators. Forrestell and Mennella (2012) for instance, found that mothers attend to facial expressions and time spent eating a food when forming judgments of their child's enjoyment of foods. At the most basic level food refusal and food acceptance give an indication of whether or not a food is liked, as does how much of the food is consumed (Eertmans, Baeyens, & Van den Bergh, 2001). It is important to consider that these behaviours are sensitive to other factors, such as the mood of the child that day and can be seen as much as a measure of wanting as they are of liking if taken at a single point in time. However, the question "how much does your child like...." asks for an overall judgment of liking based on a child's previous experience with each vegetable (Chapter 4). For this reason maternal perception of liking in this instance is likely to be far more accurate measure than a single observation by researchers.

8.1.1.iii Summary

The earliest years of childhood are a time that children acquire familiarity with a range of foods as they are introduced into the diet. The findings of this thesis suggest that the initial rate of vegetable introduction, which averages at around one vegetable per week for the first six months, begins to decline following the child's first birthday and continues to do so up to the age of three years (Chapter 4). The frequency with which children consume vegetables and how much they like them decreases with age (Chapters 4 and 5). These reported reductions in vegetable offering, intake and liking coincide with children's progression into the neophobic stage supporting the idea that mothers might adapt their food choices based on both the children's preferences and their reaction to vegetables (Carruth et al., 2004). Parents' perceptions of children's likes and dislikes seem to shape what vegetables are offered to children and how frequently. Guidance for parents which emphasises the importance of continuing to offer vegetables that are initially rejected may be beneficial. The role of exposure is known to be important but clearly this can be moderated by characteristics of the infant (such as neophobia) or the perceptions of the mother.

8.1.2 The importance of exposure

Experience with vegetables increases familiarity and liking. But it is not known what types or frequency of exposure produce the best outcomes. Mothers reported a range of preparation techniques and described specific strategies which they employed in an effort to promote children's intake (Chapters 3 and 4). While preparation methods were not found to influence children's liking, the frequency with which children were offered vegetables was related to how well vegetables were liked (Chapter 4). The role of exposure was explored experimentally in Chapters 5, 6 and 7 and comparisons were drawn between simple repeated exposure and other methods which had been reported by mothers.

8.1.2.i Flavour flavour learning (FFL) and repeated exposure

Only very young children, between six and twelve months, were likely to be offered vegetables in pure form (Chapter 4). Children over this age were far more likely to receive vegetables that had been seasoned or were served with some additional condiment or sauce (Chapter 4). This is done to improve the palatability of vegetables by enhancing or masking the flavour. This process incorporates aspects of associative conditioning via flavour flavour learning or flavour nutrient learning. This is as a result of learnt associations between the flavour of a vegetable and that of a well-liked seasoning or condiment/sauce or the additional energy associated with accompanying sauces or dips.

Findings related to associative conditioning confirmed that FFL can be successfully applied to the promotion of vegetable consumption (Chapters 5 and 6). Children ate significantly more of a novel vegetable which had been paired with either a sweet taste or additional energy, even when the vegetable was later presented in an unadulterated form. Despite this, associative conditioning appears to offer no additional benefit to repeated experiences with a vegetable in its pure form (Figure 8.2). Other studies which have looked to compare these techniques have produced similar findings (de Wild et al., 2013; Hausner et al., 2012; Remy et al., 2013), although the degree to which associative conditioning is effective may be dependent on children's age as well as other individual differences (Yeomans, 2010). The success of FFL is dependent on the evaluation of the unconditioned stimulus. Given that young children exhibit an innate preference for sweet tastes, it was assumed that the addition of sugar or a sweet tasting fruit puree would induce preference for a vegetable puree. However, differences in children's liking for or perception of sweet taste may have influenced children's responses to FFL (Yeomans, Leitch, Gould, & Mobini, 2008). Similarly the effects of both forms of flavour conditioning can be dependent on participants' level of hunger (Mobini et al., 2007). Although children's hunger was not measured as part of the present studies, all vegetable purees were offered at children's normal morning or afternoon snack time, when it was considered that they were likely to be hungry. Despite this, differences in hunger levels at snack time may have influenced responses to conditioning.

Children responded similarly to the all three strategies, however, there was a tendency to consume less of a target vegetable when paired with increased energy (Chapter 5). Despite the likely development of conditioned satiety (Brunstrom, 2007; Zandstra, Stubenitsky, De Graaf, & Mela, 2002) children's intake of a plain version of the target had increased post-intervention. This might suggest that while children adjusted intake of the higher energy puree across exposures they had not learned to associate the added energy with the flavour of the vegetable when in was offered unaltered. A near identical study conducted with children between 6 and 12 months found that intake of a plain vegetable target did not increase following ten exposures to a high energy version (Remy et al. 2013). While this could suggest that flavour nutrient learning had not taken place, it may also indicate that younger children, who demonstrate an innate ability to regulate their energy intake (Fox, Devaney, Reidy, Razafindrakoto, & Ziegler, 2006), are more sensitive to the effects of flavour nutrient learning and consequently, conditioned satiety.

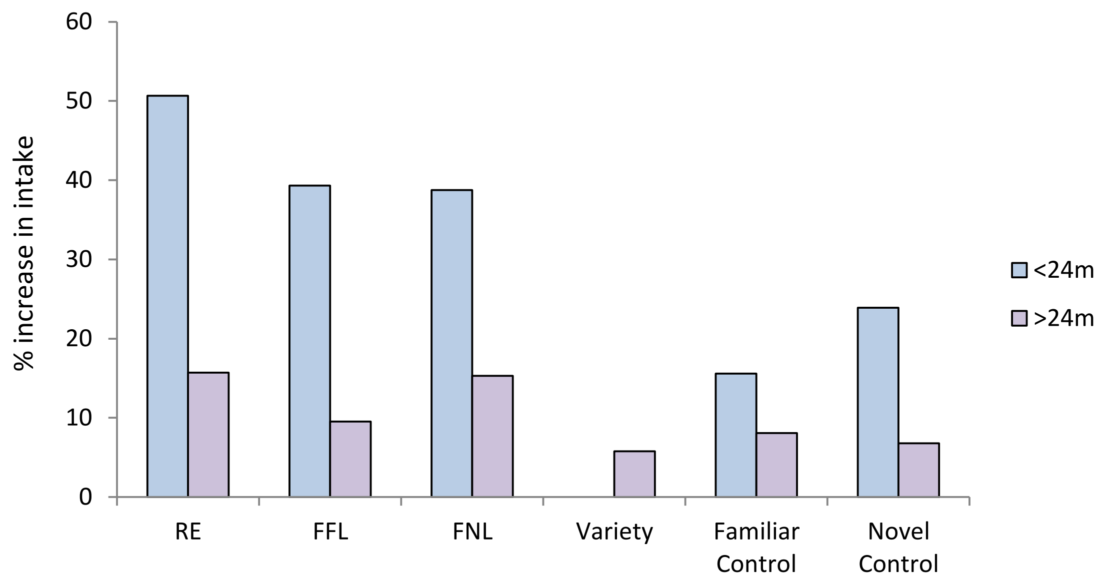

Figure 8:2: Overall percentage change in intake from baseline to post-test of target and control vegetables (familiar control = carrot control, Study 3; novel control = third vegetable puree, Study 4) by condition (RE, FFL, FNL, Variety and Control) and age group (<24m/>24m) when data for all interventions is collated. Study 5, the variety study, included only children in the >24m age group.

While mothers' use of seasonings and condiments may promote children's vegetable intake, the additional effort involved in preparing vegetables in this way appears to be unnecessary. The use of repeated exposure is successful (Chapters 5, 6 and 7; Anzman-Frasca et al., 2012; Hausner et al., 2012; Remy et al., 2013; Wardle et al., 2003) and as a strategy for increasing children's vegetable consumption it may be attractive to parents given its relative simplicity (Wardle et al., 2003). In addition the success of pairing vegetables with familiar flavours or additional energy may be dependent on the age or other characteristics of the child (Yeomans, 2010). However, offering novel vegetables with well-liked dips or sauces may help to overcome children's initial resistance to trying an unfamiliar food (Anzman-Frasca et al., 2012).

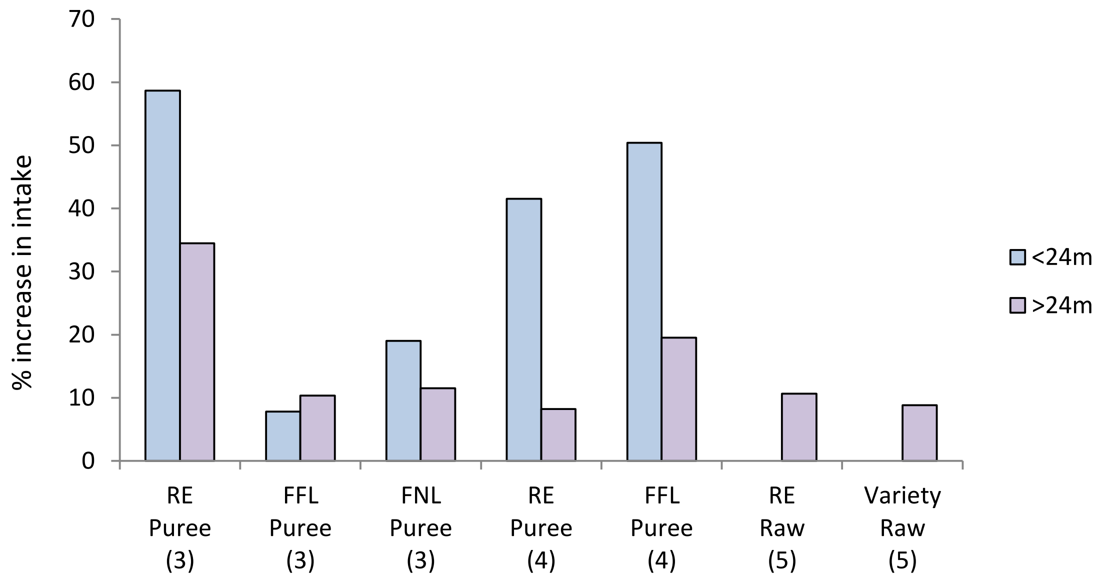

Figure 8:3: Percentage change in intake from baseline to fifth exposure for each intervention, by condition (RE, FFL, FNL and Variety) and age group (<24m/>24m). Numbers in brackets reference the relevant study. Study 5 involved children from the >24m age group only.

8.1.2.ii Repeated exposure and vegetable liking and intake

Familiarity is a key determinant of children's acceptance and rejection of foods (Cooke et al., 2007) and building familiarity through repeated exposure enhances preference and intake (Birch et al., 1987; Howard et al., 2012; Williams et al., 2008). It appears that allowing children repeated and frequent opportunities to taste new vegetables has far more impact on children's acquisition of preferences than preparation method. Vegetable intake increased significantly irrespective of additional flavours or energy and for both pureed and raw vegetables (Chapters 5, 6 and 7). However, it is worth mentioning that while a significant positive shift in intake of raw vegetables was observed following repeated exposure, the magnitude of the change in intake across the intervention and at post-test was much lower than had previously been observed for puree (Chapter 7). This is to be expected given the additional masticatory effort and time involved in consuming solid foods when compared with semi-solid purees (de Graaf, 2011). In addition when the number of exposures was considered, the difference in intake between raw and pureed vegetables decreased (Figure 8.3). Grounded in Zajonc's (1968) mere exposure effect the success of repeated exposure depends on repeated experiences with stimuli which occur in the absence of negative affect (Zajonc et al., 1974). Repeated experiences with new or unfamiliar foods, without negative consequence, facilitate 'learned safety' (Rozin & Kalat, 1971) allowing children to trust that new foods are safe to consume. In addition to building familiarity and preference for a specific vegetable, the effects of repeated exposure can generalise to other similar, previously novel vegetables (Chapter 6). Children ate significantly more of a control root vegetable puree following regular exposure to two similar purees over several weeks. Consistent with the structural mere exposure effect described by Zizak and Reber (2004) it is likely that this third control vegetable, which was presented in an identical manner, was no longer perceived as unfamiliar (Gordon & Holyoak, 1983). The structural dimension of mere exposure in the context of food preference development is yet to be examined. However, it is reasonable to suggest that children's previous experience with vegetable purees during the intervention meant that being offered a vegetable puree snack was not unfamiliar to them and, perhaps more importantly, meant children were confident that the puree was safe to eat. The level of similarity between food stimuli appears to be an important factor in determining whether the effects of repeated exposure generalise from one to another. Children who were repeatedly exposed to a single raw vegetable snack did not increase intake of other raw vegetables, when offered in an identical way (Chapter 7). This finding was expected, given that root vegetable purees are perceived as more similar than raw vegetable snacks which differed greatly in terms of colour, taste and, to some degree, texture. It does, however, lend support to the idea that the sensory characteristics of food stimuli must be relatively homogeneous for generalisation of repeated exposure effects to occur (Gordon & Holyoak, 1983; Mennella et al., 2008; Zizak & Reber, 2004).

Increasing acceptance of vegetables by repeated exposure may also be context specific (Sullivan & Birch, 1990). That is to say that repeated experiences with a vegetable prepared in a particular way, for example pureed, will not generalise to the same vegetable when offered in a more solid form. The findings of the present thesis suggest that this context specific preference may also extend to the manner in which a vegetable is presented. Children consumed significantly more of a raw vegetable snack presented on its own following five exposures to that snack presented that way (Chapter 7). Despite this, when offered the same previously exposed raw vegetable mixed with other vegetables, children's intake remained comparable to baseline levels. There are several possible explanations for this. The first is that children had become familiar with the vegetable being offered alone and when offered within a mixed snack it was no longer perceived as familiar. This might be as a result of being less recognisable within a bag of mixed vegetables. However, given that most children emptied the snack onto a plate before deciding whether to consume the vegetables, it might instead indicate that the presence of the other vegetables influenced intake in a different way. This will be discussed in more detail in the following section which addresses the influence of how vegetables are presented and how frequently.

8.1.2.iii The nature of the exposure

Repeated exposure to a single vegetable promotes liking and intake of that vegetable (Chapters 5, 6 and 7; Hausner et al., 2012; Maier et al., 2007; Lakakula et al., 2010; Remy et al., 2013; Wardle et al., 2003). In terms of food preference development, offering children repeated experiences with single vegetable tastes may therefore be favourable. Conversely, a lack of variety in what is offered increases the possibility of monotony effects, via sensory specific satiety (Hetherington et al., 2000; Sørensen et al., 2003), and can limit preference development, inhibiting acceptance of new vegetables later on (Krebs-Smith et al., 1987; Nicklaus, 2009; Nicklaus, 2011; Nicklaus, Boggio, et al., 2005a). Offering children a variety of liked vegetables within meals and snacks can increase overall vegetable consumption when compared with the same size portion of a single liked vegetable (Roe et al., 2013; Rohlfs Domínguez et al., 2013). However, when introducing children to new vegetables, the effects of offering variety become more complex.

Offering children a mix of novel or unfamiliar vegetables within a single meal or snack appears to inhibit consumption and remove the opportunity for repeated taste exposure

(Chapter 7). This reflects Cashdan's viewpoint that animals prefer to consume new foods individually so that negative post-ingestive consequences can easily be attributed and harmful foods can be avoided in the future (Cashdan, 1998). Children's reluctance to consume new or unfamiliar vegetables when served together may therefore be adaptive in that it facilitates dietary learning. It is important to note that this effect was demonstrated in children aged between two and five years, a period during which children are particularly cautious of unfamiliar foods and rely much more on visual evaluations prior to tasting (Chapter 7; Addesisi et al., 2005; Dovey et al., 2008; Tuorila, Meiselman, Bell, Cardello & Johnson, 1994). This effect may not be reproduced in a younger sample of children. For children in the earliest stage of weaning (four to nine months), Mennella et al. (2008) were able to demonstrate that introducing a new vegetable alongside a familiar vegetable eased its acceptance. Again, this result may be restricted to this age group of children, who are generally more receptive of new foods.

Using this strategy with older children, who are likely to be more neophobic, could have the opposite effect and hinder acceptance of both the new and previously liked vegetables (Chapter 7). A possible explanation for this effect is that the unfamiliar vegetables are viewed by children as contaminants. Two studies by Brown and colleagues demonstrated that a child's preferences for and acceptance of liked foods decrease when they have been seen to be in contact with a disliked food (Brown & Harris, 2012; Brown et al., 2012). The degree to which these contamination effects are evident seems to be dependent on the age of the child, with those aged around four years exhibiting the strongest response. Brown and Harris (2012, pg. 537) argue that food neophobia might "act as a catalyst to prompt a perceptual, food-based disgust" making neophobic children more likely to reject contaminated foods, even when the potential contaminant is removed. While these studies included pairing of liked and disliked foods and not those which are familiar and unfamiliar, it is reasonable to suggest that children at the height of the neophobic phase might perceive an unfamiliar vegetable as disliked or potentially harmful. In a review of children's development of food variety, Nicklaus (2009) suggests that exposure to variety before children enter the neophobic stage, allows them to develop a taste for variety that endures later in childhood. Introducing young children to a broad range of vegetables early on is therefore vital in promoting a varied diet. Rather than offering children a variety of first tastes within a single meal, evidence suggests experience with variety between meals, alternating the vegetables offered on a day to day basis, may be more successful in enhancing vegetable intake (Mennella et al. 2008).

Although some mothers report offering children repeated opportunities to taste new vegetables (Chapter 3), many mothers are likely to give up before preference is established (Carruth et al., 2004; Maier et al., 2008). The high number of exposures recommended within current UK guidance may discourage parents. Offering a vegetable ten to fifteen times may seem unrealistic and the process of offering vegetables that are repeatedly rejected may become exhausting and involve high levels of waste. In addition, the importance mothers place on the nutritional value of their children's diets and their keenness to ensure children consume sufficient vegetables (Chapter 3) might mean that mothers resort to offering only those vegetables they know will be eaten. This idea is supported by the observed contrast between the relatively small and highly liked selection of vegetables that mothers serve to children on a regular basis and the range of vegetables introduced overall (Chapter 4). As a means of ensuring that children are consuming important nutrients, offering a select number of well-liked vegetables is a logical strategy for mothers to employ. However, limiting children's exposure to variety as well as reducing opportunity for experiences with new vegetable tastes is likely to be detrimental to preference development and acceptance of new foods later on.

Consistent with previous research, the findings of the current thesis demonstrate that repeated taste exposure can improve intake of novel vegetables even in those children at an age when food fussiness is commonplace (Chapters 5, 6 and 7; Howard et al., 2012; Noradilah et al., 2012; Wardle et al., 2003; Wolfenden et al., 2012). Significant increases in intake were observed in children across age groups after just three to five exposures and intake remained high up to a month later, despite no further exposures being provided. Given that evidence suggests many mothers abandon a food as disliked after the third consecutive rejection (Carruth et al.' 2004; Maier et al., 2008) this is a particularly important finding, but should be considered within the context of the size of the changes that were observed. Children aged over two years consistently ate less than younger children and changes in intake were smaller (Chapters 5 and 6). Despite this, a gradual and significant increase in vegetable consumption was observed. The frequency with which children are exposed to vegetables may be particularly pertinent when introducing them later in childhood (Coulthard et al. 2010) meaning that older children may require a greater number of exposures in order to produce comparable changes in intake. The recommendation of offering a new food ten or more times may therefore be more relevant to older children (Birch et al., 1982; Birch et al., 1987). However, the consistency of the current findings, even when ten exposures were offered, suggest this might not be the case. Lower levels of vegetable liking and intake may well be unavoidable during the neophobic period as children become more apprehensive of foods generally and increasingly base decisions around consumption on factors other than taste (Birch et al., 1987; Dovey et al., 2008; Harris, 1993). Repeated exposure may instead offer a means of *optimising* vegetable intake during this time. Particularly if implemented alongside other strategies, such as hiding or masking vegetables (Spill et al., 2011). Continuing to offer repeated experiences with a broad range of vegetables will increase the capacity for intake to return to a more favourable level as children leave the neophobic phase. However, whether or not this potential rebound in intake occurs is yet to be investigated.

While there is growing evidence that repeated taste exposure is a critical factor in food preference development and reducing food refusal, encouraging children's first taste of a new food can be a difficult and stressful process for parents. The approach parents take to encouraging consumption of foods such as vegetables, and their response to food refusal can impact upon children's preferences and often have the opposite effect than intended. Methods such as pressuring children to eat and the use of coerscive tactics are likely to decrease children's liking for target foods and reduce intake (Blissett, 2011; Scaglioni et al., 2008), while a more positive interaction is likely to increase liking (Birch, Zimmerman, & Hind, 1980). While the findings of the current thesis found the addition of familiar flavours was no more beneficial to vegetable intake than simple repeated exposure, pairing new vegetables with well-liked dips or sauces may promote tasting in the first instance (Anzman-Frasca et al., 2012; Pliner & Stallberg-White, 2000). Similarly offering children praise or some form of tangible reward, such as a sticker, may also encourage consumption (Añez, Remington, Wardle, & Cooke, 2012; Cooke, Chambers, Añez, Croker, et al., 2011; Cooke, Chambers, Añez, & Wardle, 2011; Corsini, Slater, Harrison, Cooke, & Cox, 2011; Horne, 2009; Horne, Greenhalgh, Erjavec et al., 2011). To date there is evidence that both methods offer promising strategies for encouraging initial tasting of unfamiliar foods. However, little focus has been given to when dips and rewards should be *withdrawn*. In both cases there is a risk of the vegetable becoming devalued. For instance, children may learn to prefer the vegetable/dip combination and intake of the vegetable may become contingent on it being offered with the dip. Similarly, pairing consumption of a vegetable with a reward may decrease children's intrinsic motivation to eat it and reduce intake when the reward is withdrawn (Birch et al., 1982). While this has been found to be the case when foods are used as the reward (Newman & Taylor, 1992) studies that have paired vegetables with stickers have found that both preference and intake are enhanced and these effects are maintained up to three months after the stickers are withdrawn (Añez et al., 2012; Cooke, Chambers, Añez, Croker, et al., 2011). Research which looks to determine the number of pairings that are necessary before rewards can be sucessfully withdrawn would therefore be beneficial in developing guidance for parents.

8.1.2.iv Summary

Familiarity with a food allows children to apply previous knowledge in their appraisal of its appearance and taste and ultimately form judgments regarding its suitability to eat. Repeated taste exposure is a fundamental part of this process and has been shown to be a successful strategy for increasing vegetable intake in the early years of life. Substantial increases in intake can be achieved following a small number of exposures and the effects can generalise to other similar vegetables where they are presented in a familiar way. Differences in levels of intake between age groups suggest a possible 'sensitive' stage for the introduction of novel vegetables, with young children being more receptive than older children. However, rather than age determining intake this is likely to reflect the developmental stage of food neophobia which is associated with this older age group. Age appears to influence children's response to how new vegetables are prepared and served and this is likely to be as a result of changes in children's approaches to food. The following section looks to address the influence of age and other individual differences on food avoidance and how these factors impact on children's vegetable intake.

8.1.3 Individual differences

Each of the interventions implemented as part of this thesis produced positive shifts in children's vegetable intake. However, the extent to which children responded to the interventions differed demonstrating individual differences in children's appetites, preferences and eating behaviours (Galloway et al., 2003; Loewen & Pliner, 1999; Pliner & Hobden, 1992; Wardle et al., 2001). Within each intervention a small proportion of children, referred to as 'non-eaters', consumed very little and showed no progression in intake following exposure. Similarly a small number of children were found to consume large amounts of the vegetables at baseline or first exposure and consistently ate all of what they offered throughout the intervention. For the purpose of this thesis, these children are referred to as 'plate clearers'. These findings are particularly important as they clearly demonstrate that there is not a 'one size fits all' approach that can be taken to encouraging vegetable consumption. Examining possible reasons for such vast differences in children's response to vegetables, and establishing how these children differ from 'regular eaters' or 'learners' is not only important for increasing our understanding of children's eating behaviours but also provides crucial insight for the development of future interventions. It is likely that some of this difference can be accounted for by individual traits and temperament while some may be the result of previous experience with foods. Understanding children's relationships with food will therefore enable researchers to establish what works best for which children and will help in providing guidance for parents who may be struggling with how best to approach their children's vegetable intake.

A limitation of this thesis is the low response to parental questionnaires which makes it difficult to make generalisations about relationships observed between children's vegetable intake and the factors which were measured. However, the studies that have been undertaken contribute to work carried out as part of the HabEat project, a European collaboration which aims to determine factors and critical periods in food habit formation and breaking in early childhood (HabEat – FP7- 245012, http://www.habeat.eu/). Within this project a number of studies have been conducted to examine the effectiveness of different learning strategies on preschool children's vegetable consumption. Findings, including those described in Chapter 5, have recently been collated and analysed using structural equation modelling in an attempt to develop an understanding of what factors best predict children's vegetable intake and their response to these types of interventions (Appendix E). Thus the following section will consider the findings of this thesis, and those from a number of similar studies in relation to current literature around individual differences in children's eating behaviour.

8.1.3.i Age and food avoidance

Children's age has been shown to be an important factor in determining their vegetable intake both at home (Chapters 4 and 5) and during interventions (Chapters 5 and 6; Appendix E). Age is a significant predictor of both pre and post-intervention intake with older children likely to eat less than younger children at both time points. In the current thesis children were split into two age groups consisting of those that were aged below or above two years. These age groups were selected based on literature which suggest a peak in the neophobic response to food between two and six years of age (Dovey et al. 2008). Food neophobia is characterised by an increase in food rejection and is associated with lower liking for vegetables (Cooke et al., 2006; Cooke et al., 2003). Consistent with this heightened neophobic stage, children over the age of two years were found to exhibit a lower liking for vegetables, were offered and consumed vegetables less frequently at home and ate substantially less of the target and control vegetables during interventions (Figure 8.2; Chapters 4, 5 and 6). In addition these children showed a reduced response to all forms of learning (Chapter 5 and 6).

As well as demonstrating higher levels of food neophobia, children over two years were found to be more food fussy (Chapter 5). Measured using the CEBQ, food fussiness relates to how selective children are in what they consume as well their willingness to try new foods (Wardle et al., 2001). Sometimes referred to as 'picky eating', food fussiness is considered to differ from food neophobia in that children not only reject unfamiliar foods, but also a large proportion of foods that are familiar impacting on the variety of children's diets (Dovey et al., 2008). Although highly related (Chapters 5, 6 and 7; Pelchat & Pliner 1986; Pliner & Hobden, 1992) it is suggested that distinct differences exist in the behavioural expression of these constructs and the factors that influence them (Galloway et al., 2003; Raudenbush, Van Der Klaauw, & Frank, 1995). Notably, both food neophobia and food fussiness contribute to increased food refusal and along with satiety responsiveness determine the quantity and range of foods which children avoid (Wardle et al., 2001).

While the current thesis has highlighted the impact of age on vegetable intake, this effect is likely to be mediated by children's level of food avoidance. When food avoidance is included as a predictor, the relationship between age and pre and post-intervention intake changes (Appendix E1, Model 3). Age becomes a significant predictor of baseline vegetable consumption, with older children consuming more than younger children, and no longer predicts intake at the end of the intervention. Instead intake at both time points is predicted by food avoidance. However, the final model produced from the results of the HabEat studies, suggests that older children will change their intake to a lesser extent than younger children (delta change -0.20, $p<0.05$; slope -0.23, $p<0.01$) and that it is the more food avoidant children who will show the greatest increase in intake (delta change 0.28, $p<0.01$; slope 0.40, $p<0.001$). However this finding should be interpreted cautiously as it may indicate a ceiling effect. That is to say those children who consume more at baseline can only increase intake within the boundary of the portion offered. Children whose intake is lower prior to the intervention have greater scope for change and are unlikely to achieve comparable levels of intake. Despite this, the finding that interventions aimed at increasing vegetable consumption are successful even with food avoidant children is a promising one. Learned acceptance of vegetable flavours via repeated exposure may help to reduce children's aversion to vegetables and improve liking.

8.1.3.ii Food avoidance and individual differences

It is generally accepted that the high prevalence of food refusal and the rejection of familiar and unfamiliar foods during children's preschool years indicate that food neophobia is normal stage in children's development (Carruth et al., 1998). Thus an increase in food avoidance behaviours is to be expected as children enter the neophobic stage but the degree to which children exhibit these behaviours can vary. As previously discussed, a peak in neophobia generally occurs between two and six years of age (Dovey et al., 2008) however, high incidence of food refusal and food fussiness can occur in younger children, or may not occur at all. This is reflected in the findings of the current thesis. Based on intake during the interventions it was possible to draw distinctions between three types of eaters; those who gradually came to increase intake (regular eaters/learners), those who ate very little and showed no increase is intake (non-eaters) and those who readily accepted and consumed everything that was offered to them (plate clearers). While the group of non-eaters was predominantly made up of children in the over two years age group, there were a number of children in the younger age group who exhibited the same reluctance to consume the study foods. Similarly, children who were categorised as regular eaters and plate clearers were evenly distributed across both age groups. These findings suggest that rather than simply being a stage of development, food neophobia and other food avoidance constructs are related to individual characteristics of the child (Dovey et al., 2008). Much like other eating behaviours, it has been suggested that food neophobia is a heritable appetitive trait (Cooke et al., 2007; Llewellyn, van Jaarsveld, Johnson, Carnell, & Wardle, 2010) and it is observed in both children and adults (Cooke et al., 2007; Dovey et al., 2008; Galloway et al., 2003, Howard et al., 2012;

Knaapila, Silventoinen, Broms et al., 2011; Knaapila, Tuorila, Silventoinen et al., 2007; Pliner, 1994; Pliner & Hobden, 1992). However, as traits are generally considered to remain stable and the expression of food avoidance behaviours has been shown to decrease with age (McFarlane & Pliner, 1997) debate around the origin of food avoidance is on-going.

Studies have demonstrated associations between food avoidance and child temperament. Children who score highly for emotionality and shyness also score highly for food neophobia (Pliner & Loewen, 1997) while food fussiness has been linked to a difficult temperament (Haycraft, Farrow, Meyer, Powell, & Blissett). Positive associations between anxiety and food neophobia have also been observed (Galloway et al. 2003). The idea that food neophobia and food fussiness may be an expression or extension of child temperament rather than traits in themselves appears to be more consistent with changes in food avoidance behaviours over time. Although temperament is considered to be innate, it is subject to change during development in children of moderate disposition as a result of their experiences and the environment in which they are brought up (Schaffer, 2008; Smith, Cowie, & Blades, 2003). It is children at the extremes of temperament scales who exhibit more stable traits which are likely to continue into adulthood (Schaffer, 2008), which may explain why food neophobia and picky eating are behaviours observed in both children and adults.

While temperament was not found to be related to food neophobia or target vegetable intake in the current thesis, emotionality was negatively associated with frequency of vegetable consumption at home (Chapter 5). As previously mentioned, response rates to questionnaires makes it difficult expand on this finding and studies which look to examine the influence of temperament on children’s vegetable consumption may be beneficial to the development of future interventions. Studies have examined the relationship between different areas of child temperament and their eating behaviours as reported by parents, however, none have successfully explored the association between temperament and observed behaviours such as intake of a novel vegetable. Future studies may benefit from using parental report and structured observation to build a profile of individual children’s temperament across different scales, as well as measures of general and situational anxiety, before implementing a repeated exposure intervention within the child's home. This would allow children to be grouped as high or low in each of the included subscales and for intake data to be explored according to these groups. Significant differences in vegetable consumption between groups would suggest areas of temperament which are important in the development of food approach and food avoidance behaviours in young children and perhaps indicate 'at risk' groups.

Child temperament influences children's eating behaviours (Haycraft et al., 2011; Pliner & Hobden, 1992) and it is also likely to influence the feeding practices that parents employ. Conversely the feeding practices used by parents and resulting feeding interactions will undoubtedly impact on children's responses to foods (Blisset et al., 2011) and can often exacerbate food avoidance behaviours (Brown et al., 2011; Patrick et al., 2005; Wardle et al., 2005). Building on current understanding of how child temperament can affect the parent child feeding interaction may therefore assist in developing better guidance for parents in how to approach difficult eating behaviours.

8.1.4 Conclusions

The findings of the current thesis confirm that building children's familiarity with new foods is a crucial factor in promoting both liking and consumption of those foods. Given young children's willingness to accept and taste the unfamiliar, offering an assortment of first tastes early on is likely to be beneficial for preference development as well increasing the overall variety of a child's diet. Vegetable flavours can often be intense or bitter so introducing children to a range of vegetables early allows parents to take advantage of a 'sensitive period' during which children will be more receptive to these new tastes. However, in order to establish and maintain preferences it is necessary to continue to offer frequent and repeated experiences with a variety of vegetables. Five exposures may be sufficient to achieve optimal intake and experience with a range of vegetables may also promote intake of other similar vegetables. It is important to consider that children's acceptance of a new food and the rate at which they acquire preferences can depend on age but it is likely that the effect of age is mediated by the level of food avoidance that children exhibit. A particularly promising finding is that repeated exposure to vegetables can improve intake in children who are food avoidant, however it may not be an effective strategy for children who demonstrate a stronger negative response to unfamiliar or disliked foods. In addition, issues around perceived contamination mean the way in which vegetables are prepared and served may be have more impact on acceptance and intake in food avoidant children.

The influence of maternal perceptions and experiences on children’s vegetable intake has emerged from the studies. Mother’s experiences with foods shape their own preferences which in turn influence what foods are offered to children and how frequently. Conversely, children’s responses to those foods can determine whether mothers continue to offer them. Maternal diets which are high in a variety of vegetables predict greater intake in children as they are more likely to be offered and modelled as safe to eat. However, mother’s perceptions of their children’s diets and possible concerns about a lack of vegetable intake may also determine the approaches mothers take to vegetable introduction and offering and the feeding practices they employ which in turn impact on consumption. Based on the findings of the current thesis a theoretical model has been developed and is shown in Figure 8.4.

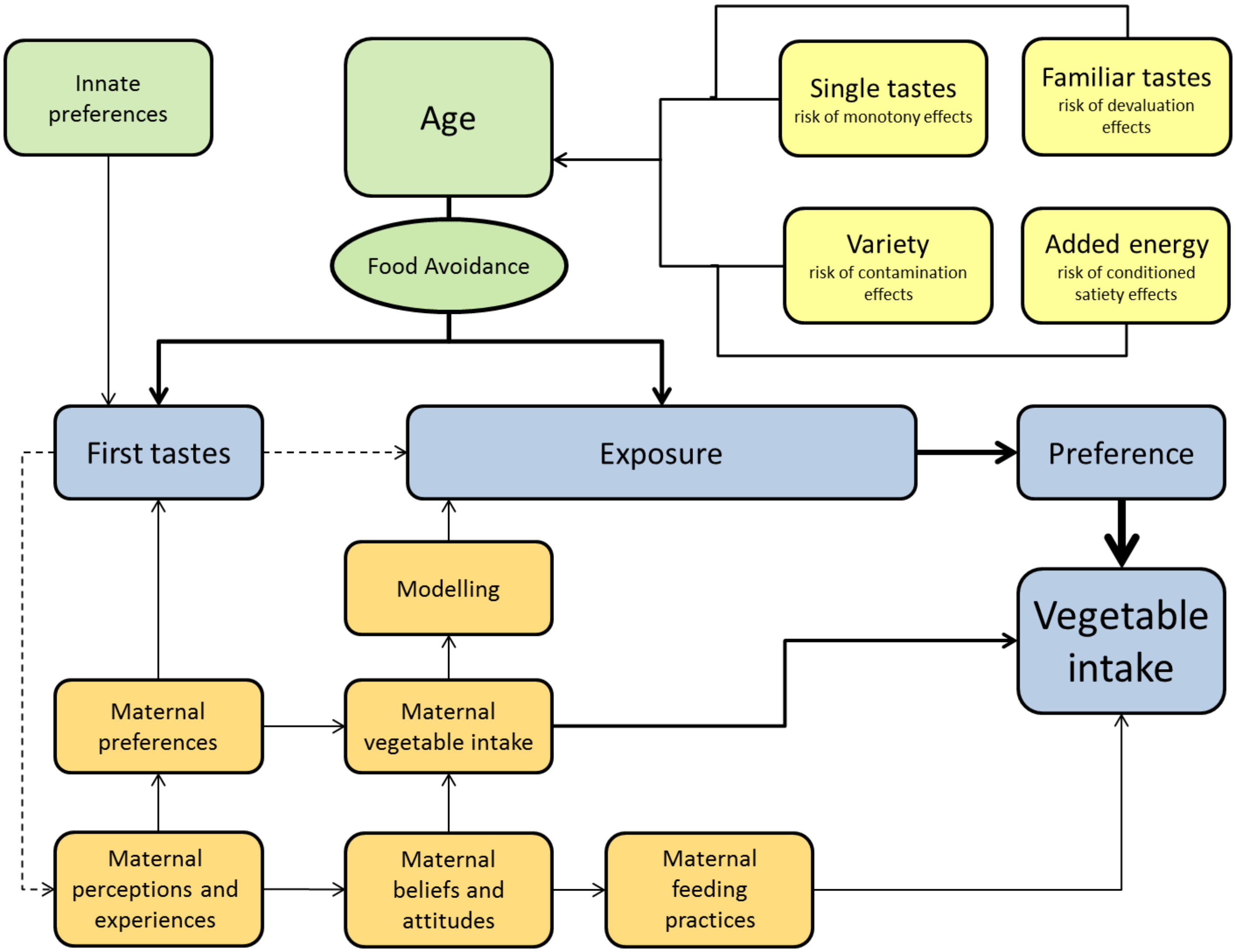

Figure.8:4: Theoretical model of children's vegetable intake

8.2 Limitations of the thesis

The limitations of individual studies have been addressed in each chapter however there were several limitations regarding the sample recruitment and methodologies involved in research described within this thesis and these will be discussed within this section.

Firstly, initial recruitment of nurseries and child-care settings was difficult. In total thirty-six nurseries were approached to take part in the experimental studies and this was done via phone, email and in person. There was a general lack of interest in participating in this research with managers reporting that nurseries were already involved in other studies and/or that staff were already very busy and finding time to participate would add unnecessary strain and disruption to their working week. Despite this many nursery managers considered the topic of the research to be very relevant to them, with improving children's health now a priority, and several thought the studies would give useful insight into ways they might improve on what was already in place. Consequently eighteen of the nurseries agreed to take part, although, given that healthy eating was already high on the agenda for these nurseries, attending children may already have been consuming more vegetables. However, none of the target vegetables were regularly offered in any of the child care settings and, with the exception of carrot and cucumber sticks, vegetables were not normally offered as snacks so it can be assumed that the vegetable snacks offered within the studies were perceived as unfamiliar.

Secondly, in recruiting parents and children for the first two experiments, nurseries sent out approximately three hundred information and consent forms and around half of these were returned. Again there is likely to be some difference in levels of interest in and concern about healthy eating between those parents who returned consent to take part in the study and those who did not which may suggest differences in children's diets. However, this does not take into account parents who may simply have had an issue with their child participating in research or the fact that some parents may have been motivated to participate because of issues around food fussiness and low vegetable acceptance at home, and this was reflected in responses to parental questionnaires. To overcome low response rates information and consent forms for the final study asked parents only to return the form if they did *not* wish for their children to take part, or needed to inform researchers about any potential food allergies. This process of opt out consent was far more successful with very few parents requesting their children not take part, and as a result a much larger sample was recruited. Maintaining participant numbers during interventions was very difficult. One nursery dropped out of the process before the start of the intervention and another shortly after starting, as they no longer wished to take part. In those nurseries that did complete the interventions, illness and holidays impacted on children's attendance. In total nearly 350 children were recruited across the three studies and just under 200 completed all the necessary tasting sessions. During the first experiment a small number of children had to be withdrawn from the study as they found the process distressing and refused to engage with researchers or the study foods. This in itself is an interesting finding and may suggest that these children are particularly sensitive to new situations and display a strong fear response to the unfamiliar, however, as children were withdrawn from the study it is not possible to comment further on this. The majority of children appeared to find the process enjoyable and even those who did not consume very much of the food chose to participate in all of the tasting sessions. However, conducting the tasting sessions in small groups did appear to impact on some children's intake with their consumption entirely dependent on whether significant friends did or did not eat. Similarly children who were particularly vocal about whether they thought a snack was "yummy" or "yucky" could influence whether or not it was consumed by others around the table. It is possible that had tasting sessions been conducted individually, patterns of intake for some children could have been different. Given the scale and timing of the interventions this would have been unfeasible. Child care settings were chosen as the location for the interventions based on them providing a naturalistic environment for children. Some level of social influencing or modelling was therefore unavoidable and should be taken into consideration when interpreting the findings. Anecdotally it is often reported that children will consume a food at nursery or at the home of another child that is consistently rejected at home. This might suggest that had these interventions been conducted at home, the findings may have been different.

However, a number of studies which have involved parent led interventions in the home have offered similar positive findings.

The presence of a researcher at tasting sessions may also have influenced children's engagement with the tasting sessions and their intake. While nurseries were asked to assist in keeping sessions as similar to normal snack time as possible, methodological constraints meant that the way in which the snacks were presented to children was likely to be unfamiliar. Children may have enjoyed the novelty of the sessions or wished to please the researcher by readily consuming what was offered. Similarly the way in which staff at the nurseries approached the interventions also impacted on what was consumed. Some staff appeared to find it difficult not to pressure children to try the vegetables and a small number quickly moved to coercive strategies despite having been instructed against this. To reduce the influence of the researcher snack sessions for the final study were conducted entirely by nursery staff. However, to ensure that protocols were correctly implemented instruction booklets were provided and researchers met with staff to offer small amount of training on how to conduct tasting sessions. In addition a researcher was present at the nursery, in order to covertly observe the first session so that staff could be given any further guidance. The result was a more representative study with a larger sample size.

8.3 Implications

Few studies have examined how mothers approach vegetable introduction during the weaning period and even fewer have included the introduction of new vegetables in the preschool years. Thus the present thesis is the first research to offer insight into the types of strategies mothers currently employ to encourage vegetable intake in young children. By examining the effectiveness of these strategies the thesis also contributes to theoretical understanding of children's food preference development and confirms the influence that children's age can have on vegetable acceptance, liking and consumption. Three factors that impact on children's acquisition of preferences for vegetables have been explored in detail and offer potential directions for future research as well as possible changes to the recommendations and guidance currently offered to parents.

8.3.1 Future research

The success of repeated exposure as a strategy for increasing children's vegetable intake is now well documented and is further supported by the findings of this thesis. The added benefit of its generalising effects means that offering children experience with a variety of vegetables is vital. However, the potential of these generalisation effects is yet to be fully explored. To date research suggests that repeated experiences with a vegetable increases liking and intake of that vegetable in the form in which it has been offered and may also enhance preference for other similar vegetables prepared in the same way. Varying cooking and preparation methods can impact on the texture and taste of vegetables and can affect how much they are liked by children (Zeinstra et al. 2010). Further experimental studies should therefore examine to what extent familiarity extends to different presentations of vegetables by including vegetables cooked and seasoned in different ways. The use of vegetable purees as targets has been shown to produce sizeable increases in intake (Chapters 5 and 6). While this could reflect ease of consumption (de Graaf, 2011), purees may also have been less recognisable as vegetables, increasing their acceptability to young children. If the role of children's visual evaluations of foods increases with age (Addessi et al., 2005; Dovey et al., 2008; Tuorila, Meiselman, Bell, Cardello & Johnson, 1994) the way in which vegetables are presented will also become a more important factor in whether they are consumed. Thus experiments should look to examine whether older children are in fact more sensitive to how vegetables are presented and whether generalisation is more likely to occur in younger children. The role of variety should also be considered. Much of the existing research into variety and vegetable consumption suggests that offering a number of vegetables together reduces potential for monotony effects and increases overall intake (Hetherington et al., 2000; Hetherington et al., 2002; Sørensen et al., 2003). However, this research has focussed on vegetables that are already liked by children. Within the present thesis offering variety was not beneficial and rather than enhance intake, offering a number of unfamiliar vegetables inhibited consumption in children aged between two and five years. As previously discussed this reflects children's progression into the neophobic stage, however, studies should look to establish whether this effect is reproduced in children across age groups in order to offer parents useful guidance in how best to introduce vegetables to children of different ages.

Consistent with previous research, repeated exposure was successful in enhancing intake of an unfamiliar vegetable even in children likely to be more food fussy. However, a particularly striking finding was that a small group of children continued to demonstrate a reluctance to consume study foods despite receiving these exposures. Possible reasons for this were considered in brief, however establishing the cause of such entrenched food avoidance is crucial in identifying children who are most likely to demonstrate low levels of vegetable acceptance and intake and in developing successful interventions for these children. There are a number of barriers to vegetables intake, the majority of which can be overcome by providing parents with better guidance around vegetable consumption (this will be discussed in the following section). Food avoidant children should be viewed as a particularly 'at risk' group and should therefore become the focus of future research so that effective strategies are developed for parents most likely to struggle during vegetable introduction. This might include an emphasis on feeding practices which reduce anxiety and promote enjoyment of meals and snacks, even when only very small amounts of food are tasted or eaten.

8.3.2 Guidelines and recommendations

Discrepancies in maternal reports of children's vegetable intake suggest an important first step in increasing vegetable consumption may be to ensure parents are able to correctly judge whether children are consuming enough. Parents who feel that children's intake is sufficient are unlikely to feel that it is necessary to improve on what is already being offered. Given that a five a day recommendation has been in place for several years and intake remains low in adults and children, this could indicate that consuming five portions of fruits and vegetables is unrealistic. However, children in Denmark, where the guidance is to consume six portions of fruit and vegetables per day, were offered more vegetables than UK children and vegetables were offered more frequently. This might suggest that increasing recommendations, even by one portion, will improve intake.

As previously discussed, current UK guidance around weaning suggests that new foods may need to be offered ‘lots of times’ before they are accepted. The present thesis suggests that offering a vegetable five times is sufficient to significantly enhance intake, particularly during the first two years of life. Guidance which makes reference to this ‘sensitive period’, when children are most receptive of new foods, would undoubtedly be beneficial to parents. The effectiveness of simple repeated exposure should be endorsed and providing parents with a suggested pattern or schedule of introduction could assist in implementing such a strategy. This might include the recommendation of alternating vegetables on a day to day basis in order to provide exposure to a variety of new tastes.

Parents can often be surprised and confused when a child who was previously a ‘good eater’ begins to exhibit more food avoidant behaviours. Guidance should therefore include a ‘normal’ pattern of food acceptance and rejection for pre-school children so that parents know to expect this change in behaviour as part of their child’s normal development. This will also help parents to identify children who might be exhibiting more extreme forms of food fussiness or picky eating. Parents should be encouraged to have realistic expectations of children during the neophobic phase. For instance, older children may need a greater number of experiences with a vegetable before intake is enhanced and introducing new vegetables singularly, as a between meal snack, may be more successful than including it as part of a meal. In addition, increasing parent’s knowledge around counterproductive feeding strategies will assist parents in dealing with instances of food refusal. Overall, more comprehensive guidance will allow parents to approach food introduction with confidence and reduce the stress that many experience. This in turn will be beneficial in reducing children’s anxiety around new and unfamiliar foods.

Finally, the experimental studies included within this thesis demonstrate that snack times in nurseries and other child-care settings provide a suitable opportunity to increase children's exposure to vegetables. Currently many nurseries offer a wide variety of fruit as snack, with carrots and cucumber occasionally offered. Encouraging nurseries to substitute a number of weekly fruit snacks for less familiar, but appropriate vegetables, will undoubtedly increase children's weekly vegetable consumption. Furthermore, nurseries can inform parents of what children have eaten and enjoyed so that parents can integrate these vegetables into children's diets at home if they wish.

8.4 Summary

The current thesis provides a clear theoretical contribution to the study of food preference development in young children. Investigation of mothers' approaches to vegetable introduction and their effectiveness has confirmed that increasing children's familiarity with vegetables is fundamental to improving intake. However, a number of factors mediate the effects of experience and these have been highlighted as potential areas for future research. There is a need to focus interventions on children who might be more resistant to the effects of exposure and identifying the possible causes for this is crucial if effective interventions are to be developed. Furthermore, a number of improvements to current guidance and recommendations for parents and care providers have been suggested which will assist them in implementing effective strategies for promoting vegetable intake. This thesis therefore provides the foundations for future research which looks to improve vegetable acceptance in those children most at risk of low consumption.

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Appendices

Appendix A: Example Forms

A1 Participant Information and Consent Form

A2 Sensory Analysis Information and Consent Form

A3 Participant Information and Consent Form, Urdu

A4 Participant Information and Consent Form, Easy Read

Appendix B: Study-specific Measures

B1 Weaning and Food Introduction Questionnaire (including Infant Feeding Questionnaire)

B2 Interview Schedule

B3 Vegetable Survey

Appendix C: Standardised Questionnaires

C1 Children's Eating Behaviour Questionnaire

C2 Child Food Neophobia Scale

C3 Child Feeding Questionnaire

C3 Child Feeding Questionnaire

C4 Caregivers Feeding Styles Questionnaire

C5 EAS Temperament Survey

C6 Food Frequency Questionnaire

C7 Food Neopohobia Scale

Appendix D: Practitioners’ Booklets

D1 Practitioners Information Pack

D2 Practitioners Instruction Manual

Appendix E: HabEat Project Models

E1 HabEat - FP7-245012 Deliverable 15, Model for identifying key behavioural mechanisms in food habit formation

Appendix A

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Dear Parent / Guardian,

We are researchers from the Institute of Psychological Sciences at the University of Leeds and our research focuses on nutrition, appetite and eating habits in young children. **We are looking to find methods of encouraging children to eat more vegetables and in …. 2013 we plan on running a study at your child's nursery.**

This study will be run by the nursery themselves and will involve all children aged between 18 months and 4 years receiving 100g of vegetables twice a week in place of their usual snack. This is equal to around 5 extra portions of vegetables a week! Children will be offered the vegetable snacks at their usual snack time and can eat as much or as little as they want. There will be no pressure placed on the children to eat the vegetables and we hope the children will have fun taking part in the study.

The study will look at the effectiveness of repeated exposure in increasing children's liking for and intake of a single vegetable snack. It will also draw comparisons between this technique and offering a variety of vegetables which has also been found to increase vegetable consumption. The study is subject to ethical guidelines set out by the British Psychological Society and has been approved by the Institute of Psychological Sciences (University of Leeds) Ethics Committee (ref# 12-0240).

Both ourselves and the nursery would like all children who are eligible to take part to be included in the study as we think that it will be a fun activity for all those involved. **We are therefore asking all parents of children in the 18 month and 4 years age range to let us know if they <u>do not</u> wish for their child to take part in the study** using the attached response slip. It may be necessary to exclude some children from the study because of food allergies. For this reason we have listed the vegetables that will be included in the study on the next page and ask that if your child has allergies or suspected allergies to any of these foods you inform the nursery using the attached response slip. In cases where children are unable to take part because of food allergies we will work with the nursery to ensure these children are still included in the snack sessions with an appropriate alternative snack. You can withdraw your child from the study at any time without explanation.

The study is planned to start on the …… 2013 so we ask that you please return the response slip to your nursery by the …… 2013. If you would like any further information regarding the study please speak to your nursery staff or contact me using the contact details below.

Yours truly

Sara Ahern 0113 343 9197 / 07714024829 / pssma@leeds.ac.uk

Information Sheet

What will the study involve for my child?

1. During the first week of the study your child will be offered a single vegetable snack of celery, red pepper, green pepper, baby sweet corn or radish and a snack consisting of all 5 vegetables at their regular snack time on 2 separate days. If your child is allergic to any of these vegetables please inform us on the attached response slip.

2. For the following three weeks your child will then receive either the single vegetable snack or the variety snack twice a week at their usual snack time (a total of 6 times). These vegetables will be offered raw and chopped into finger food size pieces. We will measure how much they have eaten after each snack.

3. At the end of the study your child will be offered each both vegetable snacks again on 2 separate days. Again we will measure how much is eaten.

4. We will visit the nursery again and repeat stage 3, one month and three months after the end of the study. We would also like to measure your child's height, weight and waist as part of this study.

What will the study involve for me?

You will be asked to complete 2 short questionnaires about your family's regular eating habits, particularly those of the child involved in our study. As a token of our appreciation for completing these questionnaires you will receive a £5 high street voucher.

Are there any benefits/risks from taking part?

Children taking part in the study will receive additional amounts of vegetables to eat on testing days. In addition, if our study is successful we will have a greater understanding of what learning mechanisms are involved in promoting the intake and the liking of vegetables in children. There is very little risk associated with this study and any risk that is involved is the same as consuming any food at nursery. All sessions will be supervised by nursery staff and all risks are minimized by the use of adequate equipment and food. The preparation and transportation of all foodstuffs will conform to strict safety and hygiene standards.

What will happen to my data if I take part?

All data will be anonymised with the exception of the response slips. All participants will be allocated a participant ID number so that names are not used and all data files will be stored securely. Data collected during the study, may be looked at by individuals from the University research team, collaborators on the research project and the University of Leeds for the purposes of research governance. The study records identifying you and your child and all the information

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that is collected about you/your child during the course of the research will be kept strictly confidential.

Response Slip

If you would not like your child to take part in this study or your child suffers with food allergies to any of the study foods please complete the response slip below and return to your nursery by 2nd May 2013.

✂--

Child's name ....

I **do not** wish for my child to take part in the vegetable study at nursery (please tick) ☐

I can confirm that my child **has known or suspected food allergies** to the following (please tick):

baby sweet corn ☐

celery ☐

green pepper ☐

red pepper ☐

radish ☐

I am happy for my child to take part in the study but (please tick as appropriate):

I **do not** wish for my child to have their height, weight and waist circumference measured ☐

I **do not** wish for my child to be filmed and or photographed as part of this study ☐

(Images recorded will only be used as part of the research project and will not be shown to members of the public/ scientific community without your consent.)

You can still take part in the research project if you do not want your child to be measured and/or filmed.

Parent/Caregiver's signature ....

Date ....

Participant Information Sheet

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Dear Participant,

We are researchers from the Human Appetite Research Unit at the University of Leeds and we are interested in all aspects of feeding behaviour and nutrition. We are conducting research into flavour preferences and vegetable consumption and would like to invite you to evaluate the taste and flavours of various vegetables.

You will be required to come to the laboratory once to taste 16 vegetable samples and to complete a number of questions about the taste and flavour of each sample. The tasting session will take around one hour. The vegetables you could receive as part of your tasting are listed below:

beetroot	swede
celeriac	sweet potato
carrot	turnip
potato	yam

As part of the study we also require you to taste a number of reference solutions, some of which contain a small amount of caffeine and salt. We cannot allow you to take part in the study if you have any known heart conditions or if you do not regularly consume at least one drink containing caffeine each day (for example 1 cup of tea or coffee).

You could receive up to 30 mg of caffeine and 0.2 g of salt. This is the equivalent of consuming 1 cup of tea/ instant coffee and 1 bag of crisps. **It is mandatory that you make the researcher aware if you have any known heart conditions or do not regularly consume caffeine or have been asked to follow a low sodium diet.**

Participation in the study is entirely voluntary and you are free to withdraw at any stage without providing any reason for doing so. Data generated in this study will be accessed only by trained researchers and will also contribute towards third year psychology student's projects. Results will also be presented at conferences and may also be submitted for publication in a scientific journal. If you would like to take part or you have any questions regarding our research, please contact Natasha or Olivia or any member of our group:

Ms Natasha Tice and Ms Olivia Naylor (3rd yr students)
olivia.natasha.sp@gmail.com

Sara Ahern	Professor Hetherington
pssma@leeds.ac.uk	**m.hetherinton@leeds.ac.uk**
(tel: 0113 3432275)	(tel: 0113 3436692)

Many Thanks
Sara Ahern, PhD Researcher

Participant Consent Form

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Please tick the appropriate box

1. I confirm that to the best of my knowledge I do not have any known heart conditions or physical illness that would cause a risk to me during participation in this study.

   Yes ☐ **No** ☐

2. I confirm that I consume at **least one** caffeine containing drink per day.

   Yes ☐ **No** ☐

3. I understand that I may consume up to 30mg of caffeine during participation in this research and that this is the equivalent to one cup of tea/ instant coffee.

   Yes ☐ **No** ☐

4. I confirm that to the best of my knowledge and belief that I have no food allergies that would cause risk to me during participation in this study.

   Yes ☐ **No** ☐

5. I have read and understood the information sheet and been given the opportunity to ask questions.

   Yes ☐ **No** ☐

6. I understand that my participation in this study is entirely voluntary and that I may withdraw from the investigation at any time without providing an explanation.

   Yes ☐ **No** ☐

____________________ ____________ ____________________

Name of participant Date Signature

____________________ ____________ ____________________

Researcher Date Signature

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Participant Recruitment Questionnaire

Name: ____________________

Contact details (email and mobile telephone number): ______________________________

Age: ____________________

Do you smoke? Yes / No

If yes, how many per day? ____________________

How many drinks containing caffeine do you usually consume per day? For example, the number of cups of tea, coffee or any other caffeine containing beverages (ie, cola, red bull): ____________________

Are there any foods that you can not or will not eat?

____

If you are currently taking any medication, please list this below

____

محترم والد/والدہ/ سرپرست ،

ہم لیڈز یونیورسٹی کے انسٹیٹیوٹ آف سائکلاجیکل سائنسز(نفسیاتی علوم) کے شعبے سے تعلق رکھنے والے تحقیق کار (ریسرچر) ہیں اور ہماری تحقیق چھوٹے بچوں میں غذائیت، بھوک اور کھانےکی عادات پر مرکوز ہے۔ **ہم ایسے طریقوں کی تلاش میں ہیں جس سے بچوں کی زیادہ سے زیادہ سبزیاں کھانے کے لیے ہمت افزائی کی جا سکے، اورہم اگلے سال فروری میں آپ کے بچے کی نرسری میں ایک تحقیقی مطالعہ (ریسرچ) کرنے کا منصوبہ بنا رہے ہیں۔**

یہ تحقیق خود نرسری کے ذریعہ انجام دی جائے گی اور اس میں وہ تمام بچے شامل ہوں گے جن کی عمر 18 مہینے اور 4 سال کے درمیان ہوگی۔ انہیں اپنے معمول کے سنیک کی جگہ پر ہفتے میں دوبار 100 گرام سبزیاں ملا کریں گی۔ یہ ہر ہفتہ میں سبزیوں کے مزید تقریباً 5 حصوں کے برابر ہے۔ بچوں کو اپنے معمول کے سنیک کے وقت میں سبزیوں کے سنیکس پیش کئے جائیں گے اور وہ جتنا کم یا زیادہ چاہیں گے کھا سکتے ہیں۔ سبزیوں کو کھانے کے لیے بچوں پر کوئی دباو نہیں ڈالا جائے گا اور ہمیں امید ہے کہ اس تحقیق میں حصہ لے کر بچے واقعی لطف اُٹھائیں گے۔

یہ تحقیق ایک واحد سبزی کے سنیک کے لینے کے لیے بچوں کی پسند کے بڑھانے میں اسے باربارسامنے لانے کے مؤثر ہونے کا جائزہ لے گی ۔ یہ تحقیق اس ٹیکنیک اور مختلف سبزیوں کے پیش کرنے کے درمیان موازنہ بھی کرے گی جس کے بارے میں یہ پتہ چلا ہے کہ اس سے سبزیوں کے استعمال میں اضافہ ہوتا ہے. یہ تحقیق برٹش سائکلاجیکل سوسائٹی کی طرف سے مقرر کردہ اخلاقی ہدایات کے تابع ہوگی اور انسٹیٹیوٹ آف سائکلاجیکل سائنسز (لیڈزیونیورسٹی) کی ایتھکس کمیٹی(اخلاقیات کمیٹی) کی طرف سے منظور شدہ ہے(ریفرنس نمبر 0240-12).

ہم اور نرسری دونوں ہی اس بات کو پسند کریں گے کہ وہ تمام بچے جو شریک ہونے کے اہل ہیں انھیں اس تحقیق میں شامل کرلیا جائے کیوں کہ ہم سمجھتے ہیں کہ اس میں شریک ہونے والے لوگوں کے لیے واقعی یہ ایک دلچسپ تجربہ ہوگا. **چنانچہ ہم 18 ماہ اور 4 سال کے درمیان کی عمر کے بچوں کے تمام والدین سے درخواست کرتے ہیں کہ اگر وہ یہ <u>نہیں چاہتے ہیں</u> کہ ان کا بچہ تحقیق میں شامل ہو** تو وہ ہمیں منسلک جوابی پرچے کا استعمال کرکے اس کے بارے میں مطلع کردیں۔ غذا کی الرجیوں کی وجہ سے کچھ بچوں کو تحقیق سے خارج کرنا ضروری ہوسکتا ہے۔ اسی وجہ سے ہم نے اگلے صفحہ پر ان سبزیوں کی فہرست دی ہے جو تحقیق میں شامل کی جائیں گی اور ہم آپ سے درخواست کرتے ہیں کہ اگر آپ کے بچے کو ان میں سے کسی غذا سے الرجی ہے یا الرجی کا شبہ ہے تو آپ منسلک جوابی پرچے کا استعمال کرتے ہوئے نرسری کو مطلع فرمائیں. جو بچے غذا کی الرجی کی وجہ سے حصہ نہیں لے سکتے، ان کے سلسلے میں ہم نرسری کے ساتھ مل کر اس بات کو یقینی بنانے کی کوشش کریں گے کہ ان بچوں کو مناسب متبادل سنیک کے ساتھ سنیک کے سیشنوں میں شامل کیا جائے . آپ کسی بھی وقت کوئی وجہ بتائے بغیراپنے بچے کو اس تحقیقی مطالعے سے نکال سکتے ہیں.

اس تحقیقی مطالعے کو 18.02.13 کو شروع کرنے کا منصوبہ ہے، اس لیے ہم آپ سے درخواست کرتے ہیں کہ آپ برائے مہربانی 15.02.13 تک جوابی پرچہ اپنی نرسری کو واپس کردیں۔ اگر اس تحقیق کے بارے میں آپ مزید معلومات چاہتے ہیں ، تو برائے مہربانی اپنی نرسری کے عملے سے رابطہ کریں یا نیچے دی گئی رابطے کی تفصیلات کا استعمال کرکے مجھ سے رابطہ کریں۔

آپ کی مخلص

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معلوماتی پرچہ

اس تحقیقی مطالعے میں میرا بچہ / بچی کیسے شامل ہوگا/گی؟

1. تحیقق کے پہلے ہفتے کے دوران آپ کے بچے کو 2 مختلف دنوں میں اُن کے معمول کے سنیک کے وقت پر سیلری، سرخ شملہ مرچ (ریڈ پیپر)، سبز شملہ مرچ (گرین پیپر) بے بی سویٹ کارن (چھوٹی دودھیا مکئی) یا مولی (ریڈش) کا ایک واحد سبزی کا سنیک یا ان تمام 5 سبزیوں پر مشتمل ایک سنیک پیش کیا جائے گا۔ اگر آپ کے بچے کو ان میں سے کسی بھی سبزی سے الرجی ہے تو برائے مہربانی ہمیں منسلک جوابی پرچے پر مطلع کریں۔
2. اس کے بعد کے تین ہفتوں کے دوران آپ کے بچے کو ہرہفتے دو دفعہ اُن کے معمول کے سنیک کے وقت پر ایک واحد سبزی کا سنیک یا مختلف سبزیوں پر مشتمل ایک سنیک پیش کیا جائے گا(کل 6 مرتبہ)۔ یہ سبزیاں کچی حالت میں فنگر فوڈ کے سائز کے ٹکڑوں میں کاٹی ہوئی پیش کی جائیں گی۔ ہر سنیک کے بعد ہم پیمائش کریں گے کہ اُنہوں نے کتنی مقدار کھائی ہے۔
3. اس تحیقق کے اختتام پرآپ کے بچے کو 2 مختلف دنوں میں دوبارہ دونوں سنیکس میں سے ہر ایک پیش کیا جائے گا۔ ہم دوبارہ پیمائش کریں گے کہ اُنہوں نے کتنی مقدار کھائی ہے۔
4. اس تحیقق کے اختتام کے ایک ماہ بعد اور تین ماہ بعد ہم دوبارہ نرسری میں آئیں گے اور مرحلہ 3 کو دہرائیں گے۔ ہم اس تحقیق کے سلسلے میں آپ کے بچے/ بچی کے قد ، وزن اور کمر کی پیمائش بھی کرنا چاہیں گے ۔

اس تحقیقی مطالعے میں میری شمولیت کیسے ہوگی ؟

آپ سے درخواست کی جائے گی کہ اپنے خاندان ، خاص طور پر ہماری تحقیق میں شامل بچے، کی معمول کی کھانے کی عادات کے متعلق 2 مختصرسوالنامے مکمل کریں۔ ان سوالناموں کو مکمل کرنے پر شکریے کے طورپرہماری طرف سے آپ کو ایک ہائی سٹریٹ کا 5 پونڈ کاواؤچرموصول ہوگا۔

اس تحقیقی مطالعے میں حصہ لینے میں کوئی فوائد / خدشات بھی ہیں ؟

اس تحقیق میں حصہ لینے والے بچوں کو ٹیسٹ والے دنوں میں کھانے کے لیے اضافی مقدار میں سبزیاں ملیں گی۔ اس کے علاوہ اگر ہماری تحقیق کامیاب رہتی ہے تو ہمیں اس بارے میں زیادہ سمجھ بوجھ حاصل ہوگی کہ بچوں میں سبزیوں کے استعمال اور پسند کو بڑھانے کے لیے سیکھنے کے کون سے طریق ہائے کار شامل ہیں ۔ اس تحقیق سے بہت کم خدشات منسلک ہیں اورجوکوئی خدشات بھی ہیں وہ وہی ہیں جو نرسری میں کوئی بھی کھانا کھانے کے ہوسکتے ہیں۔ نرسری کا عملہ تمام سیشنز کی نگرانی کرے گا اور مناسب آلات اور غذا کے استعمال کے ذریعے تمام خدشات کو کم سے کم کردیاگیاہے۔ تمام غذاؤں کی تیاری اور نقل وحمل میں حفاظت اورحفظان صحت کے اصولوں کی سختی سے پابندی کی جائے گی۔

اگر میں حصہ لیتا ہوں تو میری معلومات کا کیا ہو گا؟

جوابی پرچوں کے علاوہ تمام معلومات کو گمنام بنادیا جائےگا۔ تمام شرکاء کو ایک شناختی (آئی ڈی) نمبردے دیا جائے گا تا کہ نام استعمال نہ کیے جائیں اور معلومات پر مبنی تمام فائلوں کو حفاظت سے محفوظ رکھا جائے گا۔ تحیق کے انتظامات کے سلسلےمیں ہو سکتا ہے اس تحقیق کے دوران جمع کی گئی معلومات کو یونیورسٹی کی تحقیقاتی ٹیم، اس تحقیقی پراجیکٹ میں شامل دیگر لوگ اورلیڈز یونیورسٹی کے افراد دیکھ سکیں۔ تحقیق کے وہ ریکارڈ جن سے آپ اور آپ کے بچے کی شناخت ہوسکتی ہے اور تحقیق کے دوران آپ / آپ کے بچے سے متعلقہ جمع کی جانے والی تمام معلومات کو انتہائی رازداری میں رکھا جائے گا۔

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جوابی پرچہ

اگر آپ نہیں چاہتے کہ آپ کا بچہ /بچی اس تحقیقی مطالعے میں حصہ لے، یا اگر آپ کے بچے کو تحقیقی مطالعے میں شامل کسی بھی غذا سے الرجی ہے تو برائے مہربانی نیچے دیا گیا جوابی پرچہ مکمل کریں اور **13......** تک اپنی نرسری میں واپس بھیج دیں۔

✂---

بچے کا نام ....

میں **نہیں چاہتا/ چاہتی** کہ میرا بچہ/ بچی نرسری میں سبزیوں سے متعلقہ تحقیقی مطالعے میں حصہ لے (برائے مہربانی ٹک کا نشان لگائیں) ☐

میں اس بات کی تصدیق کر سکتا / سکتی ہوں کہ میرے بچے / بچی کو مندرجہ ذیل غذاؤں سے معلوم شدہ الرجی ہے یا ان سے الرجی کا شبہ ہے(برائے مہربانی ٹک کا نشان لگائیں) :

بےبی سویٹ کارن (چھوٹی دودھیا مکئی) ☐

سیلری ☐

سبز شملہ مرچ (گرین پیپر) ☐

سرخ شملہ مرچ (ریڈ پیپر) ☐

مولی (ریڈیش) ☐

میں خوشی سے اس بات پر رضامند ہوں کہ میرا بچہ/ بچی اس تحقیقی مطالعے میں حصہ لے لیکن (برائے مہربانی مناسب خانے میں ٹک کا نشان لگائیں) :

میں **نہیں چاہتا/ چاہتی** کہ میرے بچے / بچی کے قد ، وزن اور کمر کے گھیر کی پیمائش کی جائے ☐

میں **نہیں چاہتا/ چاہتی** کہ اس تحقیقی مطالعے کے سلسلے میں میرے بچے/ بچی کی فلم بنائی جائے اور یا اُس کی فوٹو کھینچی جائے ☐

(جو تصویریں ریکارڈ کی جائیں گی اُنہیں صرف تحقیقی پراجیکٹ کے سلسلے میں استعمال کیا جائے گا اور اُنہیں آپ کی رضامندی کے بغیر عام لوگوں / سائنسی شعبےسے وابستہ افراد کو نہیں دکھایا جائے گا۔)

اگر آپ یہ نہیں بھی چاہتے کہ آپ کے بچے کی پیمائش کی جائے اور / یا اُس کی فلم بنائی جائے تو پھر بھی آپ اس تحقیقی مطالعےمیں حصہ لے سکتے ہیں۔

والدین / سرپرست کے دستخط ....

تاریخ ....

Dear Parent / Guardian,

We are from the Institute of Psychological Sciences at the University of Leeds.

We are looking to at ways of encouraging children to eat more vegetables.

In ... we plan on running a study at your child's nursery. We would like all children between 18 months and 4 years to take part.

We will give each child an extra 100g of vegetables 2 or 3 times per week. This is around 5 extra portions of vegetables a week!

Children will have the vegetables as snacks at their usual snack time. They can eat as much or as little as they want.

We hope the children taking part will find our study fun!

For more info contact Sara:

0113 343 9197 pssma@leeds.ac.uk

We want to see if we can increase how much children like vegetables and how much they eat.

The children will eat the same vegetable snacks on 2 - 3 days a week.
This is called **'repeated exposure'**.

Some children will get 1 vegetable as a snack and some will get 5 different vegetables.
This is the **'variety'** group.

We are asking parents who **<u>do not</u>** want their child to take part in the study to let us know. **Please complete the response slip on the next page.**

If your child has a food allergy they might not be able to take part. A list of vegetables that will be used in our study is on the next page.

Please let the nursery know.

If your child cannot take part in the study because of an allergy they can still take part in the snack sessions and will be given something else to eat.

You can take your child out of the study at any time and you do not have to tell us why. Just let nursery know.

The study will start on 6th May . Please return the response slip to your nursery by the …….. 2013.

Response Slip

If you **do not** want your child to take part in this study or your child has allergies to any of the foods below please complete the response slip and return to your nursery by ……. 2013.

Child's name ....

I **do not** want my child to take part in the vegetable study at nursery (please tick) ☐

My child **has a known or suspected food allergy** to the following (please tick): baby sweet corn ☐

celery ☐

green pepper ☐

red pepper ☐

radish ☐

I **do want** my child to take part in the study **but** (please tick as appropriate):

I **do not** want my child to have their height and weight measured ☐

I **do not** want my child to be filmed and or photographed for this study ☐

(Images will only be used as part of the research project and will not be shown to the public/scientific community without your consent.)

You can still take part in the research project if you do not want your child to be measured and/or filmed.

Parent/Caregiver's signature ....

Date ....

Appendix B: Study-specific Questionnaires

Dear Parent/ Guardian,

We are researchers from the Institute of Psychological Sciences at the University of Leeds. Our research focuses on nutrition, appetite and eating habits.

We are interested in finding out more about the development of eating habits in young children. In particular we are keen to find out more about weaning and about how this may influence later eating habits. We would like to know more about all aspects of weaning: age at which solid foods were introduced; what foods were offered, in what order and in what combinations.

We would like to invite you to take part in a study of infant weaning.

If you decide to participate please fill out the questionnaires enclosed and return them to us in the **FREEPOST** envelope provided. In appreciation of your time we would like to offer you a **£5 voucher**. Please return the slip below stating which voucher you would prefer.

We would also like to invite you to join a discussion or to take part in a one to one interview. The discussion groups/ interviews will last no more than one hour during which you will be asked about feeding, weaning and the eating habits of your child. These sessions may be tape recorded so that we can transcribe comments at a later date.

If you would like to participate we can arrange the time and place to suit you. In addition, where needed, we can provide on site childcare by experienced nursery nurses. In appreciation of your time and effort you will receive a gift token and we will reimburse any reasonable travel costs.

Any information that you disclose will be treated with full confidentiality by a team of experienced researchers. Final results will be presented at conferences and published in a scientific journal.

Should you decide to participate in the research you are free to withdraw at any stage without providing any reason for doing so.

If you have any questions regarding any aspect of our research please feel free to contact Dr. Samantha Caton on 0113 343 6692 (email: s.caton@leeds.ac.uk) or Professor Marion Hetherington on 0113 3438472 (email: marion.hetherington@leeds.ac.uk).

If you feel happy with the information provided to you and you are willing to take part in the research please complete the consent form attached and return it back to us in the freepost envelope provided.

Many thanks for your time.

Yours truly, Samantha Caton.

Please tick the box to indicate which voucher you would prefer

Tesco	☐
Asda	☐
Morrisons	☐
Mothercare	☐

Code number (for office use)

Date

Participant consent form

I have read and understood the information sheet and have been given the opportunity to ask questions. YES/ NO

I understand that I can withdraw from the study at any time without providing any reason for doing so. YES/ NO

I understand that all information collected for the study will be anonymised and will only be used as part of this research project. YES/ NO

Name: ____________________________________

Name of child (ren) ____________________________________

Date(s) of birth ____________________________________

Address: ____________________________________

____

____________________ **Post code** ____________

Contact telephone number: ____________________________

Signature: ____________________________________

Date: ____________________________________

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Code number (for office use)
Date

Thank you for taking part in our research. Your participation is very much appreciated. Please complete this questionnaire as **fully and accurately** as possible. We would like to know information about yourself and your child who is aged 6-18 months old.

Parent/ Caregiver details

Name……

Age / D.O.B………

Postcode……

Height……….

Weight……….

Age of leaving full time education………………………………………………………………………..

Employment details (occupation)…………………………………………………………………………………

Fulltime ☐ Part time ☐ Unemployed ☐

Number of children…………………………………………………………………………………………..

Do you smoke? Yes ☐ No ☐

IF yes, how many per day ……………………..

Did you smoke whilst pregnant? Yes ☐ No ☐

IF yes, how many per day ……………………..

Child details

1. Name of child……………………………………………………………..................................

2. Age / D.O.B of child……………………………………………………………………………...
3. Sex Male/Female
4. Approximate birth-weight of child…………………………………………………………....
5. Approximate current weight of child (if known)………………………………………….
6. Was this child breast-fed YES/NO (if NO, go straight to question 10)
7. Was this child exclusively breast-fed (no supplemental formula feeds) YES/NO
8. Duration of breast-feeding……………………………………………………………………...
9. Age at which formula was introduced…………………………………………………………..
10. Age at which solid food (anything other than breast/formula milk, either added to the bottle or spoon-fed) was given to your child…………………
11. How was this first food given? Added to the bottle ☐ spoon-fed ☐
12. What types of food did you give to your child during the first few weeks of weaning? (eg, potato, banana, baby cereals, carrots, rusks, apple etc.)

………

………

………………………………………………………………………………...

13. During the first month of weaning when you were giving your child a new food, were these foods ***mostly*** given as a *single* food (such as banana only, carrot only, cauliflower only) or were they *mostly mixed* with others (beef, potato + carrot, banana + avocado, sweet potato + apple). In addition, please give an example of the foods used.

………

………

………

…………………………………………………………….

14. During the first few months of weaning did you use

Mostly "ready prepared" baby food ☐ **mostly** home made☐

mixture of both ☐

15. How old was your child when they were first given:

a) Dairy products (cow's milk, yoghurts etc)…………………………………………………

b) Fresh fruit juice……………………………………………………………………………………...

c) Meat…………………………………………………………………………………………………...

d) Confectionary (biscuits, chocolate, desserts e.g chocolate mousse, cakes)………………………………………………………………………………………………

e) Fruit……………………………………………………………………………………………………

f) Pulses (beans, lentils, chick peas)………………………………………………………………

g) Vegetables……………………………………………………………………………………………..

h) Fish…………………………………………………………………………………………………….

i) Cereal products (baby rice, rusks/ baby biscuits, porridge,)………………………….

j) Fruit-flavoured or other soft drinks (e.g. Ribena, cola etc)……………………...........

k) Eggs………………………………………………………………………………………………………

l) Bread……………………………………………………………………………………………….....

16. What are your child's favourite foods/drinks?

………

………

…………………………………………………………………………………………………

17. What are your child's most disliked foods/drinks?

………

………

……

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Code number (for office use)

Infant Feeding Questionnaire

Your Name	
Child's Name(s)	
Child's date(s) of birth	

Please mark the answer that applies to you using a cross e.g. (X).

	Never	**Rarely**	**Some -times**	**Often**	**Always**
1. Do you let him/her eat whenever he/she wants to?	☐	☐	☐	☐	☐
2. Do you worry that he/she is not eating enough?	☐	☐	☐	☐	☐
3. Do you only allow him/her to eat at set times?	☐	☐	☐	☐	☐
4. When he/she gets fussy, is feeding him/her the first thing you would do?	☐	☐	☐	☐	☐
5. Do you worry that he/she is eating too much?	☐	☐	☐	☐	☐
6. Is it a struggle to get him/her to eat?	☐	☐	☐	☐	☐
7. Do you get upset if he/she eats too much?	☐	☐	☐	☐	☐
8. Do you talk or sing to your son/daughter while you feed him/her?	☐	☐	☐	☐	☐

	Never	Rarely	Some -times	Often	Always
9. Do you put infant cereal in his/ her bottle so he/she sleeps longer at night?	☐	☐	☐	☐	☐
10. Do you hold him/her when giving him/her a bottle?	☐	☐	☐	☐	☐
11. When he/she was under 4 months of age, did he/she want more than just formula and/or breast milk?	☐	☐	☐	☐	☐
12. Do you put cereal in his/her bottle so he/she will stay full longer?	☐	☐	☐	☐	☐

	Disagree a lot	Disagree a little,	No strong feelings either way	Agree a little	Agree a lot
13. If I do not encourage him/her to eat, then he/she would not eat enough.	☐	☐	☐	☐	☐
14. Feeding him/her is the best way to stop his/her fussiness.	☐	☐	☐	☐	☐
15. I know when he/she is hungry.	☐	☐	☐	☐	☐
16. I am worried that he/she will become underweight.	☐	☐	☐	☐	☐
17. I know when he/she is full.	☐	☐	☐	☐	☐
18. He/ she knows when he/she is hungry.	☐	☐	☐	☐	☐
19. I am worried that he/she will become overweight	☐	☐	☐	☐	☐
20. He/she knows when he/she is full.	☐	☐	☐	☐	☐

Main Interview Questions
Question 1: Mums tend to know what is best for their baby – how did you decide that your child was ready to be given solid foods?
Question 2: What advice were you given on how to wean your baby and who gave you this advice?
Question 3: Mums use a variety of foods to introduce their babies to solid foods, what solid foods did you use and what made you decide to use these foods?
Question 4: Some infants seem not to like particular foods – what do you do when your child appears not like a particular food that you have offered them?
Question 5: Tell me about your child, how much do they eat vegetables, when did you first introduce vegetables and how much do they like or dislike them and what might you do to promote vegetable intake?
Question 6: What do you think of the current weaning recommendations?

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Dear Parent/ Guardian,

We are researchers from the Institute of Psychological Sciences at the University of Leeds. Our research focuses on nutrition, appetite and eating habits. We are interested in finding out more about the development of eating habits in young children. In particular we are keen to find out more about what vegetables your child usually eats. We would like to invite you to take part in a short questionnaire survey that should take no more than 30 minutes to complete.

Everyone who participates in the survey will have their details entered into a prize draw: 1st prize £50, 2nd prize £25, 3rd prize £15 and 4th prize £10.

If you decide to participate please fill out the questionnaire and return it to your child's nursery. Alternatively you can fill out the questionnaire online http://www.surveymonkey.com/s/DP7K3YP

Any information that you disclose will be treated with full confidentiality by a team of experienced researchers. The current study has been approved by the Institute of Psychological Sciences Ethics Committee (reference 10099-05)

You are free to withdraw from the study at any time without giving any reason for doing so.

If you have any questions regarding any aspect of our research please feel free to contact Dr. Samantha Caton on 0113 343 6692 (email: s.caton@leeds.ac.uk) or Professor Marion Hetherington on 0113 3438472 (email: marion.hetherington@leeds.ac.uk).

Many thanks for your time.

Yours truly,

Samantha Caton.

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Thank you for taking part in our research.

Your participation is very much appreciated.

We would like to know about which vegetables **your child** usually consumes.

Please answer the questionnaire with just **your child who is aged between 6 and 12 months old in mind**

Parent/ Caregiver details

Name……………………………………………………………………………………………...................

D.O.B……………………..Height…………………………….Weight……………………….

Child details

In the current questionnaire my answers refer to my child who is ……… months old and who is a boy/ girl (please circle)

		Are you familiar with this vegetable?		Have you ever offered it to your child?		If yes, how often do you offer it?				How much does your child like it?					How does your child generally eat it?
		No	Yes	No	Yes	Every day or almost	1-3 times per week	1-3 times per month	Less than once per month	Strongly disliked	Disliked	Neutral	Liked	Strongly liked	Raw, Boiled, Steamed, Stewed, Pureed, In a sauce, Roasted, Fried or Other (please state)
	Example Green beans		X		X			X					X		Boiled
		How do you generally season it?					I add salt to boiling water, and after cooking I add butter, garlic and parsley,								
1	Artichoke														
		How do you generally season it?													
2	Asparagus														
		How do you generally season it?													
3	Avocado														
		How do you generally season it?													
4	Bean sprouts														
		How do you generally season it?													
5	Beetroot														
		How do you generally season it?													

		Are you familiar with this vegetable?		Have you ever offered it to your child?		If yes, how often do you offer it?				How much did your child like it?					How does your child generally eat it?
		No	Yes	No	Yes	Every day or almost	1-3 times per week	1-3 times per month	Less than once per month	Strongly disliked	Disliked	Neutral	Liked	Strongly liked	Raw, Boiled, Steamed, Stewed, Pureed, In a sauce, Roasted, Fried or Other (please state)
6	**Broad bean**														
		How do you generally season it?													
7	**Broccoli**														
		How do you generally season it?													
8	**Brussels sprouts**														
		How do you generally season it?													
9	**Butter Beans**														
		How do you generally season it?													
10	**Butternut Squash**														
		How do you generally season it?													
11	**Cabbage**														
		How do you generally season it?													
12	**Carrots**														
		How do you generally season it?													

		Are you familiar with this vegetable?		Have you ever offered it to your child?		If yes, how often do you offer it?				How much did your child like it?					How does your child generally eat it?
		No	Yes	No	Yes	Every day or almost	1-3 times per week	1-3 times per month	Less than once per month	Strongly disliked	Disliked	Neutral	Liked	Strongly liked	Raw, Boiled, Steamed, Stewed, Pureed, In a sauce, Roasted, Fried or Other (please state)
13	**Cauliflower**														
		How do you generally season it?													
14	**Celery**														
		How do you generally season it?													
15	**Celeriac**														
		How do you generally season it?													
16	**Chard**														
		How do you generally season it?													
17	**Cucumber**														
		How do you generally season it?													
18	**Dried legumes (lentils, chickpeas)**														
		How do you generally season it?													
19	**Aubergine**														
		How do you generally season it?													

		Are you familiar with this vegetable?		Have you ever offered it to your child?		If yes, how often do you offer it?				How much did your child like it?					How does your child generally eat it?
		No	Yes	No	Yes	Every day or almost	1-3 times per week	1-3 times per month	Less than once per month	Strongly disliked	Disliked	Neutral	Liked	Strongly liked	Raw, Boiled, Steamed, Stewed, Pureed, In a sauce, Roasted, Fried or Other (please state)
20	**Endive**														
		How do you generally season it?													
21	**Fennel**														
		How do you generally season it?													
22	**Green beans**														
		How do you generally season it?													
23	**Green cabbage**														
		How do you generally season it?													
24	**Green pepper**														
		How do you generally season it?													
25	**Green salad Lettuce**														
		How do you generally season it?													
26	**Jerusalem Artichoke**														
		How do you generally season it?													

		Are you familiar with this vegetable?		Have you ever offered it to your child?		If yes, how often do you offer it?				How much did your child like it?					How does your child generally eat it?
		No	Yes	No	Yes	Every day or almost	1-3 times per week	1-3 times per month	Less than once per month	Strongly disliked	Disliked	Neutral	Liked	Strongly liked	Raw, Boiled, Steamed, Stewed, Pureed, In a sauce, Roasted, Fried or Other (please state)
27	**Kale**														
		How do you generally season it?													
28	**Leek**														
		How do you generally season it?													
29	**Mange tout**														
		How do you generally season it?													
30	**Mixed vegetables**														
		How do you generally season it?													
31	**Mushroom**														
		How do you generally season it?													
32	**Okra**														
		How do you generally season it?													
33	**Onions**														
		How do you generally season it?													

		Are you familiar with this vegetable?		Have you ever offered it to your child?		If yes, how often do you offer it?				How much did your child like it?					How does your child generally eat it?
		No	Yes	No	Yes	Every day or almost	1-3 times per week	1-3 times per month	Less than once per month	Strongly disliked	Disliked	Neutral	Liked	Strongly liked	Raw, Boiled, Steamed, Stewed, Pureed, In a sauce, Roasted, Fried or Other (please state)
34	**Orange pepper**														
		How do you generally season it?													
35	**Parsnips**														
		How do you generally season it?													
36	**Peas**														
		How do you generally season it?													
37	**Pumpkin**														
		How do you generally season it?													
38	**Radish**														
		How do you generally season it?													
39	**Ratatouille**														
		How do you generally season it?													
40	**Red cabbage**														
		How do you generally season it?													

		Are you familiar with this vegetable?		Have you ever offered it to your child?		If yes, how often do you offer it?				How much did your child like it?					How does your child generally eat it?
		No	Yes	No	Yes	Every day or almost	1-3 times per week	1-3 times per month	Less than once per month	Strongly disliked	Disliked	Neutral	Liked	Strongly liked	Raw, Boiled, Steamed, Stewed, Pureed, In a sauce, Roasted, Fried or Other (please state)
41	**Red pepper**														
		How do you generally season it?													
42	**Runnerbean**														
		How do you generally season it?													
43	**Salsify**														
		How do you generally season it?													
44	**Sorel plant**														
		How do you generally season it?													
45	**Spinach**														
		How do you generally season it?													
46	**Squash**														
		How do you generally season it?													
47	**Swedes**														
		How do you generally season it?													

		Are you familiar with this vegetable?		Have you ever offered it to your child?		If yes, how often do you offer it?				How much did your child like it?					How does your child generally eat it?
		No	Yes	No	Yes	Every day or almost	1-3 times per week	1-3 times per month	Less than once per month	Strongly disliked	Disliked	Neutral	Liked	Strongly liked	Raw, Boiled, Steamed, Stewed, Pureed, In a sauce, Roasted, Fried or Other (please state)
48	**Sweet corn**														
		How do you generally season it?													
49	**Sweet potato**														
		How do you generally season it?													
50	**Tomato**														
		How do you generally season it?													
51	**Turnips**														
		How do you generally season it?													
52	**Watercress**														
		How do you generally season it?													
53	**White cabbage**														
		How do you generally season it?													
54	**Yams**														
		How do you generally season it?													

		Are you familiar with this vegetable?		Have you ever offered it to your child?		If yes, how often do you offer it?				How much did your child like it?					How does your child generally eat it?
		No	Yes	No	Yes	Every day or almost	1-3 times per week	1-3 times per month	Less than once per month	Strongly disliked	Disliked	Neutral	Liked	Strongly liked	Raw, Boiled, Steamed, Stewed, Pureed, In a sauce, Roasted, Fried or Other (please state)
55	**Yellow pepper**														
		How do you generally season it?													
56	**Zucchini / courgettes**														
		How do you generally season it?													
	Potatoes:	**Please find below a list of different preparation methods for potatoes**													
57	**Chips/ French fries**														
		How do you generally season it?													
58	**Pan-fried potatoes**														
		How do you generally season it?													
59	**Crisps**														
		How do you generally season it?													
60	**Boiled potatoes**														
		How do you generally season it?													
61	**Mashed / puréed potatoes**														
		How do you generally season it?													

		Are you familiar with this vegetable?		Have you ever offered it to your child?		If yes, how often do you offer it?				How much did your child like it?					How does your child generally eat it?
		No	Yes	No	Yes	Every day or almost	1-3 times per week	1-3 times per month	Less than once per month	Strongly disliked	Disliked	Neutral	Liked	Strongly liked	Raw, Boiled, Steamed, Stewed, Pureed, In a sauce, Roasted, Fried or Other (please state)
62	**Baked potato**														
		How do you generally season it?													

Appendix C: Standardised Questionnaires

Child Eating Behaviour Questionnaire

Please mark one box on each line which best corresponds with your answer

	Never	Rarely	Sometimes	Often	Always
G1. My child loves food	☐	☐	☐	☐	☐
G2. My child eats more when worried	☐	☐	☐	☐	☐
G3. My child has a big appetite	☐	☐	☐	☐	☐
G4. My child finishes his/her meal quickly	☐	☐	☐	☐	☐
G5. My child is interested in food	☐	☐	☐	☐	☐
G6. My child is always asking for a drink	☐	☐	☐	☐	☐
G7. My child refuses new foods at first	☐	☐	☐	☐	☐
G8. My child eats slowly	☐	☐	☐	☐	☐
G9. My child eats less when angry	☐	☐	☐	☐	☐
G10. My child enjoys tasting new foods	☐	☐	☐	☐	☐
G11. My child eats less when s/he is tired	☐	☐	☐	☐	☐
G12. My child is always asking for food	☐	☐	☐	☐	☐
G13. My child eats more when annoyed	☐	☐	☐	☐	☐
G14. If allowed to, my child would eat too much	☐	☐	☐	☐	☐
G15. My child eats more when anxious	☐	☐	☐	☐	☐
G16. My child enjoys a wide variety of foods	☐	☐	☐	☐	☐
G17. My child leaves food on his/her plate at the end of a meal	☐	☐	☐	☐	☐
G18. My child takes more than 30 minutes to finish a meal	☐	☐	☐	☐	☐
G19. My child eats more when s/he has nothing else to do	☐	☐	☐	☐	☐
G20. If given the chance, my child would always have food in his/her mouth	☐	☐	☐	☐	☐

	Never	Rarely	Sometimes	Often	Always
G21. Given the choice, my child would eat most of the time	☐	☐	☐	☐	☐
G22. My child looks forward to mealtimes	☐	☐	☐	☐	☐
G23. My child gets full before his/her meal is finished	☐	☐	☐	☐	☐
G24. My child enjoys eating	☐	☐	☐	☐	☐
G25. My child eats more when she is happy	☐	☐	☐	☐	☐
G26. My child is difficult to please with meals	☐	☐	☐	☐	☐
G27. My child eats less when upset	☐	☐	☐	☐	☐
G28. My child gets full up easily	☐	☐	☐	☐	☐
G29. My child decides that s/he doesn't like a food, even without tasting it	☐	☐	☐	☐	☐
G30. Even if my child is full up s/he finds room to eat his/her favourite food	☐	☐	☐	☐	☐
G31. If given the chance, my child would drink continuously throughout the day	☐	☐	☐	☐	☐
G32. My child cannot eat a meal if s/he has had a snack just before	☐	☐	☐	☐	☐
G33. If given the chance, my child would always be having a drink	☐	☐	☐	☐	☐
G34. My child is interested in tasting food s/he hasn't tasted before	☐	☐	☐	☐	☐
G35. My child eats more and more slowly during the course of a meal	☐	☐	☐	☐	☐

Your child's feelings about food.

Please indicate how strongly you agree with the following statements:

	Disagree strongly	Disagree	Agree	Agree strongly
E1. My child doesn't trust new foods	☐	☐	☐	☐
E2. If my child doesn't know what's in a food, s/he won't try it	☐	☐	☐	☐
E3. My child is afraid to eat things s/he has never had before	☐	☐	☐	☐
E4. My child will eat almost anything	☐	☐	☐	☐
E5. My child is very particular about the foods s/he will eat	☐	☐	☐	☐
E6. My child is constantly sampling new and different foods	☐	☐	☐	☐

Child Feeding Questionnaire

Please answer the following questions about your child who is in this study.
If you feel a question is irrelevant because of your child's age, please leave it out.
Please circle one answer on each line.

F1. When your child is at home, how often are you responsible for feeding him/her?	Never	Rarely	Sometimes	Very Often	Always
F2. How concerned are you about your child eating too much when you are not around him/her?	Unconcerned	Slightly Unconcerned	Neutral	Slightly Concerned	Concerned
F3. My child should always eat all of the food on his/her plate	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
F4. If I did not guide or regulate my child's eating, s/he would eat too much of his/her *favourite* foods	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
F5. How much do you keep track of the *sweet* foods *(chocolate sweeties, ice cream, cake, biscuits, pastries)* your child eats	Not at all	Rarely	Occasionally	Very Often	Always
F6. How often are you responsible for deciding what your child's portion sizes are?	Never	Rarely	Sometimes	Very Often	Always
F7. How would you describe your weight during your adolescence?	Markedly under weight	Under weight	Average	Over weight	Markedly over weight

F8. How much do you keep track of the *snack* foods *(crisps, cheese puffs etc)* foods your child eats?	Not at all	Rarely	Occasionally	Very Often	Always
F9. I have to be sure that my child does not eat too much of his/her *favourite* foods	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
F10. If I did not guide or regulate my child's eating, s/he would eat much less than s/he should	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
F11. If my child is not hungry I try to get him/her to eat anyway	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
F12. How would you describe your weight during your childhood?	Markedly under weight	Under weight	Average	Over weight	Markedly over weight
F13. How often are you responsible for deciding if your child has eaten the right kind of foods?	Never	Rarely	Sometimes	Very Often	Always
F14. I have to be sure that my child does not eat too many *high-fat* foods.	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
F15. How much do you keep track of the *high-fat* foods that your child eats?	Not at all	Rarely	Occasionally	Very Often	Always
F16. How concerned are you about your child becoming over weight?	Unconcerned	Slightly Unconcerned	Neutral	Slightly Concerned	Concerned

F17. I have to be sure that my child does not eat too many *sweet* foods.	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
F18. I have to be especially careful to make sure my child eats enough.	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
F19. How concerned are you about your child maintaining a desirable weight?	Unconcerned	Slightly Unconcerned	Neutral	Slightly Concerned	Concerned
F20. How would you describe your current weight?	Markedly under weight	Under weight	Average	Over weight	Markedly over weight
F21. I intentionally keep some foods out of my child's reach.	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
F22. I offer *sweet* foods to my child as a reward for good behaviour.	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
F23. I offer my child his/her *favourite foods* in exchange for good behaviour.	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
F24. If I did not guide or regulate my child's eating, s/he would eat too many *junk* foods.	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
F25. How would you describe your child's weight during the first year of life?	Markedly under weight	Under weight	Average	Over weight	Markedly over weight

Caregiver's Feeding Styles Questionnaire

These questions deal with **YOUR** interactions with your preschool child during the dinner meal.
Please mark one answer on each line that best describes how often these things happen.
If you are not certain, make your best guess.

How often during the dinner meal do YOU….

	Never	Rarely	Sometimes	Most of the time	Always
J1. Physically struggle with the child to get him or her to eat (for example, physically putting the child in the chair so he or she will eat).	☐	☐	☐	☐	☐
J2. Promise the child something other than food if he or she eats (for example, "If you eat your beans, we can play ball after dinner").	☐	☐	☐	☐	☐
J3. Encourage the child to eat by arranging the food to make it more interesting (for example, making smiley faces on the pancakes).	☐	☐	☐	☐	☐
J4. Ask the child questions about the food during dinner.	☐	☐	☐	☐	☐
J5. Tell the child to eat at least a little bit of food on his or her plate.	☐	☐	☐	☐	☐
J6. Reason with the child to get him or her to eat (for example, "Milk is good for your health because it will make you strong").	☐	☐	☐	☐	☐
J7. Say something to show your disapproval of the child for not eating dinner.	☐	☐	☐	☐	☐
J8. Allow the child to choose the foods he or she wants to eat for dinner from foods already prepared.	☐	☐	☐	☐	☐
J9. Compliment the child for eating food (for example, "What a good boy! You're eating your beans").	☐	☐	☐	☐	☐
J10. Suggest to the child that he or she eats dinner, for example by saying, "Your dinner is getting cold".	☐	☐	☐	☐	☐
J11. Say to the child "Hurry up and eat your food".	☐	☐	☐	☐	☐
J12. Warn the child that you will take away something *other than food* if he or she doesn't eat (for example, "If you don't finish your meat, there will be no play time after dinner").	☐	☐	☐	☐	☐

	Never	Rarely	Sometimes	Most of the time	Always
J13. Tell the child to eat something on the plate (for example, "Eat your beans").	☐	☐	☐	☐	☐
J14. Warn the child that you will take a food away if the child doesn't eat (for example, "If you don't finish your vegetables, you won't get fruit").	☐	☐	☐	☐	☐
J15. Say something positive about the food the child is eating during dinner.	☐	☐	☐	☐	☐
J16. Spoon-feed the child to get him or her to eat dinner.	☐	☐	☐	☐	☐
J17. Help the child to eat dinner (for example, cutting the food into smaller pieces).	☐	☐	☐	☐	☐
J18. Encourage the child to eat something by using food as a reward (for example, "If you finish your vegetables, you will get some fruit").	☐	☐	☐	☐	☐
J19. Beg the child to eat dinner.	☐	☐	☐	☐	☐

Child Temperament Questionnaire

Please circle one number for each question which best corresponds to your answer.

	Not characteristic or typical of your child		Neutral	Very characteristic or typical of your child	
I1. Child tends to be shy	1	2	3	4	5
I2. Child cries easily	1	2	3	4	5
I3. Child likes to be with people	1	2	3	4	5
I4. Child is always on the go	1	2	3	4	5
I5. Child prefers playing with others rather than alone	1	2	3	4	5
I6. Child tends to be somewhat emotional	1	2	3	4	5
I7. When child moves about, s/he usually moves slowly	1	2	3	4	5
I8. Child makes friends easily	1	2	3	4	5
I9. Child is off and running as soon as s/he wakes in the morning	1	2	3	4	5
I10. Child finds people more stimulating than anything else	1	2	3	4	5
I11. Child often fusses and cries	1	2	3	4	5
I12. Child is very sociable	1	2	3	4	5
I13. Child is very energetic	1	2	3	4	5
I14. Child takes a long time to warm to strangers	1	2	3	4	5
I15. Child gets upset easily	1	2	3	4	5
I16. Child is something of a loner	1	2	3	4	5
I17. Child prefers quiet, inactive games to more active ones	1	2	3	4	5
I18. When alone, child feels isolated	1	2	3	4	5
I19. Child reacts intensely when upset	1	2	3	4	5
I20. Child is very friendly with strangers	1	2	3	4	5

Food Frequency Questionnaire

Please indicate how often **you** usually eat each food item/type by circling **one** answer on each line.

(For eg. If you eat a food daily you need only circle the number of times per day)

B1. SWEET BISCUITS (including chocolate covered)	NEVER	ONCE PER MONTH	ONCE PER FORTNIGHT	No. of days per week 1 2 3 4 5 6 7	No. of times per day 1 2 3 4 5
B2. CAKES, SCONES ETC (sponge cake, doughnuts, pancakes etc)	NEVER	ONCE PER MONTH	ONCE PER FORTNIGHT	No. of days per week 1 2 3 4 5 6 7	No. of times per day 1 2 3 4 5
B3. SWEET PASTRIES (fruit pies, jam tart, lemon meringue pies, danish pastries etc)	NEVER	ONCE PER MONTH	ONCE PER FORTNIGHT	No. of days per week 1 2 3 4 5 6 7	No. of times per day 1 2 3 4 5
B4. SWEETS, CHOCOLATE BARS	NEVER	ONCE PER MONTH	ONCE PER FORTNIGHT	No. of days per week 1 2 3 4 5 6 7	No. of times per day 1 2 3 4 5
B5. CRISPS (and other packet snacks)	NEVER	ONCE PER MONTH	ONCE PER FORTNIGHT	No. of days per week 1 2 3 4 5 6 7	No. of times per day 1 2 3 4 5
B6. WHITE BREAD (including pitta, chapatti, nan etc)	NEVER	ONCE PER MONTH	ONCE PER FORTNIGHT	No. of days per week 1 2 3 4 5 6 7	No. of times per day 1 2 3 4 5
B7. BROWN BREAD (granary, wholemeal, wholewheat, etc)	NEVER	ONCE PER MONTH	ONCE PER FORTNIGHT	No. of days per week 1 2 3 4 5 6 7	No. of times per day 1 2 3 4 5
B8. How many slices of bread/rolls do you eat per day?					1 2 3 4 5 6 7 a day
B9. BAKED BEANS, LENTILS, CHICK PEAS, KIDNEY BEANS, SOYA MINCE	NEVER	ONCE PER MONTH	ONCE PER FORTNIGHT	No. of days per week 1 2 3 4 5 6 7	No. of times per day 1 2 3 4 5
B10. CHIPS, FRIED OR ROAST POTATOES	NEVER	ONCE PER MONTH	ONCE PER FORTNIGHT	No. of days per week 1 2 3 4 5 6 7	No. of times per day 1 2 3 4 5
B11. OTHER POTATOES (boiled, mashed, etc)	NEVER	ONCE PER MONTH	ONCE PER FORTNIGHT	No. of days per week 1 2 3 4 5 6 7	No. of times per day 1 2 3 4 5
B12. YAMS, SWEET POTATOES, PLANTAIN	NEVER	ONCE PER MONTH	ONCE PER FORTNIGHT	No. of days per week 1 2 3 4 5 6 7	No. of times per day 1 2 3 4 5
B13. GREEN COOKED VEGETABLES (including cauliflower, peas, broccoli, green beans, brussels sprouts)	NEVER	ONCE PER MONTH	ONCE PER FORTNIGHT	No. of days per week 1 2 3 4 5 6 7	No. of times per day 1 2 3 4 5
B14. OTHER COOKED VEGETABLES (carrots, turnip etc)	NEVER	ONCE PER MONTH	ONCE PER FORTNIGHT	No. of days per week 1 2 3 4 5 6 7	No. of times per day 1 2 3 4 5
B15. SALADS (tomatoes, lettuce, raw vegetables)	NEVER	ONCE PER MONTH	ONCE PER FORTNIGHT	No. of days per week 1 2 3 4 5 6 7	No. of times per day 1 2 3 4 5
B16. FRESH FRUIT	NEVER	ONCE PER MONTH	ONCE PER FORTNIGHT	No. of days per week 1 2 3 4 5 6 7	No. of times per day 1 2 3 4 5

Your feelings about food.

Please indicate how strongly you agree with the following statements:

	Disagree strongly	Disagree moderately	Disagree slightly	Neither agree nor disagree	Agree slightly	Agree moderately	Agree strongly
C1. I am constantly sampling new and different foods	☐	☐	☐	☐	☐	☐	☐
C2. I don't trust new foods	☐	☐	☐	☐	☐	☐	☐
C3. If I don't know what's in a food, I won't try it	☐	☐	☐	☐	☐	☐	☐
C4. I like foods from different countries	☐	☐	☐	☐	☐	☐	☐
C5. Foreign food looks too weird to eat	☐	☐	☐	☐	☐	☐	☐
C6. At dinner parties, I will try a new food	☐	☐	☐	☐	☐	☐	☐
C7. I am afraid to eat things I have never had before	☐	☐	☐	☐	☐	☐	☐
C8. I am very particular about the foods I will eat	☐	☐	☐	☐	☐	☐	☐
C9. I will eat almost anything	☐	☐	☐	☐	☐	☐	☐
C10. I like to try new ethnic restaurants	☐	☐	☐	☐	☐	☐	☐

Appendix D: Practitioners’ Booklets

UNIVERSITY OF LEEDS

Increasing children's vegetable consumption.

Repeated exposure and the variety effect.

Practitioners Information Pack

Dear Practitioner,

Thank you for taking part in this University of Leeds study. Your time and effort in overseeing this study at your nursery is very much appreciated.

This manual provides detailed information about the purpose of the study and some tips on how to help make the intervention effective.

Detailed instructions on how to run the study can be found in your other booklet. Following these instructions and the advice we have given in this manual will help ensure consistency between yourselves and the other nurseries where this study is taking place.

If at any point during the study you have a question, would like some advice or require further information about the study please do not hesitate to contact us using the details below:

Ms Sara Ahern on 07714024829 (email: pssm@leeds.ac.uk)

Professor Marion Hetherington on 0113 3438472 (email: m.hetherington@leeds.ac.uk).

Many thanks for your time.
Yours truly, Sara Ahern

Contents

Why is this study important?

Vegetables are important to our diets because of their health related

properties. Vegetables:

- are extremely nutrient rich
- are low in energy
- might contribute to preventing several chronic diseases

Research shows that many people are not eating enough vegetables in their everyday diets and this is the case for both adults and children.

Children often report a strong dislike of vegetables and this may be due to taste, texture or appearance.

Children's liking for a food is the best predictor of their intake of that food so it follows helping children to learn to like vegetables is key to increasing the amount of vegetables they eat!

We also know that eating habits developed early in childhood tend to continue into later life. For this reasons it is important that we are promoting vegetable consumption in children as early as possible.

This is why we have approached your nursery about taking part in this study!

We want to look at different methods of increasing vegetable consumption in preschool children and find out what methods are most effective.

Images courtesy of Stuart Miles / FreeDigitalPhotos.net and http://health.more4kids.info

Why repeated exposure?

We tend to prefer objects and foods that we are familiar with.

The more we are exposed to an object or food, the more familiar we become and the more a preference develops.

Young children are particularly reluctant to try new foods such as vegetables. This is called food neophobia and is a normal developmental stage. They can even begin to refuse foods they previously enjoyed.

Studies have shown that giving young children repeated experience with and exposure to vegetable flavours can lead to them being more readily accepted.

Studies suggest between 8 to 15 exposures are necessary for a preference to develop. However, our previous work has shown that as few a 5 exposures are enough to increase children's intake.

Why variety?

Exposure to a variety of vegetables early in life has been found to promote increased vegetable intake later in life.

Offering a variety of vegetables as part of a meal, rather than a single vegetable, has been found to increase the amount of vegetables eaten by adults.

Very little research has been done into the effect of variety on children's vegetable consumption.

We want to find out if offering a variety of vegetables at children's snack time, rather than a single vegetable, increases the overall amount of vegetables eaten by the children.

Who, what, where and when?

We are recruiting children between 18 months and 4 years of age through nurseries and children centres across the local area. All children within this age group are eligible to take part. Those children with food allergies may need to be excluded.

The study will take place within the nursery or children's centre and will be run by the caregivers within the nursery setting.

Children will take part at their usual morning or afternoon snack time.

The main part of the study should last 4 to 5 weeks.

What are we using and what do we want to measure?

Each nursery involved in the study will be in one of three groups;

- repeated exposure
- variety
- control

Children will receive vegetables cut into finger foods as part of the experiment. The vegetable snacks will include: baby sweet corn, celery, red and green peppers, and radish.

All children involved in the study will take part in week 1 and week 5 (described in your instruction booklet).

Only those in the repeated exposure and variety groups will take part in weeks 2 and 3 and 4.

Running the study.

In order to ensure the results of our study are reliable and give a real picture of children's eating habits it is important that all of our participating nurseries run the experiment in the same way.

To help you with this we will:

- provide you with a schedule or timetable of testing with detailed instructions to refer to.
- supply all snack foods for the study at no cost to your nursery.
- prepare all snack foods. Snacks will come in containers, labelled with children's names and ready to offer.
- deliver snacks to your nursery and pick up all uneaten foods and containers at the end of the day.

Most important is making sure that the vegetable snacks are all offered in the same way at each nursery.

To make this easy you will find a list of feeding "dos and don'ts" on the next page that will assist you in encouraging your children to eat their vegetables!

Please make sure you read through these tips and that they are shared with all the members of your team who will be taking part in this study.

It is important that participating children feel relaxed and happy about taking part in the study and we think the advice we have provided should help to make the whole project an enjoyable experience for everyone!

Study “dos and don’ts”

Snack takes place at the
usual time.
Vegetable snacks should be offered
at the chil- dren’s usual snack time.
This can be a mid-morning snack or
a mid- afternoon snack but
should al- ways be at the same
time on each test day from the
beginning to the end of the study.

Everyone sits down together.
Ask children to sit down together at tables as this will help focus them on the snack and eating session. If you normally sit down with the children and eat with them at snack time make sure you do this when it’s time to eat the vegetables!

Send the right messages.
Children can be sensitive to the things that we say and how we say them. Try not to make negative comments about the snacks or the experiment, even to other members of staff, and keep facial expressions positive. The children are unlikely to try the foods if they think the adults around them think they’re disgusting!

Snack time should be enjoyable.
Children are more likely to eat in a happy and comfortable social setting. Try to keep the snack session relaxed, allowing the children to take their time and enjoy sitting down and eating with each other.

Expect refusal.
Some children are better with new foods than others. It’s completely normal for children to refuse foods they’re not familiar with. They need to taste it a few times before they learn to like it so it is important that you offer the food again at the next opportunity.

Advice adapted from Infant and Toddler Forum https://www.infantandtoddlerforum.org/feeding-toddlers-resources

Don't bargain with them.

Don't offer rewards for eating the vegetables or try and entice the children into eating. Offering the possibility of a more attractive food (fruit/a biscuit) or activity (playing outside) in exchange for children tasting the foods is unlikely to be successful in the long run. The children will learn that they just have to have a few bites to fulfil their side of the bargain and so the learning we would expect to see will not take place.

Keep them engaged.

We suggest that each snack session lasts for around 10 minutes and that the children are asked to stay seated at the table for this length of time. Even if children do not want to eat the vegetables try to keep them engaged in the snack session by drawing their attention to their special place mats or the fact that other people are still eating.

Children eat at their own pace.

Children tend to eat at different rates and so it's important to allow each child the time they need to eat their snack. While we suggest 10 minutes for the snack session some children may eat a lot slower and need longer to eat their snack. Try and allow sufficient time for all the children to eat as much as they want to eat.

Some children eat more than others.

Let the individual child decide when they have had enough. Most toddlers have the ability to control their food intake to meet their energy requirements and insisting children continue eating or finish what's on their plate can interfere with this self-regulation. Some children may eat less food than others of the same age. If a child is developing normally then they are eating the right amount of food for their needs. The amount children eat may also vary from day-to-day so if they don't finish their snack one day they may well finish it another day.

We would like to take this opportunity to thank you again for taking the time and effort to complete this study with us.

For detailed instructions of how the study should be run please see your Study Instruction Manual.

If you have any comments or questions regarding the study please contact one of our team at the University of Leeds.

Ms Sara Ahern on 07714024829 (email: pssm@leeds.ac.uk)

Professor Marion Hetherington on 0113 3438472 (email: m.hetherington@leeds.ac.uk).

UNIVERSITY OF LEEDS

Increasing children's vegetable consumption.

Repeated exposure and the variety effect.

Study Instructions

Dear Practitioner,

Thank you for taking part in this University of Leeds study. Your time and effort in overseeing this study at your nursery is very much appreciated.

This manual provides detailed instructions on how this study should be run.

This study is taking place at several nurseries across the area and because of this it is extremely important that the study is run according to the instructions provided. This will ensure consistency and guarantee that the results of the experiment are reliable.

If at any point during the study you have a question, would like some advice or require further information about the study please do not hesitate to contact us using the details below:

Ms Sara Ahern on 07714024829 (email: pssm@leeds.ac.uk)

Dr. Samantha Caton on 0113 343 6692 (email: s.caton@leeds.ac.uk)

Professor Marion Hetherington on 0113 3438472
(email: m.hetherington@leeds.ac.uk).

Many thanks for your time.
Yours truly, Sara Ahern

The Study Plan

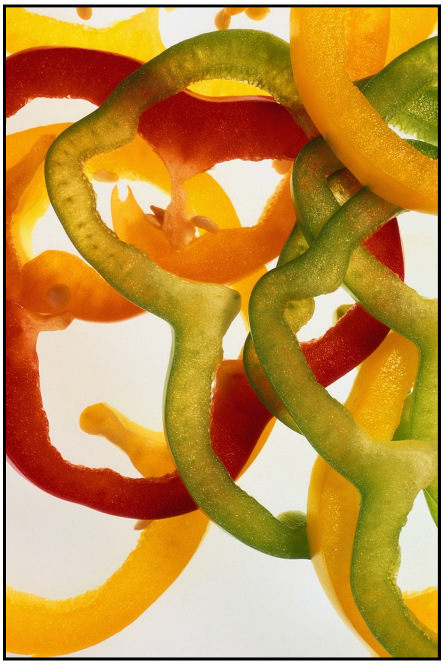
Week 1	Week 2	Week 3	Week 4	Week 5	Week 9	Week 18
Day 1 Single Vegetable Snack	Day 3 Single Vegetable Snack	Day 5 Single Vegetable Snack	Day 7 Single Vegetable Snack	Day 9 Single Vegetable Snack	Day 11 Single Vegetable Snack	Day 13 Single Vegetable Snack
1/2 days	1/2 days	1/2 days	1/2 days	1/2 days	1/2 days	1/2 days
Day 2 Variety Vegetable Snack	Day 4 Single Veg-etable Snack	Day 6 Single Veg-etable Snack	Day 8 Single Veg-etable Snack	Day 10 Variety Vegetable Snack	Day 12 Variety Vegetable Snack	Day 14 Variety Vegetable Snack

Week 1 - Before the intervention (all children)

Week 1 gives us an opportunity to get a baseline measure of the children's intake of our vegetable snacks.

- At the children's usual snack time, offer the vegetable snack provided. Each child will receive 100g of vegetables (either a single vegetable or a variety f vegetables) on alternate days in individual pots, labelled with their name.
- Encourage children to eat the vegetables in the same way that you would any other food keeping in mind the feeding tip in your information pack.

Week 1 - Before the intervention (all children)



- If a child refuses to taste the vegetable please indicate this on the sheet provided.
- Please be consistent in your encouragement each time and do not pressure children to taste or eat the food if they do not want to.
- When each child has finished eating, anything spilled should be returned to the correct pot before the pots are returned to their box ready for collection.

Weeks 2, 3 and 4 - The intervention

Weeks 2, 3 and 4 are the intervention stage of the experiment. This is when children receive the exposures to the vegetable snack foods two to three times each week. We will measure intake after every snack time.

- At the children's usual snack time, offer the vegetable snack pots. Children will receive 100g of either and single vegetable snack of a variety of vegetable snacks. This snack will remain the same throughout weeks 2, 3 and 4.
- As children all have individual labelled pots it is important that they receive the correct pot at each snack session.
- Encourage children to eat the vegetables in the same way that you would any other food and if a child refuses to taste the vegetable/s please indicate this on the sheet provided.
- When each child has finished eating, anything spilled should be returned to the correct pot before the pots are returned to their box ready for collection.

Week 5 - After the intervention

Week 5 is when we should be able to see if there has been any increase in the children's vegetable consumption. The method for this is exactly the same as week 1.

1 month later...

Children will be offered the snack vegetables at their usual snack time 1 month later on two separate days and we will measure how much they eat. This will be repeated 3 months after the end of the study.

Ready to go?

The rest of this booklet contains a study schedule and study sheets which can be used for marking when children are absent on test days, refuse to eat any of the vegetables or are withdrawn from the study for any reason. You can also record any other reasons why a child has been unable to take part in testing, for example if they feel unwell. Please take some time to familiarise yourself with these sheets before you begin the study.

Please remember that parents can choose to withdraw their children from the study at any time (as can you). Please let us know immediately if any children are withdrawn from the study.

Study Calendar

February 2012						
Mon	**Tues**	**Wed**	**Thurs**	**Fri**	**Sat**	**Sun**
				1	2	3
4	5	6	7	8	9	10
11	12 Day 1	13	14 Day 2	15	16	17
18	19 Day 3	20	21 Day 4	22	23	24
25	26 Day 5	27	28 Day 6			

March 2012						
Mon	**Tues**	**Wed**	**Thurs**	**Fri**	**Sat**	**Sun**
				1	2	3
4	5 Day 7	6	7 Day 8	8	9	10
11	12 Day 9	13	14 Day 10	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

Study Day 1:

Child's Name	Absent? (✓/✗)	Refused Snack? (✓/✗)	With-drawn? (✓/✗)	Other (please give details)

Study Day 2:

Child's Name	Absent? (✓/✗)	Refused Snack? (✓/✗)	With-drawn? (✓/✗)	Other (please give details)

Study Day 3:

Child's Name	Absent? (✓/×)	Refused Snack? (✓/×)	With-drawn? (✓/×)	Other (please give details)

Study Day 4:

Child's Name	Absent? (✓/×)	Refused Snack? (✓/×)	With-drawn? (✓/×)	Other (please give details)

Study Day 5:

Child's Name	Absent? (✓/✗)	Refused Snack? (✓/✗)	With-drawn? (✓/✗)	Other (please give details)

Study Day 6:

Child's Name	Absent? (✓/✗)	Refused Snack? (✓/✗)	With-drawn? (✓/✗)	Other (please give details)

Study Day 7:

Child's Name	Absent? (✓/✗)	Refused Snack? (✓/✗)	With-drawn? (✓/✗)	Other (please give details)

Study Day 8:

Child's Name	Absent? (✓/✗)	Refused Snack? (✓/✗)	With-drawn? (✓/✗)	Other (please give details)

Study Day 9:

Child's Name	Absent? (✓/✗)	Refused Snack? (✓/✗)	With-drawn? (✓/✗)	Other (please give details)

Study Day 10:

Child's Name	Absent? (✓/✗)	Refused Snack? (✓/✗)	With-drawn? (✓/✗)	Other (please give details)

We would like to take this opportunity to thank you again for taking the time and effort to complete this study with us.

If you have any comments or questions regarding the study please contact one of our team at the University of Leeds.

Ms Sara Ahern on 07714024829 (email: pssm@leeds.ac.uk)

Dr. Samantha Caton on 0113 343 6692 (email: s.caton@leeds.ac.uk)

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Appendix E: HabEat Project Models

<u>Model 1: CEBQ eating behaviours (only)</u>

Table 5: Standardized regression weights and significance levels for model 1

Standardised Regression Weights	*Exp Pre*	*Inter-cept*	*Delta Change*	*Slope*	*Exp Post*	*Control Pre*	*Control Post*
EF ← Food approach	0.97**	0.96**	1.00**	0.92***	-1.00**	1.00**	1.00**
FR ← Food approach	0.23**	0.24**	0.23*	0.25**	-0.23*	0.23*	0.23**
FF ← Food avoidance	0.67***	-0.67***	0.69***	0.67***	0.68***	0.67***	0.69***
SR ← Food avoidance	0.79***	-0.79***	0.77***	0.79***	0.78***	0.83***	0.80***
Intake ← Food avoidance	-0.44***	0.54***	0.18	0.22***	-0.20**	-0.41***	-0.41***
Intake ← Food approach	-0.06	-0.08	0.09	-0.01	-0.06	0.06	0.15
Error in Intake	0.91***	0.86***	0.99***	0.97***	0.97***	0.90***	0.87***
Error in SR	0.61***	-0.61***	0.64***	0.61***	-0.63***	0.56***	0.60***
Error in FF	0.74***	0.74***	-0.72***	-0.74***	0.73***	0.75***	0.72***
Error in EF	0.26	0.30	0.00	0.39	0.00	0.00	0.00
Error in FR	0.97***	0.97***	0.97***	-0.97***	-0.97***	0.97***	0.97***
Correlations							
Food avoidance ↔ Food approach	-0.37**	0.37**	-0.36**	-0.39**	0.36**	-0.33*	-0.33**

*** Significant at the 0.001 level; ** Significant at the 0.01 level; * Significant at the 0.05 level

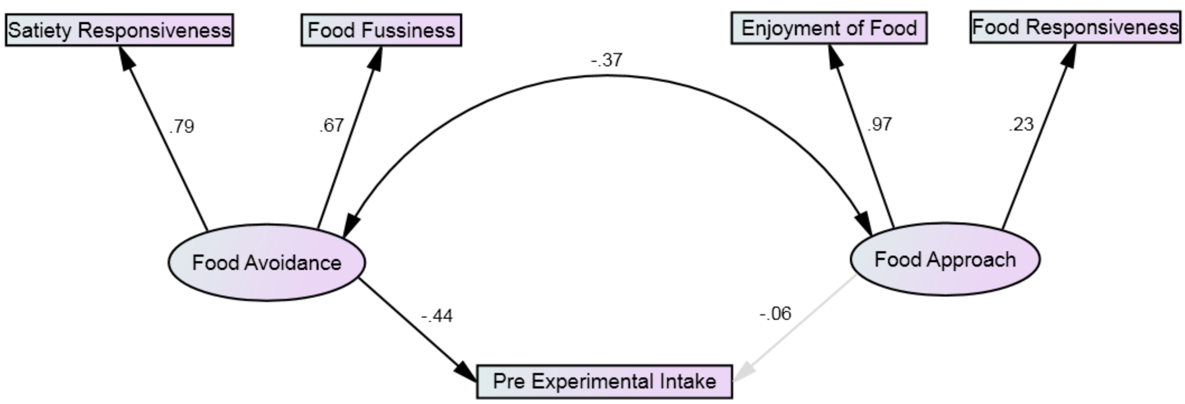

Figure 4: Model 1 for the association of CEBQ eating behaviours (only) and pre experimental intake (grey links indicates non-significant findings).

Model 2: Maternal and child characteristics (excluding CEBQ eating behaviours)

Table 6: Standardized regression weights and significance levels for model 2

Standardised Regression Weights	*Exp Pre*	*Inter-cept*	*Delta Change*	*Slope*	*Exp Post*	*Control Pre*	*Control Post*
Intake ← Maternal Neophobia	0.10	0.03	-0.13*	-0.06	-0.05	-0.03	-0.08
Intake ← Maternal Veg Intake	-0.08	-0.12	0.11	0.06	0.04	-0.03	-0.06
Intake ← Maternal Education	0.15**	0.10	-0.06	-0.04	0.08	0.06	0.01
Intake ← Breastfeeding	-0.04	-0.03	-0.04	-0.04	-0.08	-0.08	-0.07
Intake ← Age Solids	0.11*	0.14	-0.03	-0.02	0.06	0.09	0.00
Intake ← Age	-0.13**	-0.22	-0.02	0.03	-0.14**	-0.25***	-0.42***
Error in Intake	0.97***	0.95***	0.98***	1.00***	0.98***	0.96***	0.90***
Correlations							
Maternal Neo ↔ Maternal Veg	-0.22***	-0.22**	-0.22***	-0.22***	-0.22***	-0.23***	-0.23***
Maternal Neo ↔ Breastfeeding	-0.11	-0.11	-0.11	-0.11	-0.10	-0.10	-0.10
Maternal Veg ↔ Breastfeeding	0.09	0.10	0.08	0.09	0.08	0.08	0.08
Maternal Education ↔ Maternal Veg	0.23***	0.22***	0.23***	0.23***	0.23***	0.23***	0.23***
Maternal Education ↔ Maternal Neo	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.25***	-0.25***
Maternal Education ↔ Breastfeeding	0.08	0.08	0.07	0.07	0.08	0.05	0.05
Maternal Education ↔ Age Solids	0.12*	0.12*	0.12*	0.12*	0.12*	0.11*	0.12*
Breastfeeding ↔ Age Solids	-0.13**	-0.13**	-0.13*	-0.13**	-0.13**	-0.14**	-0.13**

*** Significant at the 0.001 level; ** Significant at the 0.01 level; * Significant at the 0.05 level

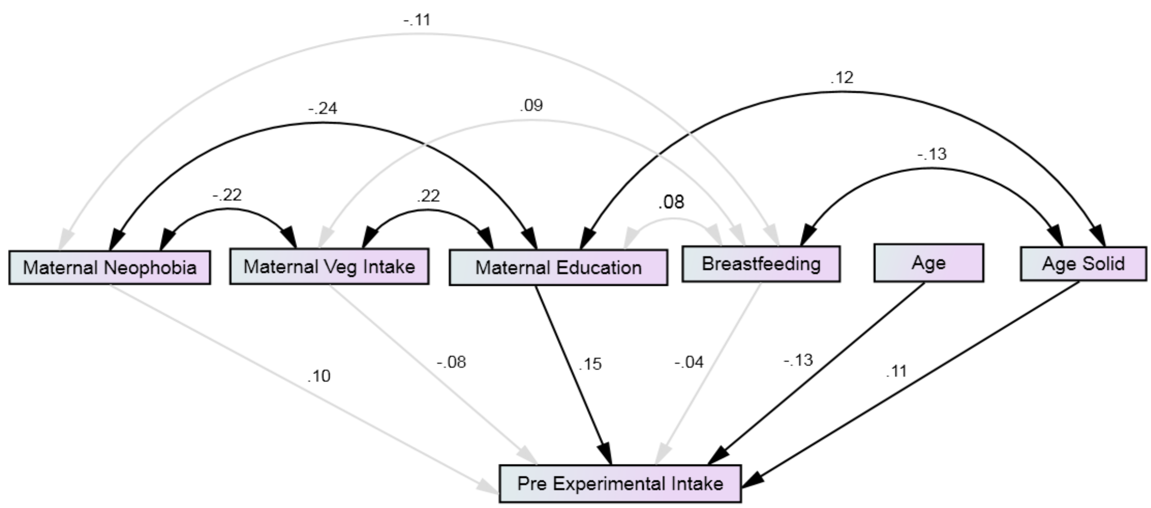

Figure 5: Model 2 for the association of maternal characteristics, feeding practices, child age (excluding CEBQ factors) and pre experimental intake.

Model 3: Combining predictors of vegetable intake from model 1 and 2 (maternal and child characteristics including CEBQ eating behaviours)

Table 7: Standardized regression weights and significance levels for model 3

Standardised Regression Weights	*Exp Pre*	*Inter-cept*	*Delta Change*	*Slope*	*Exp Post*	*Control Pre*	*Control Post*
FF ← Food Avoidance	0.67***	-0.67***	0.67***	0.67***	0.67***	0.67***	0.68***
SR ← Food Avoidance	0.78***	-0.78***	0.78***	0.78***	0.78***	0.80***	0.79***
Intake ← Maternal Education	0.01*	-0.03	0.03	0.04	0.05	0.00	-0.02
Intake ← Food Avoidance	-0.60***	0.67***	0.28**	0.40***	-0.24*	-0.44***	-0.25**
Intake ← Age	0.27**	0.24**	-0.20*	-0.23**	0.02	0.05	-0.25**
Intake ← Age Solids	0.02	0.03	0.03	0.06	0.03	0.03	-0.03
Error in intake	0.88***	-0.84***	0.98***	0.96***	0.97***	0.91***	-0.89***
Error in SR ←	0.63***	-0.63***	-0.63***	0.62***	0.63***	0.60***	-0.61***
Error in FF ←	0.74***	0.74***	0.74***	0.75***	0.74***	0.74***	0.74***
Correlations							
Maternal Education ↔ Food Avoidance	-0.16**	-0.16**	-0.16**	-0.16**	-0.17***	-0.15**	-0.15**
Maternal Education ↔ Age Solids	0.14**	0.14**	0.13**	0.13**	0.14**	0.13**	0.13**
Age Solids ↔ Food Avoidance	-0.18***	-0.18***	-0.19***	-0.19***	-0.19***	-0.19***	-0.18***
Food Avoidance ↔ Age	0.68***	-0.68***	0.68***	0.68***	0.68***	0. 68***	0.68***

*** Significant at the 0.001 level; ** Significant at the 0.01 level; * Significant at the 0.05 level

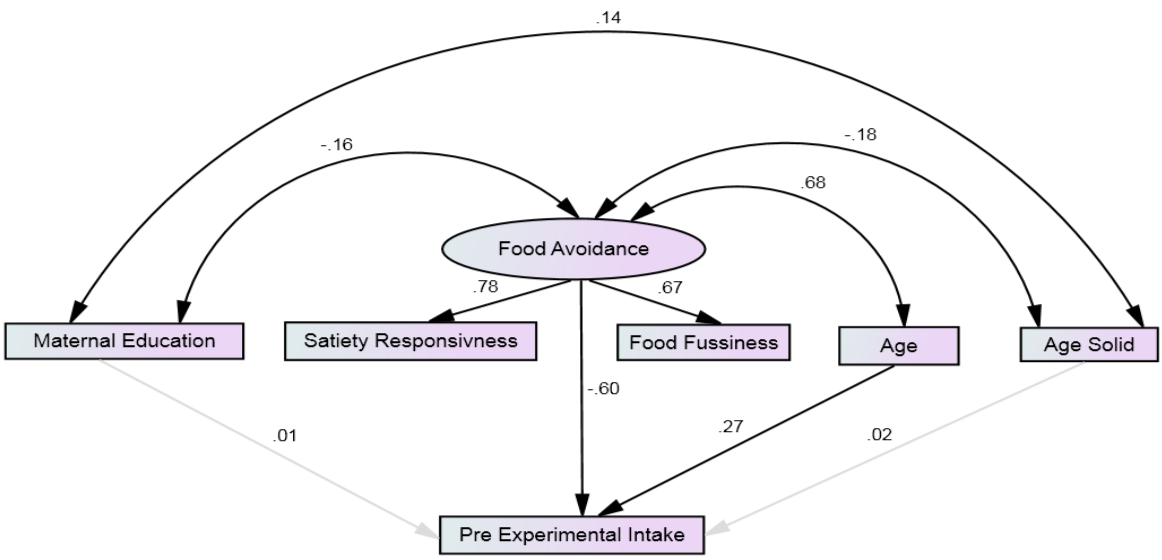

Figure 6: Model 3 for the association of maternal characteristics, feeding practices, child age including food avoidance at pre experimental intake.