Towards an understanding of the role of facial expressions in the modelling of eating behaviour

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Abstract

Facial expressions (FEs) can convey our enjoyment of food. Research has shown that exposure to others' FEs towards food influences children and adults' desire to eat food. However, the effect of adults' FEs whilst eating on children's and young adults' consumption of nutritious foods that are less preferred (e.g., vegetables) remains to be established. Hence, the primary aim of this thesis was to investigate this effect. Results indicated that exposure to adults eating a vegetable with negative FEs reduced young adults' liking of that vegetable, but not their desire to consume it. The effect of positive FEs was not consistent across populations, with Chapters 2 and 3 showing there was no effect on young adults' desire to eat vegetables, and Chapters 4-6 indicating that exposure to positive FEs increased children's consumption of the modelled vegetable. Chapter 4 showed an immediate positive effect of a single exposure to others' enjoying a vegetable on children's vegetable consumption, but Chapter 6 demonstrated that children required repeated exposure over one-week for the effect to be significant. Whilst exposure to others' positive FEs increases vegetable intake for most children, Chapter 5 indicated that positive FEs were not effective for children with high food neophobia. Consistently across populations (Chapters 2, 3 & 6), there was no generalised effect of others' FEs to a modelled vegetable on individuals' eating of a non-modelled vegetable, suggesting that enjoyment of each food must be observed for increasing consumption. This thesis shows the effectiveness of children observing others' food enjoyment to promote vegetable consumption, and the power of exposure to food disliking, for reducing vegetable liking. This highlights the importance of observational learning and food enjoyment in guiding eating behaviour. Further research is needed to determine the long-term effectiveness of using positive FEs to increase children's vegetable consumption.

Keywords: Facial expressions. Modelling. Eating behaviour. Vegetables. Children. Adults.

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‘How do you do it?’ said night.
‘How do you wake and shine?’
‘I keep it simple,’ said light,
‘One day at a time.’

This thesis is dedicated to my mum, who gave up her dream PhD to have me. Mum, your love, strength, and determination in life has made who I am today. I think it’s safe to say that your independence and passion for Psychology has rubbed off on me.

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List of Abbreviations

AASP	Adolescent / Adult Sensory Profile
AEBQ	Adult Eating Behaviour Questionnaire
ASD	Autism Spectrum Disorder
AQ-10	Autism-Spectrum Quotient
BAI	Beck's Anxiety Inventory
CEBQ	Children's Eating Behaviour Questionnaire
CFNS	Child Food Neophobia Scale
EmQue	Empathy Questionnaire
FE	Facial expression
FEs	Facial expressions
FNS	Food Neophobia Scale
F&V	Fruit and vegetables
PAS	Preschool Anxiety Scale
SEQ	Sensory Experiences Questionnaire
TEQ	Toronto Empathy Scale
TFEQ-R21	Three Factor Eating Questionnaire

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Publications and presentations from the research in this thesis

Chapter 4: The content of Chapter 4 is largely the same as the paper published:
Edwards, K. L., Thomas, J. M., Higgs, S., & Blissett, J. (2022). Exposure to models' positive facial expressions whilst eating a raw vegetable increases children's acceptance and consumption of the modelled vegetable. *Appetite*, *168*, Article 105779. https://doi.org/10.1016/j.appet.2021.105779

The findings reported in Chapter 4 formed part of an oral presentation:
Edwards, K., Thomas, J., Higgs, S., & Blissett, J. (2022). The effect of models' positive facial expressions whilst eating a raw vegetable on children's acceptance and intake of the modelled vegetable. Oral presentation delivered at the Edulia Final Conference, Florence, Italy, 21st June 2022.

Chapter 5: The findings reported in Chapter 5 formed part of an oral presentation:
Edwards, K., Thomas, J., Higgs, S., & Blissett, J. (2022). The moderating effect of food neophobia on the relationship between models' positive facial expressions whilst eating a vegetable on children's vegetable tastes and intake. Oral presentation delivered at the British Food and Drinking Group Annual Conference, 14th April 2022.

Chapter 6: The findings from Chapters 4 and 6 formed part of an oral presentation.
Edwards, K., Thomas, J., Higgs, S., & Blissett, J. (2022). The effect of adults' positive facial expressions whilst eating a green vegetable on children's acceptance and consumption of green vegetables. Oral presentation delivered at the International Society for Behavioral Nutrition and Physical Activity, Phoenix, USA, 19th May 2022.

Chapter 1: Literature Review

This literature review aims to highlight research that has addressed the modelling of eating behaviour and the role of observing food enjoyment on eating. The review will begin by outlining the importance of consuming an adequate amount of fruit and vegetables (F&V) and how food preferences develop. After providing this context, the review will then highlight research that discusses the modelling of eating behaviour, and the role of food enjoyment and facial expressions (FEs) in the modelling of others' eating behaviour. The remaining sections will outline research on how individual differences affect eating behaviour and facial processing.

1.1. Introduction

A narrative literature review was conducted to provide a broad overview of literature relating to the development of eating behaviour, how social influences guide eating behaviour, and characteristics that are associated with differences in eating behaviour and/or facial processing. The overarching question of this thesis could not be answered by a specific research question, such as is required for a systematic review. Thus, a narrative literature review was most appropriate since it allowed relevant yet disparate research to be drawn together. Moreover, research in both child and adult populations could be discussed and evaluated distinctly. Web of Science and Google Scholar were used to search for literature using key words associated with the areas of interest in a series of searches between July 2019 and May 2022. Bibliographies of relevant articles were also screened to identify additional articles.

1.2. Fruit and vegetable consumption

Most children and young adults consume fewer F&V than recommended (Health Survey for England, 2018; Keats et al., 2018; Kupka et al., 2020; Larson et al., 2012). This is of concern given that F&V provide an important source of vitamins and phytochemicals (Slavin & Lloyd, 2012), and adequate consumption is associated with reduced risk of adult chronic diseases (e.g., stroke, coronary heart disease, Boeing et al., 2012). Encouraging F&V consumption is challenging due to innate taste preferences. For example, F&V do not contain much energy and so are innately less preferred (Wardle & Cooke, 2008). Children are also particularly sensitive to bitterness, meaning the acceptance of bitter tasting vegetables (e.g., broccoli) is typically low (Mennella & Babowski, 2015; Wardle & Cooke, 2008). Establishing healthy dietary behaviours as early as possible is essential, since dietary behaviours in childhood can persist into adulthood (Craigie et al., 2011). Furthermore, encouraging healthy eating behaviour during young adulthood is important, since young adulthood is associated with poor dietary behaviour (e.g., lower F&V intake) due to life transitions and increased independence (Nelson et al., 2008; Winpenny et al., 2018). However, promoting positive dietary behaviour change in young adults is difficult, and more research is needed to establish the most effective behaviour change techniques for increasing young adults' F&V intake (Ashton et al., 2019). Therefore, it is essential to identify methods to encourage healthier eating behaviour by children and young adults.

1.3. The development of food preferences

Humans are faced with a variety of food choices, and there are many factors that influence the food decisions we make. One factor that predicts children's and young adult's food consumption is food preferences (Drewnowski et al., 1997; Gibson et al., 1998; Perez-Rodrigo et al., 2003). Indeed, children and young adults who report not liking F&V consume less of them, compared to individuals who report liking F&V (Perez-Rodrigo et al., 2003). Early childhood is a key period for developing food preferences (Ventura & Worobey, 2013), especially because these preferences persist into later childhood (Skinner et al., 2002) and adulthood (Nicklaus et al., 2004). Nicklaus and colleagues (2004) demonstrated that children's food preferences at 2-3 years remained stable into young adulthood (17-22 years). Therefore, it is important to understand the numerous factors, both innate and learned, that influence children's food preferences.

1.3.1. Determinants of food preferences

Infants are born with specific taste preferences and aversions, such as a preference for sweet tastes and rejection of bitter tastes (Mennella & Babowski, 2015). Vegetables, such as broccoli, are more bitter in taste than other food groups (Poelman et al., 2017), thus vegetable acceptance by children is typically low. The preparation of vegetables, such as the cooking method used, can affect the flavour and liking of bitter vegetables. Indeed, Poelman and colleagues (2013) found that boiled broccoli had lower flavour and odour intensity than steamed broccoli, and vegetables with a short cooking time were least liked by 5-6-year-olds (Poelman et al., 2013). These findings suggest that vegetables prepared raw or with little cooking time are more likely to be rejected by children.

Rejecting unfamiliar food is an evolutionary adaptive characteristic that protects from ingestion of harmful food (Dovey et al., 2008), however, this can be detrimental in the modern food environment where we mostly know which foods are safe to eat. Between 2 and 6 years, children become less willing to try new foods and this is known as food neophobia (Dovey et al., 2008; Hazley et al., 2022). This developmental peak in food neophobia can interfere with getting children to accept vegetables and is associated with lower variety and intake of F&V by children (Cooke et al., 2003; Perry et al., 2015). Since humans must learn to like bitter tasting food, it is important to understand how food preferences are learned.

Children's interactions with food help to guide their food acceptance and preferences. According to Birch and Anzman (2010) there are three key learning processes that influence children's learning about food: familiarisation, which involves increased evaluation of a food after repeated exposures to it; associative learning, which refers to the positive evaluation of a food after pairing with a different, already liked food, or pairing with calories; and observational learning (social learning) which suggests that behaviours are learned by observing and imitating the behaviours of others (Bandura et al., 1977).

Repeated experience with new foods enables children to become familiar with these foods and to recognise them as safe. Systematic reviews have shown that familiarisation with food is linked to increased food acceptance in young children (Paroche et al., 2017), and specifically increased liking and intake of the familiar vegetable (Appleton et al., 2018). Indeed, Wardle and colleagues (2003) reported that children aged 2-6 years had greater liking and intake of a target vegetable following repeated exposure to it (daily exposure for 14 days), compared to children whose parents were given nutritional information, and children in the control group. Research has also demonstrated that repeated taste exposures in utero can influence infants subsequent liking of vegetables. Mennella and colleagues (2001) discovered that pregnant women who consumed carrot juice for three consecutive weeks during their final trimester had infants who showed fewer negative facial reactions when eating a carrot-flavoured cereal, compared to a plain cereal. Therefore, familiarisation with food through repeated tastes develops children's food preferences.

Another way in which children learn to accept food is through associative learning (or conditioning). Associative learning involves repeated taste exposures, in addition to the pairing of a food with a positive or negative consequence. For example, a new flavour is paired with an already liked flavour (flavour-flavour learning). Flavour-flavour learning has been examined by Capaldi-Phillips and Wadhera (2014), who exposed preschool children to a bitter vegetable (Brussels sprouts) and less bitter vegetable (cauliflower) either paired with cream cheese, or without cream cheese (exposure condition). Children had greater liking and intake of Brussels sprouts after being paired with cream cheese, compared to children who experienced exposure only. Whereas for the less bitter vegetable (cauliflower), children liked it regardless of whether it was paired with cream cheese. Therefore, in this study, associative conditioning was more effective than repeated exposure for encouraging the eating of bitter tasting vegetables. However, some research has suggested there is no additional benefit of associative learning beyond the benefits provided by repeated exposure. Forestell and Mennella (2007) exposed children (4-8 months) to a vegetable (green beans) for 8 days, followed by a sweet tasing fruit (peach) puree, versus no fruit puree. Children had greater vegetable consumption following repeated exposure, but there was no difference in consumption between children who were exposed to the fruit puree, and those who were not. This suggests that repeated exposure was effective for encouraging green bean consumption, but associative conditioning did not provide any additional benefit. Thus, repeated exposure may be sufficient for encouraging children to eat non-bitter vegetables, but pairing this technique with associative learning may be advantageous for improving acceptance of vegetables with more challenging taste profiles (Wadhera et al., 2015).

Finally, observational learning can guide children's development of eating. Bandura's social learning theory (1977) suggests that we learn behaviours by observing and imitating the behaviours of others. Indeed, children learn what, and what not, to eat by watching and modelling the eating behaviour of others. This phenomenon is known as the social modelling of eating behaviour, which has been demonstrated as a robust social influence on eating behaviour (Cruwys et al., 2015; Vartanian et al., 2015). Since others guide children's eating behaviour, it is important that children are exposed to healthy eating models who can encourage them to enjoy eating nutritious food, such as vegetables. A detailed discussion of research into the modelling of eating behaviour can be found in section 1.3.

Overall, children's food preferences are shaped by their learning experiences and interactions with food. Since vegetables are commonly rejected, due to their low energy density and our innate dislike of bitter tastes, it is important that children learn to like and accept vegetables to create healthy dietary patterns that persist through life.

1.3.2. The role of parents

Parents play an important role in the development of children's food preferences. They often control the provision of food (e.g., what food is available), adopt feeding practices that shape what and how much food their child eats, and act as models for their child to observe and imitate (Savage et al., 2007). Modelling is a commonly used parental feeding strategy (Blissett et al., 2012), which has been linked to healthy eating behaviour in children (Gregory et al., 2011; Vaughn et al., 2018). Gregory and colleagues (2011) examined the longitudinal relationship between maternal modelling of healthy eating and children's intake of F&V. Maternal modelling of healthy eating at 1 year was found to predict greater frequency of vegetable intake at 2 years old. Furthermore, Vaughn and colleagues (2018) examined the relationship between parent modelling of healthy eating and preschool children's dietary intake. Healthy parent modelling was associated with higher healthy eating scores for children, even when parental diet was controlled for. Thus, these findings suggest that parental modelling of healthy eating is a useful strategy to encourage healthy eating behaviour by children and highlights the role that parents have as models for guiding their children's eating.

However, previous research is limited due to parental report of feeding practices. For example, parent responses could have been influenced by perceptions about how they 'should' feed their children. Although research using parent-report is informative, there is a lack of experimental research examining parental modelling (Larsen et al., 2015). One study used observational methods to examine the effectiveness of parental feeding strategies (e.g., modelling) on children's willingness to try a novel fruit (Blissett et al., 2012). Parental modelling behaviours were associated with increased exposure to the novel fruit by children, suggesting that modelling is an effective strategy to encourage children's interaction with novel fruit. However, more experimental studies investigating the effect of parent modelling on children's acceptance of nutritious food is warranted to fully determine whether parents are useful models to encourage their child's acceptance of F&V.

1.4. Modelling of eating behaviour

Eating often occurs with others, such as at home and restaurants, and these social environments can influence our eating behaviour (Higgs & Thomas, 2016). For example, eating with others can influence how much food we decide to eat, and the types of foods we decide to eat (Vartanian et al., 2015). From a young age, children observe and imitate others' eating (Bandura, 1977). This modelling of others eating behaviour is a robust social influence on eating behaviour in children and adults (Cruwys et al., 2015; Vartanian et al., 2015).

Indeed, research has shown that modelling increases children's willingness to try novel food. Early research by Harper and Sanders (1975) examined the effect of modelling on toddlers' novel food acceptance at 14-, 20- and 42- months. In their home environment, children observed an unfamiliar adult model eating a novel food or an adult simply offering novel food, and children's novel food acceptance was examined. Children were more likely to consume a novel food if they observed an adult eating it, compared to when an adult merely offered the food. Furthermore, Addessi and colleagues (2005) investigated the effect of unfamiliar adult models on preschool children's (2-5 years) novel food acceptance. Twenty-seven children were exposed to either an adult model eating the same food, an adult eating a different coloured food, or an adult model not eating. Children accepted and consumed more novel food when it was the same food as the model's, compared to when the food was a different colour, or when the adult ate none. These findings demonstrate that children model adults' eating behaviour, and this can increase their acceptance of novel food. However, whether observing others eating novel foods that are often refused, such as vegetables, is effective for increasing children's vegetable acceptance, remains to be examined.

Additionally, the effect of modelling on adults' eating behaviour has been examined and has been found to have a powerful and robust effect on influencing adults' eating behaviour (Cruwys et al., 2015; Vartanian et al., 2015). However, little research has examined the effect of modelling on adult's intake of nutritious food, specifically (Vartanian et al., 2015). Laboratory research by Hermans and colleagues (2009) exposed young adult women to a peer model who ate either a large or small number of vegetables, or nothing. Participants were found to consume more vegetables after seeing a peer eat a large number of vegetables, compared to when a peer ate a small number of vegetables, or no vegetables. Furthermore, Liu and Higgs (2019) exposed young adult women to fictitious information indicating that previous participants consumed a small or large amount of vegetables (i.e., a low intake versus a high intake norm). Women consumed more vegetables following exposure to a high intake norm, compared to participants who were exposed to the low intake norm. Thus, these studies indicate that young adult women model other people's vegetable consumption. However, it may be argued that these studies have limited ecological validity due to being conducted in a laboratory setting. For example, consuming vegetable snacks in the presence of an unfamiliar co-eater may not reflect a real-life eating occasion. More recently, Garcia and colleagues (2021) conducted an observational study examining whether adults were influenced by the food choice of an individual ahead in the queue at a self-service canteen. Adults were more likely to choose a salad when the person ahead in the queue had also chosen a salad. Therefore, this suggests that the findings from laboratory studies are likely to translate to real-life eating occasions, where adults' food choice is influenced by others' eating behaviour. Overall, these findings show that vegetable consumption by adults is influenced by the eating behaviour of others.

1.4.1. Food enjoyment of others

One factor that can influence food consumption is observing a co-eater's enjoyment of food. For example, an eating companion might make a verbal statement about how palatable a food is (e.g., "mmm, this is yummy") or a facial reaction whilst eating the food (e.g., wrinkling your nose to a disliked taste). The principles of social learning theory suggest that through vicarious learning, a behaviour is more likely to be imitated if positive consequences are observed, and less likely to be imitated if negative consequences are observed (Bandura, 1977). For example, an observer may be less inclined to want a food after watching someone else look disgusted whilst eating it. Avoiding disgusting foods is an adaptive trait that helps to prevent the ingestion of harmful substances (Curtis, 2011), thus individuals are likely to increase their food rejection in response to other's food disliking, to protect from harm.

Conversely, observing others experiencing food enjoyment may help to guide food selection. Marty and colleagues (2018) suggested that learning pleasure from positive eating experiences with others is an important strategy to encourage children's healthy eating. Indeed, experiencing shared enjoyment of food at mealtimes has been found to facilitate healthy eating by children (Kremer-Sadlik & Morgenstern, 2022). According to Haines and colleagues (2019), emphasising the pleasure of eating nutritious foods should be an important focus for public health campaigns, rather than promoting nutritious foods based on nutritional content. Therefore, it is important to examine the effect of others' food enjoyment on the observers' eating behaviour to determine whether it is a useful strategy to nudge healthier eating.

Research has examined the effect of information about models' food enjoyment on children and adults' eating behaviour. Children regularly eat with their peers (e.g., at school) and thus peers are important models for children's eating. Indeed, children choose snacks that are eaten by (Frazier et al., 2012), or are popular with other children (DeJesus et al., 2018). Research by Hendy (2002) examined the effectiveness of positive peer models on preschool children's acceptance of novel fruit. Preschool children were exposed to 3 novel fruits at two lunch times, paired with verbal statements that the fruit tasted nice from a female or male peer model, versus no peer modelling. Children's food acceptance was measured as the number of bites of novel fruit. Female peer models, but not males, increased children's acceptance of novel fruit. Therefore, watching female peers enjoy eating novel fruit increases preschool children's novel fruit acceptance. Differences in the effectiveness of female and male models suggest that the modelling of eating behaviour could be influenced by both the sex of the model, and the sex of the participant. However, due to the small sample sized used (11 males, 11 females), more research using larger sample sizes is required to replicate and confirm this effect.

Furthermore, research by Greenhalgh and colleagues (2009) exposed children aged 3- to 4- and 5- to 7- years to positive and negative statements about a novel food from an older peer. Novel food consumption increased following positive peer modelling and decreased following negative peer modelling, compared to no modelling. These findings suggest that positive peer modelling can increase novel food intake, whereas exposure to negative peer modelling can have negative effects on novel food intake. Since peer models were slightly older than participants, this suggests that the effects of peer modelling are not constrained by age. It is also noteworthy that the effect of positive modelling occurred after two presentations, suggesting that multiple exposures to positive modelling are required to encourage children's novel food acceptance.

Taken together, these studies demonstrate that positive modelling is an effective strategy to increase children's novel food acceptance (Greenhalgh et al., 2009; Hendy et al., 2002). Examining children's novel food consumption is particularly important, since children become less willing to try new foods between 2 and 6 years old, when food neophobia peaks. Thus, it is important to identify methods to encourage children's acceptance of novel foods during this developmental stage. However, children differ in their willingness to try new foods, and it is not clear from these studies whether positive modelling is effective for children who are high in food neophobia (i.e., less willing to try F&V). Since food neophobia relates to fears about the safety and palatability of food (Dovey et al., 2008), it is possible that modelling could be less helpful for children with high food neophobia because they might be more resistant to information that confirms the safety of food (e.g., watching someone consume a bitter vegetable, without any negative consequence), or because they might have already learned not to trust information from others about the tastiness of food (e.g., observing a parent pretend that a food is tasty, when it is not). Therefore, research that examines the moderating effect of children’s food neophobia on the modelling of eating behaviour is required to determine whether modelling is a useful strategy for more reticent eaters, whose vegetable acceptance is typically low, and who would benefit the most nutritionally from an effective intervention.

In addition to examining novel food intake, research has investigated the effect of positive modelling on children’s intake of a familiar vegetable. Staiano and colleagues (2016) exposed children to videos of other children eating a vegetable (pepper) and interacting positively with it. Children who watched others enjoy eating this vegetable ate more of the modelled vegetable at day 7, compared to children who saw a control video. Similar findings have also been demonstrated by Appleton and colleagues (2019), who randomised children (7-10 years) to hear a story of fictional characters who either ate carrots (modelling intake), mentioned liking of carrots (modelling enjoyment), or did not mention carrots (control). It was found that carrot liking and intake was higher after observing characters mention their liking of carrots (positive modelling), compared to conditions where liking was not mentioned. This demonstrates that positive peer modelling is an effective strategy for encouraging children’s eating of vegetables. Moreover, these studies demonstrate the effectiveness of remote modelling (i.e., the model is not in the same room as the participant) to influence children’s eating behaviour.

Adults are also important models to guide children’s eating behaviour. Research has demonstrated that 3–4-year-old children prefer to ask their mother or a teacher about the palatability and healthiness of a food, rather than a child or cartoon character (Nguyen, 2012). Thus, adults’ opinions of food palatability are important to children. Indeed, research by Hendy and Raudenbush (2000) examined the effect of positive teacher modelling on children’s novel fruit acceptance. Preschool children were exposed to teachers who made enthusiastic comments about the novel fruit (e.g., “Mmm! I love Mangoes!”), and this was found to increase children’s novel fruit acceptance, compared to simple exposure without positive comments (control condition). Therefore, positive teacher modelling is effective for increasing children’s novel fruit acceptance. Since children value adult’s opinions about food (Nguyen, 2012), these findings suggest that modelling from other adults (e.g., parents) is an effective way of communicating those opinions to children, which in turn has a positive influence on children’s intake of modelled foods.

Most research has focused on the effect of modelling on others’ food liking, however, an eater’s disliking of food can also influence eating behaviour. Indeed, Greenhalgh and colleagues (2009) found that exposing children to negative statements from peers about a novel food decreased children's intake of the novel food. The effect of food disliking has also been examined in adult populations. Robinson and Higgs (2012) investigated the effect of negative written information from fictitious peers on young adults' food liking. Participants were exposed to fictional written accounts from two previous participants, who reported that the target snack tasted average (neutral information) or that they did not like eating it (negative information). Participants liked the taste of the target snack less after being exposed to negative information, compared to those who were exposed to neutral information. This suggests that exposure to written information about others' dislike of food can reduce an eaters' subjective liking of that food (or at least, their reports of their liking). Whilst participants did not observe the eater's dislike of the snacks, these findings suggest that exposing adults to written information about others' food dislike is effective for reducing adults' subjective liking of that food. Thus, it is plausible that observing an eater showing dislike whilst consuming food will reduce liking of that food. Investigating the effect of observing food dislike is important, particularly for vegetables, because if individuals are exposed to co-eaters who dislike eating vegetables, it could have negative implications for their own consumption of vegetables. Examining this in adult populations is important to quantify the effect of observing other's dislike of food. However, it is not always appropriate to research the effects of food disliking, especially towards vegetables, in child populations because the effects of negative modelling can be difficult to reverse (Greenhalgh et al., 2009).

Overall, research has demonstrated that exposure to other's enjoyment of food influences the eating behaviour of children and adults. Findings from child populations have shown that positive information about another's food enjoyment has a greater impact on encouraging children's acceptance of the modelled food, compared to when children are simply exposed to the food (simple exposure), or exposed to another person eating the food, with no comments (modelling alone). This suggests that providing children with information about how tasty a food is, appears to be an effective strategy to encourage the acceptance of typically less preferred foods by children. However, whether the social transmission of food enjoyment (i.e., conveyed via FEs) influences children's vegetable consumption remains to be examined. Furthermore, research is yet to examine the social transmission of other people's food enjoyment conveyed via FEs, on adults' eating behaviour, thus research is needed to investigate this. Whilst there has been little research examining the effect of others' food dislike on eating behaviour, this does appear to influence eating behaviour. Examining the effect of another's food dislike towards nutritious, but less preferred food (e.g., vegetables), is important in future research to establish the potential negative effects on people's consumption of vegetables.

1.5. The role of facial expressions

It has been well established that emotions are communicated through FEs (Ekman & Friesen, 1969). These FEs are mostly used to convey 6 basic emotions (happiness, surprise, sadness, anger, disgust, and fear) which are universal (Ekman & Friesen, 1971). Using the Facial Action Coding Scheme, developed by Ekman and Friesen (1978), researchers can identify emotions by coding facial muscle movements. For example, the emotion of disgust is characterised by nose wrinkling and raising the upper lip. Indeed, food can elicit such emotional responses and thus, food enjoyment can be conveyed through FEs. These facial reactions to food are often indicative of food liking. For example, sweet tastes elicit relaxed and soothed facial responses (Forestell & Menella, 2012). Whereas, disliked tastes elicit intense, disgust-like facial responses (e.g., wrinkled nose; Danner et al., 2014; Horio, 2003; Hu et al., 1999; Wendin et al., 2011). These facial reactions to tastes are evident in utero. Ustun and colleagues (2022) found that foetuses at 32-36 weeks gestation produced laughter-face gestalts after exposure to a sweet taste (carrot), and cry-face gestalts after exposure to a bitter taste (kale). This early evidence suggests that initially, facial reactions whilst eating convey information about the sensory properties of food, rather than social reward. Based on the principles of social learning theory (Bandura, 1977), individuals are less likely to consume a food if they observe a negative consequence of eating it (e.g., a disgust facial reaction), and more likely to consume a food if they a observe positive consequence of eating it (e.g., positive facial reaction). Indeed, children look to others for guidance when exposed to new foods that they are unsure about. Research by Klinnert and colleagues (1986) showed that observing smile signals from adults encouraged children's approach behaviour to an unfamiliar toy. Therefore, it is plausible that observing positive facial reactions towards food may also encourage approach behaviour, thereby increasing children's acceptance of a food.

1.5.1. The development of emotional understanding

For children to recognise that emotions can be shown through FEs, emotional understanding is required. Children experience significant and important development in their emotional understanding between 18 months and 12 years. According to Pons and colleagues (2004), there are three developmental stages of emotional understanding: external, mentalistic, and reflective appraisal. The first stage (external) occurs around 5 years old and is characterised by the development of basic skills, such as recognising the FEs of others, and understanding that desires and situational factors can influence emotions. Stage two (mentalistic) occurs around 7 years old, when children begin to understand the link between desires and beliefs, and that outward emotional expressions may not reflect the felt emotion (e.g., people can hide how they are feeling). Finally, around 9-11 years, reflective appraisal develops as children learn to understand to use different perspectives to reflect upon situations, to regulate their emotions, and learn that emotions can be mixed. However, children's basic ability to recognise other people's desires may develop by 18-months-old, as demonstrated by Repacholi and Gopnik (1997), who exposed 14- and 18-month-old children to an adult expressing disgust to one food, and happiness to another food. Children were asked to predict which food the adult would want. Children who were 14 months old chose the food they wanted themselves, whereas 18-month-olds correctly selected the food that the adult showed happiness towards. This suggests that by 18-months-old, children recognise that others' desires can be different from their own. However, these findings could relate to differences in compliance between 14- and 18-month-olds, since a larger proportion of the younger children failed to comply with the study. Despite age, it is the development of emotional understanding that is essential for children's ability to recognise and understand others' FEs. Whilst emotional understanding increases with age, research has found that emotional understanding is a better predictor of 3-5-year-olds performance on a facial recognition task, than age (Arterberry et al., 2020). Although the age at which children develop the ability to recognise emotions based on FEs varies, most children have developed this skill by 5 years old (Pons et al., 2004).

1.5.2. Modelling food enjoyment: facial expressions

The effect of others' FEs towards food on eating behaviour has received some research attention. Research by Rousset and colleagues (2008) examined the effect of models' FEs on young adults' desire to eat familiar and unfamiliar meat. Participants were shown 8 images of familiar and unfamiliar meat items without a model, followed by images of models looking at the meat items whilst expressing pleasure, disgust or neutral FEs. Exposure to models expressing pleasure and neutral FEs increased the desire to eat meat, compared to when no eater was shown. The effect of pleasure FEs was greater for familiar than unfamiliar meat products, but only for women. Exposure to models showing disgust FEs decreased men's desire to eat familiar meat, but had no effect on the desire to eat unfamiliar meat for all participants. Whilst these findings suggest there are gender differences in the modelling of eating behaviour, there were differences in desire to eat meat at baseline; men had greater eating desire than women. It is possible that others' FEs influence eating desire where there is greatest capacity for change; for example, pleasure FEs increase the eating desire for individuals with low baseline eating desire (i.e., women in this study) and disgust FEs decrease the desire to eat food when individuals have a high eating desire (i.e., men in this study).

More specifically, Barthomeuf and colleagues (2009) investigated the effect of others' FEs towards food on adults' desire to eat foods that are liked (chocolate, bread, and French beans) and foods that are disliked (rare red meat, kidney, and black pudding). Young adults were exposed to static images of foods, presented without a model initially, and secondly presented with adult models expressing either disgust, pleasure or neutral FEs, whilst looking at the foods. Participants' desire to eat liked foods was lower after exposure to images of adults with disgust FEs, compared to food images presented alone, and compared to food images with adults expressing pleasure or neutral FEs. For disliked foods, the desire to eat was greater after exposure to adults with pleasure FEs, compared to when food was presented alone, and when presented with adults expressing disgust or neutral FEs. These findings demonstrate that observing adults express positive FEs whilst looking at food increased adults desire to eat foods that are disliked, and observing adults express disgust FEs whilst looking at food decreased adults desire to eat foods that are liked. These findings are consistent with Rousset and colleagues (2008), that the effect of others' FEs depends on whether the food is already liked or disliked.

Using similar methodology, Barthomeuf and colleagues (2012) examined the effect of others' FEs towards food on children (aged 5 and 8 years) and adults desire to eat. Participants were exposed to images of liked foods (chocolate, bread, and cream cake) and disliked foods (kidney, black pudding, and cooked sausage with vegetables), either alone or with an adult expressing a disgust, pleasure, or neutral facial expression (FE). For adults and children, disgust and neutral FEs decreased the desire to eat liked foods, and pleasure and neutral FEs increased the desire to eat disliked foods, compared to when food was presented alone. Consistent with previous findings, exposure to FEs towards food modified the desire to eat liked and disliked food. Thus, since exposure to pleasure FEs increases children and adults' eating desire of disliked foods (Barthomeuf et al., 2009, 2012), it is possible that this effect could translate to nutritious food that is innately less preferred (e.g., vegetables). However, the effect of neutral FEs on desire to eat is inconsistent across studies (Barthomeuf et al., 2009, 2012).

In another study, Rizzato and colleagues (2016) investigated the effect of emotional context on food desirability. Using a within-subjects design, young adults were exposed to pizza images alone (no-context condition), and paired side by side with images of adults expressing happy, angry, or neutral FEs. Exposure to angry and neutral FEs decreased adults' ratings of pizza desirability, compared to when pizza images were presented alone, consistent with previous research, which demonstrated that exposure to disgust and neutral FEs towards food decrease the desirability of liked foods (Barthomeuf et al., 2009, 2012). However, there was no effect of happy FEs on pizza desirability. Since pizza is typically palatable and liked, these findings are consistent with previous research, showing that exposure to positive FEs do not increase the desirability of foods that are already liked (Barthomeuf et al., 2009, 2012). One explanation for this could be a ceiling effect, whereby participants are not influenced by positive FEs for liked foods because they already perceive them to be desirable to eat, and so observing others with positive FEs simply confirms the belief that the food is palatable.

Taken together, these studies demonstrate that exposure to static images of adults portraying FEs whilst looking at food, or images of others' expressing FEs paired with images of food, can modify the desirability of liked and disliked food. Thus, it is plausible that watching an eater enjoy a typically disliked but nutritious food, such as vegetables, could increase the observers' desire for, and intake of, that food. However, this remains to be established in both adults and children.

One inconsistent finding across previous research is the effect of neutral FEs towards food on desire to eat, with one study showing no effect (Barthomeuf et al., 2009), and three studies showing that neutral FEs can positively and negatively influence the desire to eat foods (Barthomeuf et al., 2012; Rizzato et al., 2016; Rousset et al., 2008). If neutral FEs affect the desire to eat foods, then it is the presence of an eater influencing eating behaviour (a modelling effect), rather than the valence of the eaters' FE, which is driving the effect. To elucidate this, research is needed to compare the effect of eaters expressing positive FEs (positive modelling) and negative FEs (negative modelling), with the effect of modelling alone (neutral FE) and a no-modelling control condition. Examining this will determine whether FEs specifically influence eating behaviour, or simply that the presence of an eater facilitates acceptance via a modelling effect that is independent of the model's apparent emotional experience.

A key limitation of previous research methodology is the use of static images of adults looking at food or being paired with food (Barthomeuf et al., 2009, 2012; Rizzato et al., 2016; Rousset et al., 2008). These stimuli lack ecological validity as they do not represent the actual consumption of food or the dynamic nature of facial reactions whilst eating. Instead, observing adults consume food and produce facial reactions whilst eating is more representative of a real-life eating situation. Therefore, exposing participants to video stimuli of others' expressing FEs whilst eating is a more ecologically valid method. Indeed, research by Kawai and colleagues (2021) examined young adults' taste perceptions and intake of popcorn when watching a silent video of a stranger eating potato chips, compared to watching a video of a stranger on the phone, or a video with potato chips and a phone but no eater. Participants who watched the video of the model eating reported greater perceived tastiness and intake of the popcorn, compared to the videos without an eater. However, it is possible that these findings were due to the social facilitation of eating, rather than modelling, because the model and observer consumed different food (potato chips versus popcorn). Nonetheless, this study demonstrates that watching a video of someone eating is an effective methodology for influencing the observers' eating behaviour. Research has also shown that using video stimuli of others' eating vegetables are an appropriate methodology for examining the modelling of eating behaviour in children. Preschool children (3-5 years) were exposed to videos of peer models eating vegetables enthusiastically, and this was found to increase children's vegetable consumption (Staiano et al., 2016), compared to a no-food video control condition. Furthermore, a meta-analysis by Sharps and colleagues (2022) discovered a large effect of observing remote peers eating on children's food intake and showed no difference between the effect of remote and present confederates. Therefore, video stimuli of remote model eaters are an appropriate methodology for examining the modelling of eating behaviour by children and adults, providing a more ecologically valid presentation of others' FEs whilst eating.

1.6. Wider effects of modelling

1.6.1. Non-modelled food

Most research examines the effect of social modelling on the eating of the modelled food. It is also important to consider whether modelling influences the eating of other foods that are not modelled. For example, if children observe their parent enjoying one green vegetable (e.g., broccoli), are they also more likely to accept a different, but similar vegetable (e.g., mangetout)? According to the learned safety hypothesis (Kalat & Rozin, 1973), when food is consumed repeatedly without negative consequence, it is determined safe to eat. Thus, based on the principles of classical conditioning, it is plausible that this perceived safety of one food will generalise to similar food (e.g., food of the same colour). However, since food is varied and the potential for ingesting something poisonous is so great, having an evolved system that generalises broadly might not be sensible nor adaptive. Indeed, research has shown that without social information, infants are reluctant to touch plants, compared to other objects (Wertz & Wynn, 2014b). Therefore, there might not be generalisation in this context, and so we need to see others consuming each type of food, particularly when it is a plant, to encourage consumption. Establishing whether the effect of modelling generalises to a similar non-modelled food will enhance our understanding of the practicality of modelling as a strategy for parental use. If the effect of modelling does not generalise to similar, non-modelled vegetables, the usefulness of using modelling to encourage children's vegetable acceptance is more limited.

There have been multiple intervention studies which have examined whether the effect of modelling generalises to non-modelled foods within the same category. An intervention study exposed preschool children to videos of two animated characters who enthusiastically consumed F&V and provided children with sticker rewards for consuming the target F&V (Horne et al., 2011). Exposure to the intervention increased children's consumption of both modelled and non-modelled F&V directly after the intervention, and at a 6-month follow-up. Thus, interventions using positive modelling and rewards increase children's intake of modelled and non-modelled F&V, and these effects are sustained over time. This suggests that modelling interventions are useful for encouraging long-term F&V acceptance by children. Another study by Farrow and colleagues (2019) examined the effectiveness of a mobile application, Vegetable Maths Masters, which used repeated visual exposure of vegetable images, positive modelling of vegetable intake (statements about vegetable tastiness, e.g., "yummy, I love cauliflower"), and reward (children could win points for correct answers). Children (3-6 years) played with either the Vegetable Maths Masters application or a no-food control application. Using the vegetable application resulted in greater liking and intake of vegetables that children were exposed to in the app, and greater liking and intake of vegetables that children were not exposed to. Therefore, exposing children to an intervention using positive modelling and reward can be effective for increasing the intake of both exposed and non-exposed vegetables. This suggests that the effect of modelling may not be limited to the modelled food, and so modelling appears useful for encouraging healthier eating by children more generally. However, one limitation of these studies is that they did not examine the effect of modelling alone, meaning it is not possible to disentangle the effect of modelling from repeated exposure and reward.

Indeed, research has examined the effect of positive modelling alone, in the absence of reward. Children aged 7-10 years were randomised to hear a story of fictional characters who either consumed carrots (modelling intake), mentioned liking of carrots (modelling enjoyment), or did not mention carrots (control; Appleton et al., 2019). Children's intake and liking of a modelled vegetable (carrots) and non-modelled vegetable (sweetcorn) were examined. Exposure to positive modelling increased children's intake and liking of the modelled vegetable, but did not influence liking, and led to lower intake of the non-modelled vegetable. These findings suggest that modelling alone does not always increase children's intake of a similar, non-modelled vegetable. Instead, it appears that modelling paired with reward is effective for increasing children's consumption of a non-modelled food (Horne et al., 2011; Farrow et al., 2019), but more research is needed to confirm this. It is possible that reward has the capacity to generalise vegetable consumption, since reward for eating motivates the trying of other food, whereas modelling provides information about the safety of trying food, so may be less likely to encourage consumption of a different vegetable. If the effect of modelling alone does not generalise to another food, modelling could be more effortful for use by parents. For example, making explicit statements about the liking of every vegetable they would like a child to eat is much less practical or realistic for parents in comparison to regular expression of general enjoyment of vegetables. Another, more subtle, approach to convey food enjoyment is using FEs. However, whether positive FEs influence children's acceptance of a non-modelled vegetable is yet to be examined. Research examining this is warranted to determine the practicality of positive modelling as a technique to nudge healthier eating by children.

1.6.2. The long-term effect of modelling

It is also important to consider the long-term effects of modelling on children's F&V consumption, to determine whether the effects are sustained over time. Childhood is an important period to identify long-term strategies to encourage vegetable acceptance as childhood dietary behaviours can track into adulthood (Craigie et al., 2011). Intervention studies have examined the long-term effect of modelling on children's consumption of F&V. The Food Dudes intervention uses positive modelling and rewards to increase primary school children's F&V intake. The 16-day intervention comprises exposure to videos and letters from the Food Dudes, who are heroic peers who enjoy eating F&V. Children were given a portion of fruit, or on alternate days, vegetables, at snack time and lunchtime throughout baseline and intervention stages. During the intervention, children received small rewards (e.g., stationery) for eating the F&V. The Food Dudes intervention has been found to increase children's F&V intake, compared to baseline (Lowe et al., 2004), and a control school who did not receive the intervention (Horne et al., 2004; Horne et al., 2009; Marcano-Olivier et al., 2021). Moreover, research has demonstrated that greater F&V intake after exposure to the Food Dudes intervention persists over time. Indeed, children who received the Food Dudes intervention had greater F&V intake 4-months after the intervention, compared to baseline, whereas children in the control group did not (Horne et al., 2004). This is consistent with recent findings, that children in the intervention group had greater F&V intake 2-months after baseline, compared to the control group (Marcano-Olivier et al., 2021). Furthermore, positive effects on children's eating have been found 12-months after the Food Dudes intervention (Horne et al., 2009). Parents provided more F&V in children's lunchboxes and children consumed more F&V after exposure to Food Dudes, compared to the control group. Overall, these findings demonstrate that exposing children to positive modelling and rewards is effective for increasing children's immediate and long-term consumption of F&V intake.

In contrast to findings from the Food Dudes intervention, other research has found that an intervention using positive modelling and repeated exposure had no immediate effect on children's vegetable intake (Zeinstra et al., 2017). Children aged 4-6 years were exposed to a video of television idols who ate carrots enthusiastically and suggested they make you strong and fast (positive modelling), or no modelling video (control condition). Repeated exposure to positive modelling had no effect on children's carrot intake immediately after the intervention, but at the 9-month follow-up, carrot intake was greater compared to children in the control condition. Thus, these findings provide further evidence for the long-term effect of positive modelling on children's vegetable intake. However, the findings are not consistent with other research since no immediate effect of modelling was observed.

Previous research is limited in its design because the effect of positive modelling cannot be disentangled from the effect of reward and repeated exposure. Indeed, it is well established that giving children non-food rewards encourages their consumption of foods that are less liked (Cooke et al., 2011), and repeated exposure to vegetables increases children's vegetable acceptance (Appleton et al., 2018). Thus, it is possible that children's vegetable intake was increased due to either reward or repeated tastes of the F&V, rather than positive modelling.

The longer-term effect of positive modelling alone has been examined, but mixed findings have been reported. Staiano and colleagues (2016) exposed preschool children to videos of other children eating a vegetable (pepper) and interacting positively with it. Watching peers enjoy eating a vegetable resulted in greater vegetable intake 7 days later, compared to children who watched a non-food video. Furthermore, Hendy and Raudenbush (2000) reported that the exposure to positive peer modelling increased girl's novel fruit acceptance, and this effect was maintained one month later, compared to positive teacher modelling and simple exposure. However, when examining the effect of peer modelling only, Hendy (2002) found that the increase in children's novel fruit acceptance did not persist one month later. Therefore, findings about the long-term effect of positive peer modelling on children's F&V acceptance are mixed. More research is needed to establish whether the effects of positive modelling on children's vegetable intake persist, to determine the usefulness of modelling as a strategy to promote children's vegetable acceptance in the longer term.

1.6.3. Repeated modelling exposures

An important consideration is the number of exposures children need to others enjoying food, to create a long-term effect on eating behaviour. Determining whether parents need to smile each time they eat a vegetable, or whether one occasion is sufficient, is essential for understanding the practicality of using modelling in real-life eating occasions, to encourage children's healthy eating. As discussed, evidence from intervention studies has demonstrated that repeatedly being exposed to modelling increases children's vegetable liking and intake (Horne et al., 2004; Horne et al., 2009; Lowe et al., 2004; Zeinstra et al., 2017). However, since these studies did not compare the effect of single and repeated exposures to positive modelling, the number of times that children need to observe others enjoying food to influence their eating behaviour remains to be established. Hence, further experimental research is needed to investigate whether children require single or repeated exposures to adults enjoying vegetables to encourage vegetable acceptance.

Intervention studies often last over several weeks or months and can be time consuming. Thus, it is more practical to examine the acute and short-term effect of others' FEs initially. Whilst the short-term effect of repeated exposure to others' positive FEs whilst eating remains to be established, research has examined this effect for repeated exposure to F&V stimuli (Houston-Price et al., 2009). Houston-Price and colleagues (2009) examined the number of exposures that toddlers needed to a F&V picture book, to influence their looking preferences for food images. After parents read their children the book, children had looking preferences for the food images that they had seen multiple times, but this increase was irrespective of whether children were exposed to the book for one, two, or three weeks. This suggests that repeatedly exposing children to F&V stimuli over short time periods (1-3 weeks) is effective for encouraging children's looking preferences for food images. Although the stimuli did not include models who were eating, it is plausible that numerous exposures to modelling over one-week will be sufficient to experimentally compare the effect of single and repeated exposures to modelling on children's eating behaviour.

1.6.4. Characteristics of the model

Characteristics of the model, such as age and familiarity, are also important to consider when examining the social modelling of eating behaviour. Both parents and peers act as important models to guide children's eating behaviour. Research has compared the effect of adult and peer models on children's eating. Hendy and Raudenbush (2000) conducted five studies examining the effect of teacher modelling on preschool children's novel food acceptance. The fourth study showed that positive teacher modelling increased children's acceptance of novel food. However, in the fifth study, when children were exposed to either positive teacher modelling, positive peer modelling or simple exposure (control condition), teacher modelling was no longer found to be effective for encouraging novel food acceptance. For boys, novel food acceptance was not influenced by either modelling condition, whereas girls accepted more novel food when it was modelled by enthusiastic peers. This suggests that adult models are effective for increasing children's novel food acceptance, but not in the presence of a competing peer model. There also appear to be gender differences in the effect of modelling on food acceptance, however, due to the small sample size in this study (6 boys and 8 girls), it is not possible to draw meaningful conclusions about gender differences. Furthermore, research has investigated the effect of model characteristics on children's snack choice (Frazier et al., 2012). Forty preschool children (3-6 years) were shown photographs of adult or child (peer) models who appeared to be eating. Children were told that each person had a different snack and were asked to choose which one they wanted to eat. Children preferred snacks eaten by children, compared to adults, suggesting that peer models may be more influential on children's snack choice. In addition, DeJesus and colleagues (2018) demonstrated that 5–6-year-old children consumed more of a food that was described as popular with children, than a food that was described as popular with adults. This suggests that positive information about food from peers has a greater influence on children's food intake than if the information was from adults. One explanation for the fact that peers have a greater influence on children's eating than adults is that children view adults as unreliable sources of information about food palatability, possibly due to differences in food preferences. However, research has shown that children prefer to ask adults for information about food palatability (Nguyen, 2012) and nutrition (VanderBorght & Jaswal, 2009). Parents also play an important role in shaping children's eating environments, such as acting as models for their child to observe and imitate (Savage et al., 2007). Therefore, in addition to peer models, adults play an important role in guiding children's eating behaviour.

Familiarity between a child and model must also be considered. Although models are likely to be parents in real life eating occasions, unfamiliar adult models provide an appropriate proxy in experimental research to examine the effect of modelling on children's eating behaviour. Indeed, unfamiliar adult models have been found to increase children's novel food acceptance when seen to be eating the same novel food (Addessi et al., 2005). Furthermore, findings from a meta-analysis on adults and children showed that model familiarity had no effect on the modelling of food intake (Vartanian et al., 2015). Moreover, the use of unfamiliar adult models in experimental research is advantageous. For example, it allows the standardisation of experimental manipulations, to ensure that all participants are exposed to the same models conveying the same eating behaviour and facial reactions. Using unfamiliar models also allows the use of standardised remote stimuli, which would not be possible if familiar models were used. Furthermore, using unfamiliar models has positive implications for generalisability of the findings to other settings, such as caregivers in out of home settings, and use in marketing and intervention materials that could be delivered in numerous ways (e.g., in schools or through media). However, it is possible that children might respond more favourably (e.g., eat more vegetables) in response to unfamiliar models, due to social desirability, so findings from research using unfamiliar models may not translate to familiar models (e.g., parents). Despite this caveat, using unfamiliar adult models is advantageous for use in experimental research that requires standardised experimental manipulation.

1.7. Individual differences

One aspect of the effects of modelling on food intake and preference that has seldom been researched is how the individual differences of the observer influence modelling effectiveness. Some individual differences influence eating behaviour, some influence people's processing of FEs, and some individual differences influence both eating behaviour and perception and processing of FEs. It is theoretically plausible that individual differences influence the degree to which, or determine whether, modelling occurs. This must be investigated to examine potential mechanisms that could explain differences in the effectiveness of modelling of eating behaviour. Investigation of these characteristics as moderators is beyond the scope of this thesis. However, due to their potential interaction with the modelling of eating behaviour, measuring individual differences in these traits is important to examine differences in participant characteristics between experimental conditions.

1.7.1. Sensory processing

Individuals vary in their sensitivity and reactivity to sensory stimuli, and this can be characterised by four patterns: sensory avoiding, sensory sensitivity, sensation seeking and low registration (Dunn, 1997). Individuals with low neurological thresholds may actively avoid stimulation to avoid activating their low threshold (sensation avoiding) or become overwhelmed by sensory experiences when thresholds are activated (sensory sensitivity). Individuals with high neurological thresholds may actively seek external stimulation to increase their sensory experiences (sensory seeking) or have difficulty registering sensory stimuli and so appear uninterested (low registration; Blissett & Fogel, 2013).

Sensory profiles characterised by low neurological thresholds (sensory sensitivity and sensation avoiding) may be negatively affected by external stimulation due to over-responsiveness to sensory stimuli (Blissett & Fogel, 2013). Indeed, these sensory profiles are associated with less healthier eating patterns. For example, research examining palatable food intake in adults has demonstrated that individuals scoring high in sensory sensitivity consumed more palatable food compared to individuals scoring low in sensory sensitivity (Naish & Harris, 2012). Furthermore, research in children and young adults has found that high sensory sensitivity is associated with picky eating (Zickgraf & Elkins, 2018). Research in children has also demonstrated that sensory sensitivity is associated with selective eating behaviour and lower F&V intake by children (Coulthard & Blissett, 2009; Farrow & Coulthard, 2012). Although there is little research on sensation avoiding specifically, the avoidance of food based on sensory properties is evident in picky eating (Mauer et al., 2015) and Avoidant/Restrictive Food Intake Disorder (Zimmerman & Fisher, 2017). The hyper-responsiveness that individuals with low neurological thresholds experience towards food may be particularly evident for vegetables since they are innately less preferred. For individuals with low neurological thresholds, exposure to other people's positive reactions towards vegetables may reduce concerns about the tastiness of nutritious foods and possibly nudge the acceptance of these foods. However, these individuals might be less likely to model another's eating behaviour due to aversive experiences with textures and smells of food (Blissett & Fogel, 2013). Therefore, it is possible that differences in sensory processing could influence the modelling of eating behaviour, and so should be examined in research.

Other sensory profiles are characterised by high neurological thresholds, in which individuals have low awareness of external stimulation (low registration) or actively seek external stimulation (sensation seeking). Individuals with high neurological thresholds are unlikely to be negatively affected by external stimulation (Blissett & Fogel, 2013). Thus, sensory profiles characterised by high neurological thresholds are not likely to influence the occurrence of modelling and so are not discussed further.

1.7.2. Autism

One individual difference that may influence the processing of FEs is the degree to which an individual has autistic traits. A key characteristic associated with Autism Spectrum Disorder (ASD) is difficulties in social communication which may be related to early delays in basic facial processing (Webb et al., 2017). A deficit in facial processing in ASD is well-established, however, explanations regarding why this deficit occurs remains contentious and is beyond the scope of the present review. Since autism is largely associated with impairment in social communication, possibly due to a facial processing deficit (Webb et al., 2017), it is possible that individuals with autistic traits may not model eating behaviour in the same way as others. However, this remains to be investigated.

Moreover, individuals with ASD show differences in eating behaviour. For example, children with autism show greater food selectivity, such as more food refusal and a limited food repertoire, compared to typically developing children (Bandini et al., 2010). This selectivity is problematic for child diet quality because a limited food repertoire was also associated with inadequate nutrient intakes (Bandini et al., 2010). Therefore, it is important to examine differences in autistic traits when investigating the modelling of eating behaviour, due to the facial processing impairment and selective eating behaviour associated with ASD.

1.7.3. Anxiety

Another individual difference that is characterised by differences in facial processing is anxiety. Anxiety disorders characterise a group of conditions that involve symptoms of anxiety and fear. These symptoms may be consistent (trait anxiety) or transitionary and situationally dependent (state anxiety). Across anxiety disorders, there is consistent evidence of an attentional bias, typically to threatening stimuli, in adults and children (Shechner et al., 2012).

Research has shown that anxious individuals have an attentional bias to threatening FEs (e.g., anger). Waters and colleagues (2010) examined the attentional bias towards happy and angry FEs in children (8-12 years) with and without anxiety disorders. After completing a visual-probe task for FE pairs (angry/neutral and neutral/happy), results demonstrated that highly anxious children showed an attentional bias to angry, rather than neutral faces, compared to less severe and non-anxious children. No differences between groups were found for the happy and neutral pair. These findings demonstrate that children with severe anxiety have an attentional bias for threatening faces. Similar findings have been demonstrated in adults with social anxiety (Peschard & Philippot, 2017). Adults scoring high and low in social anxiety completed an emotion identification task. Individuals scoring high in social anxiety were more likely to misclassify neutral FEs as anger FEs, compared to individuals scoring low in social anxiety. This shows that socially anxious adults have a bias for identifying emotional stimuli as threatening. Conversely, the attentional bias in anxiety could lead to an avoidance of threatening stimuli (Shechner et al., 2012). For example, a systematic review of eye-tracking studies discovered hypervigilance-avoidance for emotions, especially for negative FEs, in adults with social anxiety disorder (Claudino et al., 2019). This avoidance was characterised by avoidance of aspects of the face, such as the eyes. However, evidence for avoidance of threatening stimuli is less prevalent than evidence for attention towards threatening stimuli (Shechner et al., 2012). Overall, individuals with anxiety show differences in their attention to FEs, likely due to an attentional bias to threatening stimuli. Therefore, since anxiety is associated with differences in facial processing, it is possible that differences in anxiety could influence the role of others' FEs on the modelling of eating behaviour.

In addition to differences in facial processing, anxiety is also associated with differences in eating behaviour. Farrow and Coulthard (2012) explored this in ninety-five parents of 5-10-year-old children. Anxiety was found to be associated with children's selective eating behaviour. Moreover, it was found that sensory sensitivity mediated the relationship between anxiety and selective eating in children. This finding was also demonstrated in a replication of the study in children, adolescents (8-17 years; n = 158) and young adults (n = 813; Zickgraf & Elkins, 2018). Research has also shown a link between anxiety and food neophobia, for example, Maiz and Balluerka (2018) found that trait anxiety was positively associated with food neophobia in children and adolescents (8-16 years). Furthermore, Maratos and Staples (2015) found that children (8-11 years) with high food neophobia had heightened attentional bias for images of unfamiliar F&V. This suggests that the cognitive mechanisms that underlie anxiety disorders, such as attentional biases, could also underlie food neophobia in children. Thus, these findings demonstrate that anxiety is associated with selective eating and food neophobia. Overall, this evidence highlights the importance of examining individual differences in both anxiety and sensory processing at different stages of development when exploring the modelling of eating behaviour.

1.7.4. Empathy

It has been suggested that individuals model eating behaviour for ingratiation; we model another's eating because of goals to be liked by them (Robinson et al., 2013b). If the modelling of eating behaviour is influenced by a desire for social approval, it is plausible that differences in traits that promote affiliation with others could affect the modelling of eating. One such trait is empathy, which can be broadly defined as the ability to share and appreciate another's feelings. Empathy comprises two main facets: emotional empathy which refers to an observers' emotional response to another's emotional state (e.g., "I feel what you feel"); and cognitive empathy which refers to an individual's ability to infer the perspective of others (e.g., "I understand why you are sad"; Seibt et al., 2015). Research has examined the role of empathy in the modelling of eating behaviour. Robinson and colleagues (2011) provided female dyads with a snack (chocolate M&Ms) whilst they completed a problem-solving task. Participants' trait empathy was also assessed. High empathy was associated with greater matching of palatable food intake, suggesting that empathetic individuals are more likely to model eating behaviour. However, Robinson and colleagues (2013a) showed conflicting findings. Trait empathy was not found to moderate the effect of information about fictitious peers' snack consumption, on young adults' intake of the snack. One explanation for the inconsistent findings could be due to the remote confederate design (Robinson et al., 2013a). Participants did not observe the eating of others and so could have been less concerned with gaining social approval. Therefore, differences in empathetic traits could have a greater influence on the modelling of eating when individuals can see others eating (e.g., in real life eating occasions), compared to when they cannot. There is currently little research examining the role of empathy, thus research investigating this in child and adult populations is needed. Differences in empathetic traits could play an important role in whether the modelling of eating occurs, however, whether this is specific to live modelling (versus remote modelling) is not clear.

1.7.5. Facial mimicry

One mechanism that could explain why individuals model others' eating behaviour is behavioural mimicry. Behavioural mimicry occurs during social encounters, in which individuals display unconscious or unintentional changes in their behaviour in response to another person. One behaviour that is often mimicked is FEs, which is referred to as facial mimicry (e.g., smiling when seeing someone else smile). Facial mimicry is the rapid imitation of another's FE, which acts as a 'social glue' that promotes affiliation and positive social relationships with others (Hess & Fischer, 2013; Seibt et al., 2015). Findings from mimicry studies suggest that individuals mimic the eating behaviour of others (e.g., reaching for food immediately after an eating companion does), implying that the modelling of eating behaviour is partly mediated through behavioural mimicry (Cruwys et al., 2015). Indeed, modelling could be an automatic, unconscious response to another's behaviour, regardless of goals to be liked (Robinson et al., 2013b).

Research has examined the role of behavioural mimicry in the modelling of eating behaviour (Hermans et al., 2012). Dyads of young adult women consumed a meal together, and the time and number of their bites were recorded. Women mimicked each other's eating behaviour, consuming food at the pace of their co-eater, rather than their own pace, and this mimicry was more prevalent at the beginning of the mealtime, than the end. These findings suggest that behavioural mimicry plays a role in the modelling of eating behaviour by adults. Furthermore, research has examined the imitation of snack food intake in children (Bevelander et al., 2013). Children consumed a snack food with a confederate peer and findings showed children were more likely to reach for a snack food when exposed to a peer who did, than when exposed to a peer who did not reach for the food. This suggests that mimicry between two eaters occurs when consuming a snack. Additionally, Sharps and colleagues (2015) examined behavioural mimicry between adolescent women and their parents during a mealtime. Parent and adolescent's overall intake was associated, and adolescents were more likely to pick up the same food as their parent, after their parent placed it in their mouth. Thus, this provides further evidence that behavioural mimicry underlies the modelling of eating behaviour. However, one type of mimicry that is yet to be examined is facial mimicry. Investigating the role of facial mimicry in the modelling of eating behaviour is important to better understand the mechanisms that underlie modelling. For example, if mimicry of a disgust facial reaction occurs whilst eating, does this influence the individual's eating of that food (e.g., whether they like the taste)?

In addition, the occurrence of facial mimicry can be influenced by differences in empathetic traits. For example, research has shown that young adults with high empathy display greater facial mimicry to pictures of adults with happy and angry FEs, compared to young adults with low empathy (Sonnby-Borgstrom et al., 2003). Indeed, meta-analysis findings have shown that facial mimicry is positively related to empathy (Holland et al., 2021). Therefore, this highlights the importance of examining empathetic traits and facial mimicry when investigating the effect of others' FEs on eating behaviour.

1.8. Thesis aims

Social modelling is a powerful influence on eating behaviour (Cruwys et al., 2015) and positive modelling could be used as a strategy to encourage healthier eating behaviour. Exposure to others' FEs towards food influences the desire to eat food by children and adults (Barthomeuf et al., 2009, 2012). However, the effect of others' FEs on the consumption of nutritious foods that are typically disliked (e.g., vegetables) remains to be examined. This thesis comprises five empirical chapters consisting of two studies of young adult's eating behaviour and two studies of children's eating behaviour. The aim of this thesis is to establish whether exposure to adults conveying their enjoyment of eating a raw vegetable, using their FEs, can encourage young adult and children's own consumption of vegetables. Specific aims of each empirical chapters are detailed below.

1. Chapter 2 aimed to examine the effect of models' FEs whilst eating a green vegetable on young adults' intake and change in liking of a modelled and non-modelled vegetable. The mediating role of facial mimicry in the relationship between models' FEs and vegetable intake and liking were also examined.
2. Chapter 3 aimed to examine the effect of models' FEs whilst eating a green vegetable on young adult women's change in liking and change in desire to eat a modelled and non-modelled vegetable.
3. Chapter 4 aimed to examine the effect of models' FEs whilst eating a green vegetable on children's acceptance and intake of the modelled vegetable.
4. Chapter 5 examined the moderating role of food neophobia on the effect of models' FEs on children's vegetable tastes and intake.
5. Chapter 6 examined the effect of repeated exposure to models' positive FEs whilst eating a green vegetable on children's acceptance, intake, and liking, of a modelled and non-modelled vegetable.

Chapter 2: Examining the effect of models' facial expressions whilst eating a raw vegetable on young adults' vegetable consumption and change in liking

As discussed in Chapter 1, the role of others' FEs whilst eating on young adults' eating of vegetables is yet to be established. Investigating this will provide an understanding of how others' FEs contribute to eating behaviour. This will help to determine whether there are positive effects which could form the basis of interventions to encourage healthier eating by young adults. Examining the mediating role of facial mimicry in this relationship will help us to establish whether facial mimicry is the mechanism by which the effect of others' FEs whilst eating a vegetable on adults eating behaviour occurs. The study contained within this chapter aimed to investigate whether observing models convey FEs towards raw broccoli whilst consuming it, influences young adults' subsequent consumption and change in liking of the modelled vegetable (raw broccoli) and a similar non-modelled vegetable (cucumber). Eighty-two young adults (63 women, 19 men) were randomised to watch a video of unfamiliar adult models eating raw broccoli with a positive, negative, or neutral FE. Participant's intake and change in liking of a modelled and non-modelled vegetable was assessed. Facial mimicry between the model and participant was measured, and data about participant characteristics was gathered. There was no significant main effect of FE type on young adults' intake or change in liking of the modelled or non-modelled vegetable, and facial mimicry did not significantly mediate this relationship. This chapter presents planned analyses even though the study is not sufficiently powered due to premature completion of data collection due to the COVID-19 pandemic.

2.1. Introduction

Most young adults consume fewer vegetables than recommended (Health Survey for England, 2018; Larson et al., 2012; Rodrigues et al., 2019). This is concerning given the associated health benefits of sufficient vegetable consumption (Boeing et al., 2012; Slavin, 2012). Young adulthood is associated with poor dietary behaviour, such as lower F&V intake (Nelson et al., 2008; Winpenny et al., 2018), thus research is required to establish strategies to encourage positive dietary behaviour change by young adults (Ashton et al., 2019). Since dietary behaviours established during young adulthood can persist into later adulthood (Craigie et al., 2011), identifying novel ways to encourage healthier eating behaviour is essential for establishing lasting health behaviours.

Eating often occurs in social contexts, and this can influence our eating behaviour (Higgs & Thomas, 2016). One powerful and robust social influence on eating behaviour is modelling (Cruwys et al., 2015; Vartanian et al., 2015). During the modelling of eating behaviour, an eater can convey their enjoyment of food using FEs indicative of food liking or disliking (e.g., wrinkling nose to a disliked taste; Hu et al., 1999). If you see someone dislike eating a food, how likely are you to then eat it?

The effect of others' FEs towards food on adults' eating behaviour has received some research attention. Research has exposed participants to static images of adult models expressing a pleasure, disgust, or neutral FE whilst looking at food (Barthomeuf et al., 2009, 2012). These studies have shown that observing an adult eater express a pleasure FE whilst looking at food increases adults' desire to eat foods that are disliked (Barthomeuf et al., 2009, 2012). In contrast, exposure to eaters expressing a disgust FE towards food, decreases adults' desire to eat foods that are liked (Barthomeuf et al., 2009, 2012). Furthermore, Rizzato and colleagues (2016) reported that exposure to pizza images paired side by side with images of adults expressing angry or neutral FEs decreased adults' ratings of pizza desirability. Thus, exposure to static images of models portraying FEs towards, or paired with food, can modify the desirability of liked and disliked food.

One food group that is often less preferred across the lifespan is vegetables, particularly those that are characterised by bitter tastes (e.g., broccoli; Dinnella et al., 2016; Hoffman et al., 2016; Wardle & Cooke, 2008). It is plausible that exposing adults to other eaters enjoying nutritious foods that are typically disliked, such as vegetables, could be a useful strategy to enhance the consumption of vegetables by adults. However, this remains to be fully established, since previous research has not examined the effect of observing others' enjoyment on the consumption of nutritious foods specifically, and the static images used in previous research did not show models eating food (Barthomeuf et al., 2009, 2012). Furthermore, whether the effect of others' FEs whilst eating translates to actual food consumption, rather than anticipated desire to eat, must be investigated, to determine whether exposure to others' food enjoyment is a useful strategy to increase adults' vegetable consumption.

It is also important to investigate whether modelling influences adults' eating of foods that are not modelled. For example, it is not yet clear whether modelling of a positive response to a vegetable (e.g., broccoli) enhances the desirability of another similar vegetable (e.g., cucumber), as well as the modelled food. Establishing whether the effect of modelling generalises to a non-modelled vegetable will provide a greater theoretical understanding of the mechanisms underlying the modelling of eating. For example, if modelling occurs through observational learning of food safety or enjoyment, generalisation effects would not be expected, but if it occurs by social facilitation of eating, generalisation to other foods would be predicted. Furthermore, examining the potential for generalisation will elucidate the practicality of using modelling as a strategy to encourage young adults' eating of vegetables more broadly; the potential for application of this strategy is more limited in the absence of generalisation, because observers would need exposure to modelling of each different vegetable before acceptance was increased. A further mechanistic possibility for generalisation is that of the 'halo effect': engaging in one health behaviour has been found to promote engagement in another health behaviour (Dohle et al., 2015). Thus, it is plausible that enhancing the desirability of a modelled vegetable could also enhance the desirability of a different, non-modelled vegetable. If so, this behavioural ripple effect could have positive implications for strategies to encourage healthier eating behaviour more broadly (Dolan & Galizzi, 2015). Whilst this is yet to be researched in adult populations, research in children has demonstrated mixed findings, with some studies demonstrating that modelling vegetable intake can increase the intake and liking of non-modelled vegetables (Farrow et al., 2019), and others showing that positive modelling does not influence liking, and can lead to lower intake of a non-modelled vegetable (Appleton et al., 2019). Thus, research in adult samples is needed to determine whether the effect of modelling generalises to a non-modelled vegetable or displaces consumption of an alternative vegetable.

If effective, there are several mechanisms by which FEs could influence ingestion, such as transmission of information about safety or palatability, emotional contagion, or motor imitation. Whilst investigation of all these potential mechanisms is beyond the scope of this thesis, one candidate mechanism is facial mimicry. It is possible that facial mimicry mediates the relationship between models' FEs and eating behaviour is facial mimicry. Facial mimicry refers to the rapid unconscious and unintentional imitation of another's FE to promote affiliation with others (Seibt et al., 2015). According to Cruwys and colleagues (2015), modelling of eating is partly mediated through behavioural mimicry, since individuals imitate the eating of others (e.g., reaching for food immediately after an eating companion does). Therefore, it is possible that mimicry of facial reactions between eating companions (facial mimicry) can promote affiliation between an eater and observer. For example, an observer would be more likely to model another's eating behaviour if facial mimicry occurs. It is possible that the mimicry of another's FE occurs via mood effects. According to the James-Lange theory of emotion (Cannon, 1987), a physiological response (i.e., smiling in response to a model) can induce positive mood. However, whether facial mimicry mediates the relationship between an eater's FE and an observer's eating of that food is yet to be examined. Investigating potential mechanisms underlying the modelling of eating behaviour is essential to understand why social modelling occurs.

Hence, this study examined the effect of models' FEs towards raw broccoli on young adults' change in liking and consumption of a modelled vegetable (raw broccoli) and a non-modelled vegetable (cucumber). This study hypothesised that after exposure to models expressing positive FEs whilst eating raw broccoli, consumption of modelled and non-modelled vegetables would be greater, compared to exposure to models expressing negative or neutral FEs whilst eating raw broccoli. Based on previous literature, it was hypothesised that there would be a greater increase in change in liking of modelled and non-modelled vegetables following exposure to models expressing positive FEs whilst eating raw broccoli, compared to exposure to models expressing negative or neutral FEs whilst eating raw broccoli. This study also examined the mediating role of facial mimicry in the relationship between FE type, and consumption (Figure 2.1) and change in liking (Figure 2.2) of the modelled and non-modelled vegetable.

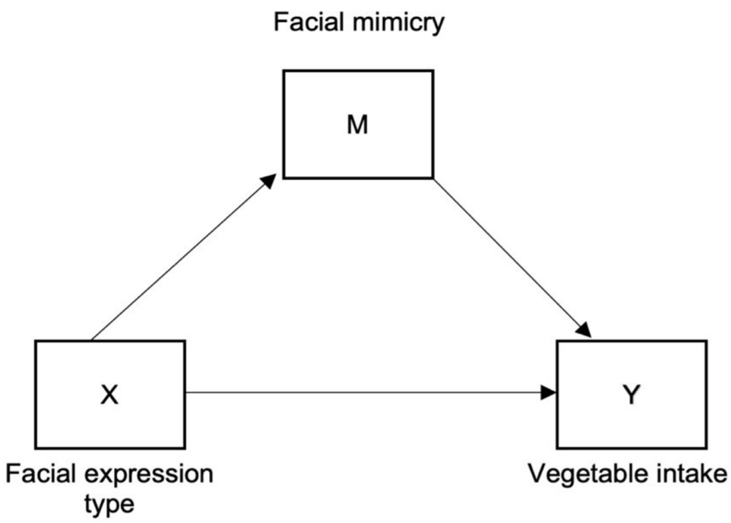

Figure 2.1. Facial mimicry as a mediator of the effect of FE type on intake of broccoli and cucumber, depicted as a conceptual diagram.

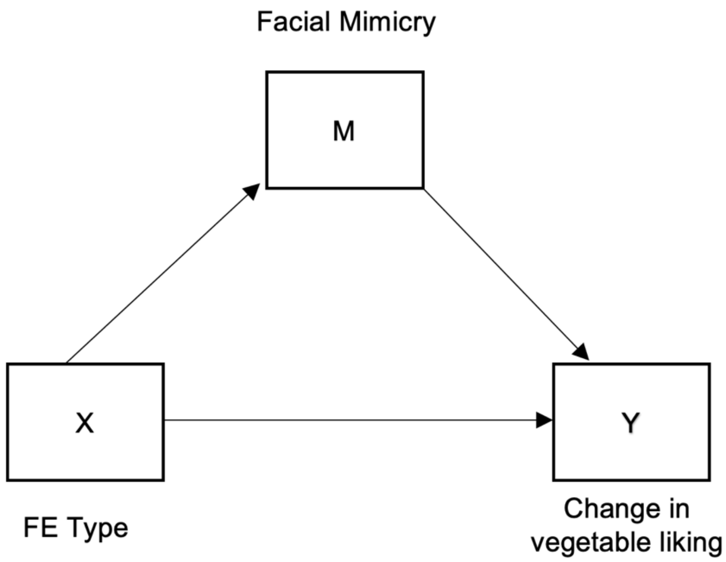

Figure 2.2. Facial mimicry as a mediator of the effect of FE type on change in liking of broccoli and cucumber, depicted as a conceptual diagram.

2.2. Method

2.2.1. Participants

A power calculation (G*Power 3; Faul et al., 2007) indicated that to detect a significant main effect of condition with *d* = 0.5 (based on research demonstrating a medium to large effect of modelling on food intake; Vartanian et al., 2015), 80% power, $\alpha = 0.05$, minimum of 153 young adults were required. Additionally, a Monte Carlo power analysis for indirect effects (Schoemann et al., 2017) indicated that to conduct a mediation analysis with one predictor, 80% power, $\alpha = 0.05$, and correlations between predictor, mediator and outcome set at 0.3, a minimum of 150 participants were required. Therefore, a minimum of 153 participants was the target for recruitment. In total, 86 young adults (18–30-year-olds) were recruited using the Psychology Research Participation Scheme and posters at Aston University between November 2019 and March 2020 (premature termination of study due to the COVID-19 global pandemic; see Appendix A-1 for example poster). Participants were told that the study was investigating emotions and food. Young adults with current or previous eating disorders, food allergies, or diabetes were excluded. Young adults who did not fit the age criteria (18-30 years old) were excluded. Participants received course credit or opted to enter a prize draw for a £50 shopping voucher. Ethical approval was obtained from Aston University Research Ethics Committee (#1332; Appendix B-1). All participants provided informed consent for their participation.

2.2.2. Design

In a between-subjects design, participants were randomly assigned to one of three conditions (positive, negative, or neutral), in which they were shown one of three stimuli (see section 2.2.3.3. for details).

2.2.3. Measures

2.2.3.1. Food consumption and change in liking

Consumption and change in liking of raw broccoli and cucumber were examined. Participants were provided with a food buffet of low energy-dense food (180g of raw broccoli; 330g of cucumber) and high energy-dense foods (90g of tortilla chips; 90g of crisps). High energy-dense food items were included to disguise the aims of the study. Raw broccoli and cucumber were selected as the modelled and non-modelled vegetables, respectively, due to their similarity in colour and energy density (cucumber = 15kcal and broccoli = 35kcal, per 100g). Tortilla chips and crisps were selected as the high energy-dense snacks because they are both savoury snacks that are similar in appearance and energy density (tortilla chips = 480kcal and crisps = 534kcal, per 100g). Foods were presented in individual bowls and made to look equally full. Participants were asked to taste each food item and rate their liking of it using a 100mm VAS, anchored to the left and right with 'absent / no liking' and 'most liking you can ever imagine' (respectively). Participants were informed that uneaten food would be thrown away and left to consume the buffet ad libitum for 10 minutes. Broccoli and cucumber intake were measured as the grams consumed; each food was weighed in grams pre- and post-presentation. Food liking using the VAS was measured pre- and post-manipulation. Change in liking scores were computed by subtracting post- from pre- manipulation liking scores.

2.2.3.2. Sample characteristics

2.2.3.2.1. Demographics and Lifestyle Questionnaire

Demographic information was gathered, assessing gender, age, and ethnicity (Thomas et al., 2016). Lifestyle information was also collected: smoking status, and whether they were a regular breakfast and or lunch eater (Thomas et al., 2016; Appendix D-1). Information about food allergies, intolerances or medical conditions affecting eating behaviour was also recorded and used to exclude participants based on study criteria. BMI was assessed by measuring participants' height using a stadiometer and weight using weighing scales.

2.2.3.2.2. Hunger and Mood State

Baseline hunger and mood state was assessed using widely used visual analogue scales (VAS; Thomas et al., 2016): alert, drowsy, light-headed, anxious, happy, nauseous, sad, withdrawn, faint, hungry, full, desire to eat and thirst. VAS ratings featured a 100mm line anchored to the left and right with ‘not at all’ and ‘very much’ (respectively) and required participants to move a slider between these anchors indicating how much they felt a state at that present time (e.g., hunger; Appendix D-3).

2.2.3.2.3. Habitual Intake and Liking

Participants’ habitual intake and enjoyment of fruit, vegetables, junk food, and sugar-sweetened beverages was examined to establish differences between conditions (Thomas et al., 2016). Habitual intake was assessed via the number of daily servings (e.g., “how many servings of vegetables do you normally eat a day?”) and enjoyment was assessed using a VAS anchored left and right with ‘not at all’ and ‘very much’ (e.g., “how much do you enjoy eating vegetables?”; Appendix D-4).

2.2.3.2.4. Questionnaires measuring individual characteristics

Participants completed several questionnaires about their own characteristics: typical eating behaviour; general eating style; food neophobia; sensory processing; anxiety; empathy; and autistic traits (see Appendix D-5 – D-11). These traits differ between individuals and have been associated with selective eating behaviours. Thus, these traits were examined to check participants did not differ in these measures between conditions.

Toronto Empathy Scale (TEQ; Spreng et al., 2009). Participants’ empathy was measured using the 16-item TEQ (e.g., ‘I enjoy making other people feel better’). Responses are on a 5-point Likert scale ranging from ‘never’ to ‘always’. High empathy is associated with greater modelling of eating behaviour, thus differences between conditions were assessed (Robinson et al., 2011). The TEQ has good internal reliability, test-retest reliability, and convergent validity (Spreng et al., 2009). Internal consistency in this study was good (α = 0.78).

Autistic-Spectrum Quotient (AQ-10; Allison et al., 2012). The 10-item version of the Autism-Spectrum Quotient measured participants’ autistic traits (e.g., ‘I find it difficult to work out people’s intentions’). Responses are scored as 1 and 0, indicating autistic traits or not, respectively. Scores above 6 are indicative of ASD. Differences in autistic traits between conditions were examined since ASD is characterised by a deficit in facial processing (Webb et al., 2017), and is associated with food selectivity (Mari-Bauset et al., 2014; Spek et al., 2020). The AQ-10 has good internal reliability, excellent predictive validity and correlates with the 50-item AQ (Allison et al., 2012). However, internal consistency in this sample was below acceptable (α = 0.35).

Adolescent / Adult Sensory Profile (AASP; Brown & Dunn, 2002). Three subscales of the AASP measured participant's sensory processing: taste/smell processing (8-items, e.g., 'I add spice to my food'); visual processing (10-items, e.g., 'I don't notice when people come into the room'); and touch processing (13-items, e.g., 'I like how it feels to get my hair cut'). Responses are on a 5-item Likert scale from 'almost never' to 'almost always'. Sensory sensitivity is associated with picky eating (Zickgraf & Elkins, 2018) and greater intake of unhealthier palatable foods (Naish & Harris, 2012). Thus, differences between conditions in sensory processing domains were examined (low registration, sensory sensitivity, sensation seeking, sensory avoiding). The AASP has satisfactory internal consistency and discriminant validity (Brown & Dunn, 2002) and showed satisfactory internal consistency in this sample (α = 0.49 – 0.57).

Food Neophobia Scale (FNS; Pliner & Hobden, 1992). The 10-item FNS measured participants' willingness to try novel foods on a 7-point Likert scale ranging from 'disagree strongly' to 'agree strongly' (e.g., 'I don't trust new foods'). Food neophobia is associated with picky eating (Elkins & Zickgraf, 2018; Jaeger et al., 2017) and lower F&V consumption (Costa et al., 2020; Knaapila et al., 2015), thus differences in FNS scores between conditions were examined. The FNS has good internal reliability and test-retest reliability (Pliner & Hobden, 1992). It also has good predictive validity, as scores predicted behaviour to novel foods in laboratory tasks, and good convergent and discriminant validity (Pliner & hobden, 1992). Internal consistency in this study was good (α = 0.87).

Beck's Anxiety Inventory (BAI; Beck & Steer, 1988). BAI measured participants' somatic symptoms of anxiety. Individuals report how much a symptom bothers them using a 4-point Likert scale (e.g., 'numbness' on a scale from 'not at all' to 'severely'). Anxiety has been associated with picky eating behaviour (Fox et al., 2018; Wildes et al., 2012; Zickgraf & Elkins, 2018), thus, differences in anxiety between conditions were assessed. The BAI has good internal consistency, test-retest reliability, and robust convergent reliability (Bardhoshi et al., 2016). Internal consistency in this study was excellent (α = 0.91).

Adult's Eating Behaviour Questionnaire (AEBQ; Hunot et al., 2016). The AEBQ measured participants' typical eating behaviour on 8 subscales: enjoyment of food (3 items, e.g., 'I love food'); emotional over-eating (5 items, e.g., 'I eat more when I'm annoyed'); emotional under-eating (5 items, e.g., 'I eat less when I'm worried'); food fussiness (5 items, e.g., 'I refuse new foods at first'); food responsiveness (4 items, e.g., 'I am always thinking about food'); slowness in eating (4 items, e.g., 'I eat slowly'); hunger (5 items, e.g., 'I often feel hungry'); and satiety responsiveness (4 items, e.g., 'I get full up easily'). Responses are on a 4-point liking scale from 1 (strongly disagree) to 5 (strongly agree). AEBQ subscales have been associated with BMI, so were measured to check for associations with outcome measures (Hunot et al., 2016). Subscales have demonstrated good internal consistency and test-retest reliability (Hunot et al., 2016; Hunot-Alexander et al., 2019). Correlations between the AEBQ and the Dutch Eating Behaviour Questionnaire subscales showed good convergent validity (Hunot-Alexander et al., 2019). AEBQ subscales had good internal consistency in this study (α = 0.65 – 0.90).

Three Factor Eating Questionnaire (TFEQ-R21; Cappelleri et al., 2009). Participants' eating style was measured using the TFEQ-R21: cognitive restraint (6 items, e.g., 'I deliberately take small helpings to control my weight'); uncontrolled eating (9 items, e.g., 'sometimes when I start eating, I just can't seem to stop'); and emotional eating (6 items, e.g., 'when I feel lonely, I console myself by eating'). Responses are on a 4-point Likert scale (i.e., 'definitely true' to 'definitely false'). Typical eating style was assessed to characterise the sample and to examine associations with outcome measures. The TFEQR-21 is a commonly used measure and has been validated in obese and non-obese populations, showing good psychometric properties (Cappelleri et al., 2009). Subscales had good internal consistency in this study (α = 0.75 – 0.87).

2.2.3.3. Experimental stimuli

The stimuli in each condition comprised 32 videos in total: 4 repeated runs of 8 video clips, presented in the same randomised order. Video clips comprised 8 unfamiliar adult models (4 men, 4 women), aged 24-30 years old and comprised White and Asian ethnicities (White British = 6; Asian British = 2). Each of the models were videorecorded facing towards the camera, consuming one piece of raw broccoli whilst expressing a positive, negative, or neutral FE (positive, negative, and neutral conditions, respectively). Individual videos lasted the time taken to eat one piece of raw broccoli by the model (M = 11.17 seconds; SD = 2.04). Overall, stimuli were each at least 5 minutes in length (positive = 333 seconds; negative = 373; neutral = 306 seconds). Sound was removed from all video clips, to remove its potential influence on eating behaviour. For an example video clip of an adult model eating raw broccoli with a positive, negative, and neutral FE, please see https://doi.org/10.17036/researchdata.aston.ac.uk.00000552 (Figure 2.3).


Figure 2.3. Example of an adult model consuming raw broccoli with a positive, negative, and neutral FE

To validate the stimuli, twenty adult participants (*M* age = 27.9 years; range = 19-51) rated each video clip. Participants selected whether they thought the model felt positive, negative, or neutral whilst consuming the raw broccoli, and rated it on a 100mm VAS from ‘negative’ (0mm) to ‘positive’ (100mm). Participants also rated whether they thought each model liked eating the broccoli (liked, disliked, neutral), and which emotion best described how they felt about eating it (neutral, happy, surprised, sad, scared, angry, disgust or fear). Results showed that for the positive videos, the modal response was that all models felt positive and happy whilst eating broccoli and liked it. The modal response for negative videos was that all models felt negative, disgust and dislike towards broccoli. For neutral videos, the modal response was that all models felt neutral towards eating broccoli. Mean ratings of how models felt were: positive = 81.59 (SD = 3.70); neutral = 48.18 (SD = 4.58); and negative = 14.75 (SD = 4.58). Therefore, all videos of models eating broccoli were deemed suitable for use in experimental stimuli. Also, FaceReader 7.0 software (Noldus, 2016), which objectively measures FEs, was used to examine the overall valence of the videos. Results showed that each stimuli conveyed their intended valence of positive (*M* = 0.61, SD = 0.08), negative (*M* = -0.57, SD = 0.22), or neutral (*M* = -0.12, SD = 0.07).

2.2.3.4. Experimental task

Participants were told they would be watching a video of adults eating raw broccoli and that they would be recorded whilst watching it. Participants were instructed to watch the full video closely as they would be asked questions about it later. Whilst watching the video, participants were video recorded using a webcam (Logitech C920 HD Pro with 1080p resolution) positioned on top of the computer monitor. Room lights were switched off and a ring light was positioned on a tripod in front of the participant to illuminate their face. Video recordings were analysed using FaceReader 7.0 software (Noldus, 2016), to measure the valence of participants’ emotional responses. FaceReader automatically measures FEs in real-time; objectively classifying the magnitude of individual emotional reactions. To classify an emotional expression, a face is initially detected using the Viola-Jones cascaded classifier algorithm, which is a method used for finding the face in images (Viola & Jones, 2004). Next, an algorithmic approach is used to create a 3D model of the face using 500 key points and textures of the face. Deep Learning, an artificial intelligence technique, is then used to analyse the face. Finally, the emotional expression of the face is classified using the artificial neural network, which has been trained to classify the six basic emotions as described by Ekman (1970): happy, sad, angry, surprised, scared, and disgusted, and can also classify neutral. FaceReader calculates valence scores as the intensity of positive emotion (happy) minus the intensity of negative emotions (sad, angry, scared and disgust). Valence scores are categorised into positive (above 0.33), negative (below -0.33) or neutral (-0.33 to 0.33). Participants' overall valence scores whilst watching the first run of the 8 randomised videos were used to determine facial mimicry. Only the first run was analysed to determine facial mimicry because facial mimicry is an automatic response that required engagement in a task, and engagement will reduce with repeated runs (Sachisthal et al., 2016).

2.2.4. Procedure

Participants were invited into the Psychology Laboratories between 11am and 5pm. Participants read the information sheet and provided consent for their participation (Appendix C-1 & C-2). Firstly, participants completed the demographics questionnaire, reported their baseline mood and appetite state, and rated their liking of raw broccoli, cucumber, tortilla chips and crisps. Next, they completed the experimental task, followed by non-food related questionnaires assessing autistic and empathetic traits. Participants were then given the food buffet to consume ad libitum and completed a taste test, rating their liking of each food (raw broccoli, cucumber, tortilla chips and crisps). After 10 minutes, the buffet was removed and participants were left to complete the remaining questionnaires assessing habitual intake and liking, sensory processing, food neophobia, anxiety, typical eating behaviour, and eating style. Once finished, height and weight were measured and recorded. To check participants paid attention during the experimental task, they were asked to identify how the model felt about eating broccoli (positive, negative, or neutral) and how intensely they thought the model felt this towards the broccoli (100mm VAS anchored from 'low intensity' to 'high intensity'). Finally, participants were asked to describe what they thought the aims of the study were and were debriefed and thanked for their participation. Study sessions lasted 50 minutes maximum.

2.2.5. Statistical analysis

Statistical analyses were conducted using SPSS Version 26. Chi-square tests examined differences between conditions on gender and ethnicity. Differences between conditions in participant age, BMI, baseline food liking, habitual food intake and liking, and mood and appetite scores were examined (one-way ANOVA). One-way ANOVA was used to examine differences between conditions on questionnaires measuring individual differences. Pearson's correlations examined associations between eating style (TFEQ-R21 subscales) and eating behaviour (AEBQ subscales) with dependent variables. Measures that differed significantly between conditions or correlated with dependent variables were included as covariates in relevant ANCOVA. Baseline liking scores for broccoli and cucumber were included in ANCOVA when change in vegetable liking was the outcome measure, as suggested by Clifton and Clifton (2019). Main effect of condition on dependent variables was explored using one-way ANCOVA. Significant main effects of condition for all ANOVA/ANCOVA were explored with Bonferroni corrected t-tests. Facial mimicry was examined as a mediator of the relationship between models' FEs on intake and liking of raw broccoli. For mediation analysis, the predictor variable was FE type (positive vs. negative; positive vs. neutral; and negative vs. neutral) and the mediator was facial mimicry (valence of participant emotional responses measured by FaceReader). Mediation analyses were conducted using PROCESS version 3.5 (Hayes, 2020).

2.3. Results

2.3.1. Demographics

In total, 86 young adults participated. Participants were excluded for not completing the taste test (n = 1) and not meeting age inclusion criteria (n = 3). Hence, the final sample included 82 participants (63 women, 19 men).[1] Participants mean age was 20.1 years (SD = 2.37; range = 18-29) and BMI was in the healthy range (mean = 24.65, SD = 4.71). Ethnic background: 39.1% Asian, 26.8% Black, 25.6% White, 6.1% 'other', and 2.4% mixed ethnicities. Most participants ate breakfast (51.2%) and lunch regularly (81.7%) and did not smoke (97.6%). Most participants (74.4%) correctly identified the valence of the models' FE. Excluding participants who did not correctly identify the valence did not alter the effect of condition on dependent variables. Excluding participants who guessed the aimed of the study (n = 7) did not change the effect of condition on dependent variables. Therefore, all cases were included in the analysis.

Conditions did not differ significantly on participant gender (X^2(2, *N* = 82) = 5.72, *p* = .06) or ethnicity (X^2(2, *N* = 82) = 16.00, *p* = .59). Participant age, BMI scores and baseline

[1] Excluding men from analyses did not change the pattern of results.

food liking, and habitual food intake scores did not differ significantly between conditions (Table 2.1). Baseline appetite scores (hunger, fullness, and desire to eat) were significantly correlated (*p*'s < .05), so a mean score for baseline appetite was computed. To compute this, fullness scores were reversed by calculating 100 minus fullness scores. Hunger, desire to eat and fullness reversed scores were then used to calculate an appetite score. There was a significant main effect of condition on appetite score ($F(2, 81) = 4.19$, $p = .02$), so it was entered as a covariate in all analyses. Bonferroni corrected t- tests showed that baseline appetite scores were significantly higher in the positive condition, compared to the negative condition ($p = .02$) but did not differ from the neutral condition ($p > .05$). Appetite scores did not significantly differ between negative and neutral conditions ($p > .05$). Conditions did not differ significantly on mood measures (all *p*'s > .05; see Appendix E-1: Table A).

Table 2.1: Mean (SD) demographics, baseline liking and habitual food intake scores for participants in each condition (one-way ANOVA)

		Positive (n = 27)	Negative (n = 29)	Neutral (n = 26)	*F*	*P*
Age		22.07 (2.62)	19.48 (0.95)	20.65 (3.05)	1.71	.19
BMI		23.26 (3.22)	25.40 (5.44)	25.25 (4.99)	1.79	.17
Habitual Intake	Fruit	2.11 (1.53)	2.03 (1.30)	2.00 (1.33)	0.05	.96
	Vegetables	1.83 (0.84)	1.83 (1.10)	2.27 (1.80)	1.02	.37
	Junk Food	2.23 (1.52)	1.97 (1.17)	2.44 (1.49)	0.81	.45
	SSB	1.00 (1.18)	1.41 (1.32)	1.73 (1.34)	2.17	.12
Liking	Fruit	86.48 (12.84)	79.66 (15.15)	78.62 (16.33)	2.24	.11
	Vegetables	63.74 (23.65)	59.93 (26.23)	60.65 (20.88)	0.21	.81
	Junk Food	82.22 (18.85)	78.28 (19.99)	85.58 (16.12)	1.08	.35
	SSB	68.78 (27.26)	68.79 (23.91)	79.27 (18.10)	1.94	.15
Baseline Liking	Broccoli	18.59 (17.79)	23.72 (25.95)	24.54 (26.74)	0.49	.61
	Cucumber	71.19 (27.41)	70.76 (27.98)	67.35 (34.94)	0.13	.88
	Crisps	77.15 (20.49)	74.00 (25.55)	76.38 (24.34)	0.14	.87
	Tortilla Chips	69.70 (26.16)	65.97 (27.39)	70.27 (25.83)	0.54	.58

Note. SSB = Sugar-sweetened beverages

Conditions did not differ significantly on questionnaires measuring individual differences, except for anxiety measured by BAI ($p < .05$; see Appendix E-1: Table B), however, Bonferroni corrected t- tests revealed no significant differences in BAI scores between positive and negative ($p > .05$) and neutral ($p > .05$) conditions, or between negative and neutral ($p > .05$). Given this, and that BAI scores did not correlate with the outcome measures, it was not included as a covariate.

2.2.2. Manipulation check

Most participants correctly identified how the models felt about eating broccoli in the positive (55.5%), negative (93.1%), and neutral condition (73.1%). Positive, negative, and neutral FEs were rated as high in intensity (*M* = 68.76; *M* = 75.78; *M* = 69.52, respectively).

2.3.3. Food consumption

One-way ANCOVA controlling for appetite scores, examined the effect of FE type on broccoli and cucumber intake. There was no significant main effect of condition on broccoli intake ($F(2, 78) = .15$, $p = .86$, $\eta_p^2 = .00$) or cucumber intake ($F(2, 78) = .25$, $p = .77$, $\eta_p^2 = .01$; Figure 2.4).

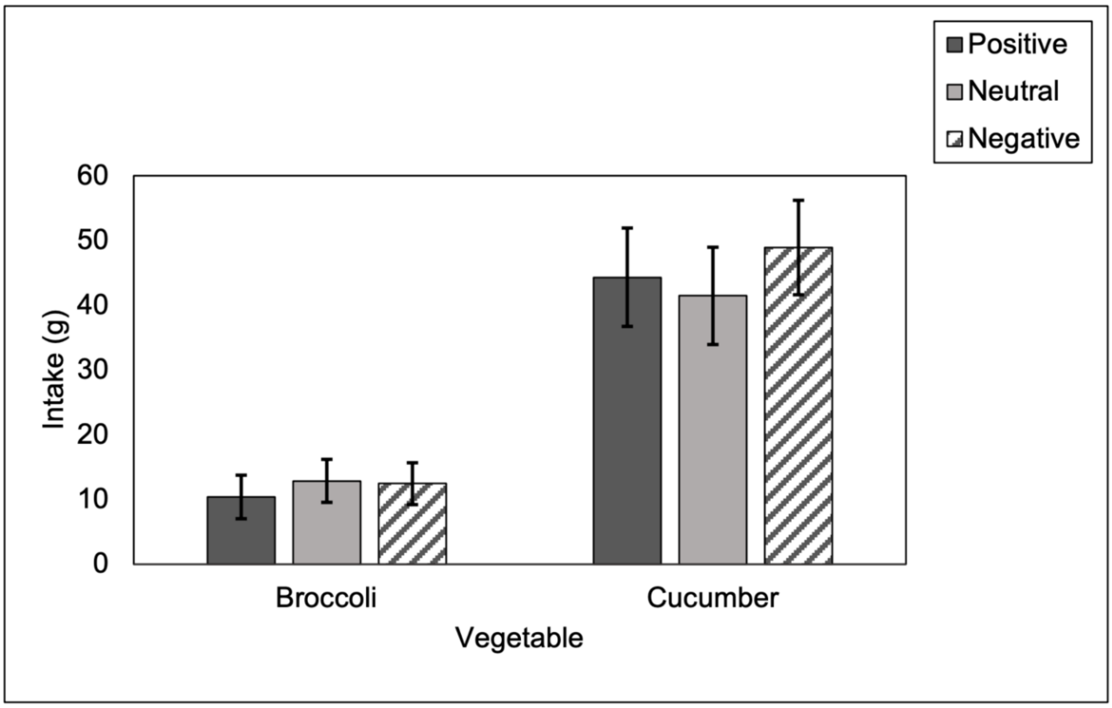

Figure 2.4. Estimated marginal means of broccoli and cucumber intake split by condition (standard error).

2.3.4. Change in Food Liking

One-way ANCOVA controlling for baseline liking and appetite scores, examined the effect of FE type on change in liking of broccoli and cucumber. There was no significant main effect of condition on change in broccoli liking ($F(2, 77) = 2.44$, $p = .09$, $\eta_p^2 = .06$) or change in cucumber liking ($F(2, 77) = 0.51$, $p = .60$, $\eta_p^2 = .01$; Figure 2.5).

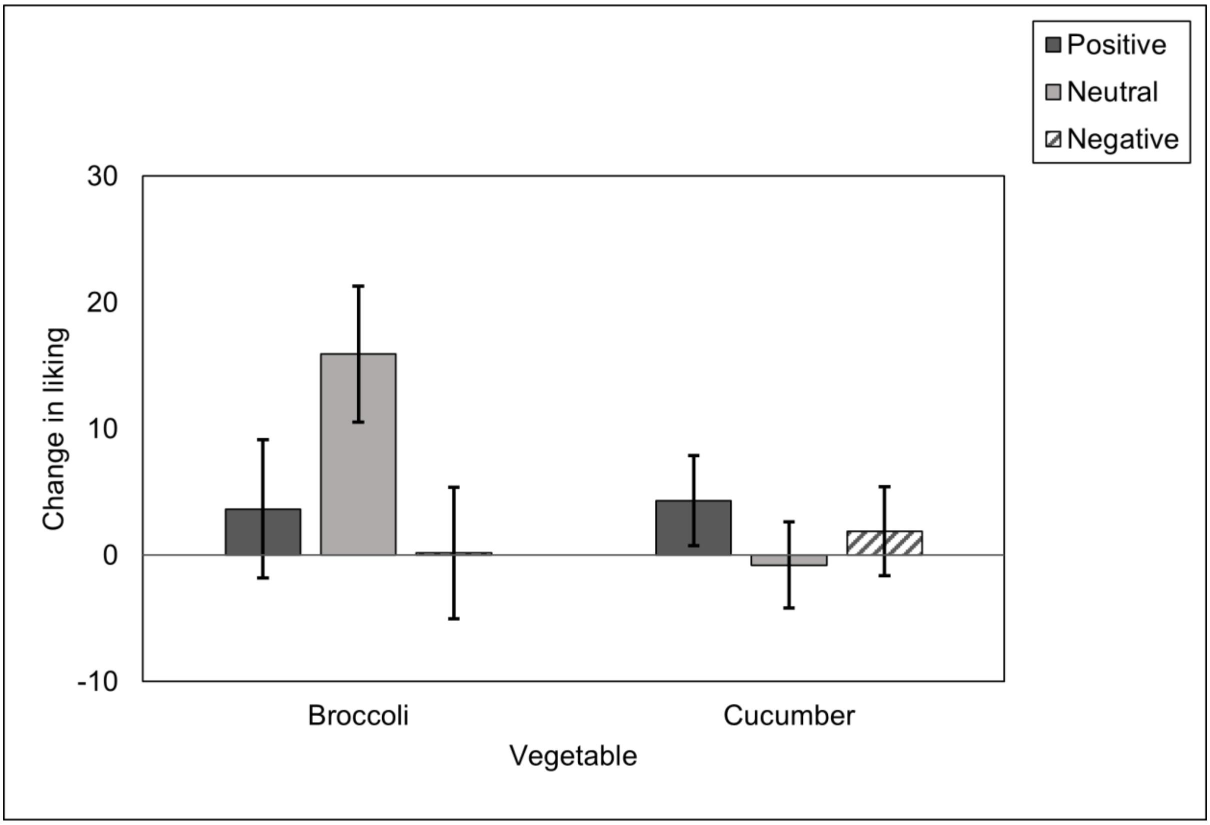

Figure 2.5. Estimated marginal means of change in liking of broccoli and cucumber split by condition (standard error)

2.3.5. Facial Mimicry

Facial mimicry was measured using FaceReader valence scores. FaceReader measures emotional response intensity from 0 (not present) to 1 (fully present). Valence scores are calculated as the intensity of happy minus the intensity of highest intensity negative emotion. Results indicate that the intensity of all emotional responses, apart from neutral, were low in each condition (Table 2.2). Participants with less than 95% of the recording were excluded from analyses (n = 7), thus the sub-sample for this analysis consisted of 75 participants.

Table 2.2: Mean (SD) emotional responses split by condition

	Condition		
	Positive (n = 23)	Negative (n = 28)	Neutral (n = 24)
Neutral	0.63 (0.18)	0.70 (0.14)	0.78 (0.12)
Happy	0.15 (0.19)	0.14 (0.14)	0.07 (0.10)
Sad	0.14 (0.14)	0.09 (0.06)	.09 (0.06)
Angry	0.06 (0.08)	0.06 (0.07)	0.05 (0.06)
Surprised	0.04 (0.06)	0.05 (0.07)	0.04 (0.04)
Scared	0.02 (0.02)	0.02 (0.02)	0.02 (0.02)
Disgusted	0.04 (0.03)	0.03 (0.05)	0.02 (0.02)
Valence	-0.02 (0.26)	0.01 (0.18)	-0.04 (0.13)

Mediation analyses were conducted to explore whether facial mimicry mediated the relationship between FE type and young adults' consumption and change in liking of broccoli and cucumber. Appetite score was included as a covariate in all mediation analyses. 95% bootstrap confidence intervals at 5000 samples were used and variables were mean centered to reduce multicollinearity. For vegetable intake, separate mediation analyses showed that facial mimicry did not significantly mediate the relationship between FE type and intake of broccoli or cucumber (all *p*'s > .05; see Appendix E-2, Table A for coefficients). For change in vegetable liking, separate mediation analyses showed that facial mimicry did not significantly mediate the relationship between FE type and change in liking of broccoli or cucumber (all *p*'s > .05; see Appendix E-2, Table B for coefficients).

2.4. Discussion

This study examined the effect of models' FEs whilst consuming raw broccoli on young adults' intake and change in liking of a modelled vegetable (raw broccoli) and a non-modelled vegetable (cucumber). Contrary to hypotheses, the findings showed no effect of models' FEs towards broccoli on consumption or change in liking of broccoli and cucumber, and facial mimicry did not significantly mediate this relationship. However, this study is not sufficiently powered to detect meaningful effects due to an inadequate sample size; 82 participants were recruited rather than the 150 required, due to the lockdown caused by the COVID-19 pandemic. According to Robinson and colleagues (2018), thirty-two or fewer participants per condition is problematic for making accurate inferences from the findings. Hence, it is inappropriate to interpret the results based on statistical significance alone as this produces a high risk of Type II error.

Not only were findings not statistically significant, results also showed very small effect sizes for broccoli and cucumber consumption, and the change in cucumber liking. However, there was a small-moderate effect size for change in broccoli liking. Performing post hoc power analyses was not appropriate due to the lack of significant findings. Instead, post hoc sample size calculations were conducted using the effect sizes generated in the present findings. For change in broccoli liking, the sample size needed to detect a significant main effect was 183 participants, which is reasonably close to the sample size defined a priori. This, in tandem with small effect sizes, implies that with adequate power, a significant effect may have been detected for the change in liking of broccoli. However, other outcome variables required very large sample sizes (more than 950 participants), implying that even if an adequate sample was recruited, significant effects are unlikely to be yielded, and even if they were statistically significant, the effect would not be meaningful in terms of impacting eating behaviour.

Though interpreting the data on this basis is speculative, it was undertaken for the purpose of this thesis because COVID-19 prevented completion of the study. On this basis, exposure to adults eating broccoli with positive FEs does not appear to influence adult's intake and liking of a modelled and non-modelled vegetable. Based on post hoc sample size calculations, any potential effect of models' FEs does not seem to generalise to a non-modelled vegetable either. Whilst not statistically significant, mean scores indicate that the greatest increase in broccoli liking was in the neutral condition. Thus, recruiting the target sample size would be required to determine the likely presence or absence of the effect of models' FEs towards a vegetable on adults' consumption, but this was not possible under the circumstances during which this study was undertaken.

Regardless of power, this study demonstrated that almost half of participants (44.5%) in the positive condition did not correctly identify how the models felt about eating broccoli. This suggests that positive FEs might not accurately convey food enjoyment. One explanation for this is that participants might have perceived the positive FEs as pretend. Natural facial responses to liked tastes are relaxed and soothed (Wendin et al., 2011), rather than the exaggerated smiles used to convey food enjoyment in this study. Thus, positive FEs whilst eating might not convincingly convey food enjoyment.

It is difficult to confirm the absence of an effect of facial mimicry as a mediator in this study, due to lack of a significant effect of FE on consumption as well as an inadequate sample size. There were also several limitations associated with the measurement of facial mimicry. To eliminate the invasive nature of using electromyography, FaceReader software was used to record automatic facial reactions to measure facial mimicry. However, some issues arose. Firstly, FaceReader requires highly sensitive conditions for recording: optimal lighting; seated participants avoiding any movement or covering of their face; controlled camera height (Danner et al., 2014; Hofling et al., 2020). Due to the lighting conditions needed, participants were required to remove their glasses during video recordings as light reflection in the lenses disrupted FaceReader analysis. Recording issues were also seen for participants with darker skin tones, which has also been suggested by Hofling and colleagues (2020). As a result, data for 7 participants was excluded due to inadequate recordings. Though controlled environments are often expected for laboratory studies, these stringent conditions fail to make FaceReader a reliable non-invasive alternative to electromyography and result in loss of data. Additionally, FaceReader may not be a sensitive enough tool to detect facial mimicry. When showing participants arousing images to evoke facial responses, Hofling and colleagues (2020) found a 2 second latency delay in the measurement of facial responses using FaceReader, when compared to electromyography. This is problematic for measuring facial mimicry as it occurs rapidly, with muscular changes occurring within 500ms after stimulus onset (Seibt et al., 2015). However, there could also be issues with the analysis of facial mimicry; it occurs rapidly so studies typically measure the immediate facial responses after stimulus onset, rather than the duration of watching a video. Thus, measuring participants' emotional responses over the duration of watching the video could have diluted the detection of facial mimicry. Furthermore, the intensity scores of emotional responses measured by FaceReader were very low, except for neutral responses which showed the highest intensity. Evidence of emotional responses measured by FaceReader being low has been reported in previous research (Cobo et al., 2022; Van der Donck, 2020). This may reflect issues with the task, such as models being remote and strangers which can reduce mimicry (Hess, 2020; Hsu et al., 2020). Alternatively, it could be a result of sensitivity issues with FaceReader. Hofling and colleagues (2020) found that FaceReader was not sensitive enough to detect differences between neutral and negative FEs, whereas electromyography was, when participants saw arousing images. Overall, it appears that there may be issues with both the task and use of FaceReader for measuring facial mimicry.

Although this study was not sufficiently powered to detect important effects, the study used an efficient experimental design, with the novel use of video stimuli, which allowed participants to observe the dynamic nature of others' FEs whilst eating. This method is more ecologically valid than the previously used static images of models (Barthomeuf et al., 2009, 2012). Using video stimuli is also advantageous over the use of live models as it allows standardisation of the facial reactions that participants are exposed to. Few men participated in this study; thus, it is not possible to investigate gender differences in the effect of models' FEs on eating behaviour. Based on power calculations, a minimum of 78 men are required to detect a significant interaction between models' FEs and gender on eating behaviour. Thus, future research that recruits an adequate number of men as determined by power calculations is required to investigate gender effects in the modelling of eating behaviour.

In conclusion, this study provided no statistically significant evidence that models' FEs towards raw broccoli influence young adults' intake and change in liking of a modelled and non-modelled vegetable. However, given the premature completion of data collection due to COVID-19, meaningful conclusions cannot be drawn from the findings. Future research exploring the effect of others' FEs on young adults' eating behaviour with an adequate sample size is required.

Chapter 3: The effect of models' facial expressions whilst eating a raw vegetable on young adult women's liking, but not their desire to eat vegetables

As discussed in Chapter 2, data collection was terminated prematurely due to COVID-19 restrictions. Therefore, the study outlined in this chapter was conducted using online methods, to examine the effect of models' FEs towards raw broccoli on women's eating behaviour, to provide better understanding of how other people's FEs influence the modelling of eating behaviour. The study presented within this chapter aimed to investigate whether observing models convey FEs towards raw broccoli whilst consuming it influenced young adult women's change in liking and change in desire to eat the modelled vegetable (raw broccoli) and a similar non-modelled vegetable (cucumber). Young adult women (N = 205) were randomised to watch a video of unfamiliar adult models eating raw broccoli with a positive, negative, or neutral FE. Participants' change in liking and change in desire to eat the modelled and non-modelled vegetable was examined. Data about participant characteristics was gathered. Observing models conveying negative FEs whilst eating raw broccoli resulted in a statistically significant reduction in liking ratings of broccoli, but not cucumber. There was no effect of models' FEs on the change in desire to eat foods. These findings suggest that watching others express a negative FE whilst eating a raw vegetable reduces women's liking of the modelled vegetable, in the absence of a significant change to their desire to consume these foods.

3.1. Introduction

Modelling is known to influence eating behaviour (Cruwys et al., 2015; Vartanian et al., 2015) and could be a useful strategy to promote healthy dietary behaviour by young adults, who often have poor dietary habits (Nelson et al., 2008; Winpenny et al., 2018). Information about an eater's food enjoyment can be conveyed through FEs whilst eating, and this can influence the observer's perceived desirability of the food. Research has shown that observing adults with disgust FEs whilst looking at food decreases the desire to eat disliked food (Barthomeuf et al., 2009, 2012). In contrast, observing adults with pleasure FEs looking at food increases adults' desire to eat liked food (Barthomeuf et al., 2009, 2012). This demonstrates that exposing adults to others' food enjoyment, conveyed through FEs, influences adults' desire to eat.

It is possible that these findings could generalise to nutritious foods, such as vegetables, which are commonly less preferred. However, since previous research has not looked at nutritious food specifically, and the study in Chapter 2 could not be completed, the effect of others' FEs whilst eating nutritious food remains to be established. Research is also needed to determine whether the effect of others' FEs translates to actual food consumption. However, since food acceptability is associated with food intake (de Graaf et al., 2005), and can be measured remotely using online methodology, examining the effect of others' FEs on the subjective liking and desire to eat vegetables provides an appropriate alternative to examining food intake during the COVID-19 global pandemic restrictions, which applied when this study was conducted.

Additionally, it is important to establish whether modelling influences the desirability of a non-modelled vegetable, to determine whether it is a useful strategy to influence vegetable desirability more generally. Since engagement in one health behaviour can promote engagement in another health behaviour (Dohle et al., 2015), it is possible that the effect of others' FEs could generalise to the liking and desirability of non-modelled vegetable. However, this remains to be examined in adult populations.

Therefore, this study examined the effect of models' FEs towards raw broccoli on young adult women's change in liking and change in desire to eat a modelled vegetable (raw broccoli) and a non-modelled vegetable (cucumber). Women were examined because gender differences may exist within the modelling of eating behaviour, with larger modelling effects on women's, than men's, eating (Vartanian et al., 2015). Based on previous literature, it was hypothesised that there would be a greater increase in change in liking and desire to eat the modelled vegetable (raw broccoli) after exposure to videos of adult models consuming raw broccoli with positive FEs, and a greater decrease in change in liking and desire to eat the modelled vegetable after exposure to videos of adult models eating raw broccoli with negative FEs, compared to exposure to videos of adult models eating raw broccoli with neutral FEs. Furthermore, it was hypothesised that the effect of models' positive FEs would generalise to women's change in liking and desire to eat a non-modelled vegetable (cucumber).

3.2. Method

3.2.1. Participants

A power calculation (G*Power 3; Faul et al., 2007) indicated that to detect a main effect of condition with d = 0.45 (based on effect size calculations from Barthomeuf et al., 2009), 80% power, and α = 0.05, a minimum of 190 participants were required. In total, 279 young adults aged 18-30 years old were recruited from across the UK. Participants were recruited via online advertisements through Aston University and on social media between May and July 2020 (see Appendix A-2 for example poster). Participants were told that the study was investigating the relationship between emotions and food. Young adults with current or previous eating disorders, food allergies, or diabetes were excluded. Young adults who did not fit the age criteria (18-30 years old) or gender criteria (women participants only) were excluded. Participants could opt to enter a prize draw for a £50 shopping voucher. Ethical approval was obtained from Aston University Research Ethics Committee (#1332; Appendix B-2). All participants provided informed consent for their participation.

3.2.2. Design

A between-subjects design was utilised. Using the randomise feature in Qualtrics, participants were randomly assigned to one of three conditions (positive, negative, or neutral), in which they were shown one of three stimuli (see section 3.2.3.3 for details).

3.2.3. Measures

3.2.3.1. Outcome Measures: Change in Food liking and Desire to Eat

Change in liking and change in desire to eat raw broccoli and cucumber were measured, separately. Six additional food items were included to disguise the aims of the study (apple, grapes, tortilla chips, crisps, chocolate, and cookies). Participants were shown the word of each food, in a randomised order, and rated their liking and desire to eat each food, pre- and post-manipulation. Food liking was measured on a 100mm VAS, anchored to the left and right with 'absent / no liking' and 'most liking you can ever imagine'. Participants were asked to rate how much they wanted to eat each individual food at that time, on a 10-point scale, for example 10 being 'I have a great desire to eat raw broccoli' and 0 being 'I have no desire to eat raw broccoli' (Barthomeuf et al., 2009, 2012). Change scores were computed by subtracting post- from pre-manipulation scores.

3.2.3.2. Sample Characteristics

3.2.3.2.1. Demographics and Lifestyle Questionnaire

Demographic information was collected, assessing gender, age, ethnicity, and employment status (Thomas et al., 2016). Participants self-reported their height and weight, from which BMI was calculated. Lifestyle information was also gathered: smoking status, and whether they were a regular breakfast and or lunch eater (Thomas et al., 2016; Appendix D-2). Information about food allergies, intolerances or medical conditions affecting eating behaviour was also recorded and used to exclude participants based on study criteria.

3.2.3.1.2. Hunger and Mood State

Participants rated their baseline hunger and mood state using VAS anchored from left and right with 'not at all' and 'very much' (respectively). VAS items included: alert, drowsy, light-headed, anxious, happy, nauseous, sad, withdrawn, faint, hungry, full, desire to eat and thirst (Thomas et al., 2016; Appendix D-3). Baseline hunger and mood scores were used to check for differences between conditions.

3.2.3.1.3. Habitual Intake and Liking

Participants' habitual intake and liking of fruit, vegetables, junk food and sugar-sweetened beverages were assessed to establish whether conditions differed at baseline (Thomas et al. 2016). Intake was assessed via the number of daily servings and liking was assessed using 100mm VAS anchored left and right with 'not and all' and 'very much' (Appendix D-4).

3.2.3.1.4. Questionnaires measuring individual characteristics

Several questionnaires measured participant's characteristics, to examine differences in these traits between conditions: typical eating behaviour (AEBQ); general eating style (TFEQ-R21); food neophobia (FNS); sensory processing (AASP); anxiety (BAI); empathy (TEQ); and autistic traits (AQ-10). In this study, good internal consistency of measures was demonstrated: AEBQ (α = 0.67 – 0.89); TFEQ-R21 (α = 0.82 – 0.92); FNS (α = 0.80); BAI (α = 0.93); TEQ (α = 0.81). AASP subscales showed satisfactory internal consistency in this sample (α = 0.44 – 0.57) and AQ-10 was below the acceptable level (α = 0.43). See Chapter 2 for details of these questionnaires (Appendix D-5 – D-11).

3.2.3.3. Experimental stimuli

Experimental stimuli were identical to Chapter 2; however, runs were not repeated to ensure that participants watched the video, due to the online nature of this study. Overall, stimuli were each at least 1 minute in length (positive = 84 seconds; negative = 94 seconds; neutral = 77 seconds). Sound was removed from all video clips, to remove its potential influence on eating behaviour. See Chapter 2 for detail about the validation of the video clips used in the stimuli.

3.2.3.4. Experimental task

Participants were told they would be watching a video of adults eating raw broccoli and were instructed to watch the full video closely as they would be asked questions about it later. Participants then watched a video of models eating broccoli with positive, negative, or neutral FEs, and then rated the valence of models' FEs (positive, negative, or neutral), the authenticity of their FEs (genuine, pretend, not sure), how they actually thought the model felt (positive, negative or neutral), and the intensity of this feeling (100mm VAS from 'negative' (0mm) to 'positive' (100mm).

3.2.4. Procedure

Participants read the information sheet and provided consent for their participation using the online study link on the online survey platform, Qualtrics (Appendix C-3 & C-4). Firstly, participants completed baseline questionnaires gathering demographic and lifestyle information. Participants then rated their liking and desire to eat broccoli, cucumber, and the 6 additional food items. Mood and appetite ratings were also completed. Next, participants completed the experimental task, followed by non-food related questionnaires about their autistic and empathetic traits. Participants then completed post-manipulation ratings of their liking and desire to eat broccoli, cucumber and the 6 additional food items, and then the remaining questionnaires assessing habitual intake and liking, sensory processing, food neophobia, anxiety, typical eating behaviour and eating style. Finally, participants reported their height and weight if they were willing. Participants then described what they thought the aims of the study were and were debriefed and thanked for their participation. The study took approximately 20 minutes to complete.

3.2.5. Statistical analysis

Statistical analyses were conducted using SPSS Version 26. Chi-square tests examined differences between conditions on ethnicity. Differences between conditions in participant age, BMI, habitual food intake and liking, and mood and appetite scores were examined (one-way ANOVA). One-way ANOVA was used to examine differences between conditions on questionnaires measuring individual characteristics. Pearson's correlations were used to examine associations between eating style (TFEQ-R21 subscales) and eating behaviour (AEBQ subscales) with dependent variables. Measures that differed significantly between conditions or correlated with dependent variables were included as covariates in relevant ANCOVA. Baseline liking and desire to eat scores for broccoli and cucumber were included in ANCOVA when change in liking and change in desire to eat were the outcome measures, as suggested by Clifton and Clifton (2019). One-way ANOVA/ANCOVA was used to explore main effects of condition on dependent variables. Finally, Bonferroni corrected t-tests were used to explore significant main effects of condition for all ANOVA/ANCOVA.

3.3. Results

3.3.1. Demographics and Baseline Measures

In total, 279 young adults completed the study. Participants were excluded for: having a food allergy (n = 9); not meeting age inclusion criteria (n = 1); not meeting gender inclusion criteria (n = 40); and not identifying the correct FE for their condition, as this indicated they might not have watched the video manipulation, given the online nature of the data collection (n = 24). The final sample consisted of 205 young adult women. Participants mean age was 22.3 years (SD = 2.64; range = 18-30) and mean BMI was in the healthy range (mean = 23.50, SD = 4.69). Ethnic background: 42.4% White, 31.2% Asian, 5.4% Black, 5.9% mixed ethnicities, 14.1% 'other' and 1.0% 'prefer not to say'. Participants were mainly students (full-time = 79.5%; part-time = 5.4%) and unemployed (48.8%) or employed part-time (34.1%). Most participants ate breakfast (65.4%) and lunch regularly (85.4%) and did not smoke (96.6%).

Conditions did not differ significantly on participant ethnicity ($X^2(205) = 26.32$, $p = .34$). Participant age, BMI scores, and baseline food intake and liking scores did not differ significantly between conditions (Table 3.1). Baseline mood and appetite scores did not differ significantly between conditions (all *p*'s > .05, see Appendix E-3: Table A for means and details). See Appendix E-3: Table B for mean change in liking and change in desire to eat scores for additional food items used to disguise the study aims.

Table 3.1: Mean (SD) demographics and baseline food intake and liking scores for participants in each condition (one-way ANOVA)

		Positive (n = 65)	Negative (n = 73)	Neutral (n = 67)	*F*	*p*
Age		22.54 (2.50)	22.59 (2.83)	21.84 (2.52)	1.74	.18
BMI		24.58 (4.60)	22.98 (5.20)	23.00 (5.20)	2.60	.08
Habitual Intake	Fruit	2.32 (2.32)	1.98 (1.23)	1.93 (1.09)	1.77	.17
	Vegetables	2.52 (1.81)	2.73 (1.93)	2.25 (1.20)	1.46	.23
	Junk Food	1.95 (1.37)	1.74 (0.99)	1.73 (1.18)	0.74	.48
	SSB	1.02 (1.19)	1.14 (1.46)	0.70 (1.05)	2.24	.11
Habitual Liking	Fruit	83.45 (19.04)	78.03 (22.17)	79.90 (18.46)	1.28	.28
	Vegetables	71.69 (23.60)	74.32 (24.00)	70.15 (23.54)	0.56	.57
	Junk Food	79.40 (20.45)	76.52 (19.57)	77.79 (25.35)	0.30	.74
	SSB	60.22 (32.97)	61.38 (28.50)	53.87 (35.06)	1.08	.34
Liking	Broccoli	30.35 (28.47)	31.27 (25.80)	30.27 (25.80)	0.03	.97
	Cucumber	65.54 (27.67)	66.07 (24.98)	66.13 (27.94)	0.01	.99
Desire to eat	Broccoli	2.18 (2.28)	2.16 (2.53)	2.27 (2.47)	0.04	.97
	Cucumber	5.77 (2.96)	5.74 (2.92)	5.99 (3.09)	0.14	.87

There were no significant differences between conditions on questionnaires measuring individual characteristics (all *p*'s > .05; see Appendix E-3: Table C for means and details). AEBQ and TFEQ-R21 subscales were not significantly associated with outcome measures (all *p*'s > .05), except for change in cucumber liking, which was significantly negatively associated with emotional eating and slowness in eating, and significantly positively associated with emotional undereating (*p*'s < .05; see Appendix E-3: Table D for details). However, since correlations were weak (*r*'s < .02), and it was not theoretically plausible that such measures would be related to change in cucumber liking, emotional eating, emotional undereating, and slowness in eating were not entered as covariates.

3.3.2. Manipulation check

Most participants thought that the models' FEs they observed were pretend (positive = 87.7%; negative = 79.5%; neutral = 68.7%), and few participants (16.9%) in the positive condition thought models felt positive about eating raw broccoli. However, most participants in the negative condition (56.2%) thought models felt negative about eating raw broccoli, and most participants in the neutral condition (52.2%) thought models felt neutral about eating raw broccoli. Positive and negative FEs were rated as higher in intensity (*M* = 69.49 and *M* = 80.19, respectively), and neutral FEs were rated as lower in intensity (*M* = 36.51). Excluding participants who guessed the aimed of the study (n = 12) did not change the effect of condition on dependent variables. Therefore, all cases were included in the analysis.

3.3.3. Change in liking

One-way ANCOVA, controlling for baseline broccoli liking, showed that there was a significant main effect of condition on the change in broccoli liking ($F(2, 201) = 3.60$, $p = .03$,

η_p^2 = .04; Figure 3.1). Bonferroni corrected t-tests revealed that the change in broccoli liking was significantly more negative in the negative condition, compared to the positive condition (p = .03). Change in broccoli liking did not differ significantly between neutral vs. positive (p > .05) or neutral vs. negative conditions (p > .05). One-way ANCOVA showed that there was no significant main effect of condition on the change in cucumber liking (F(2, 201) = 2.16, p = .12, η_p^2 = .02).

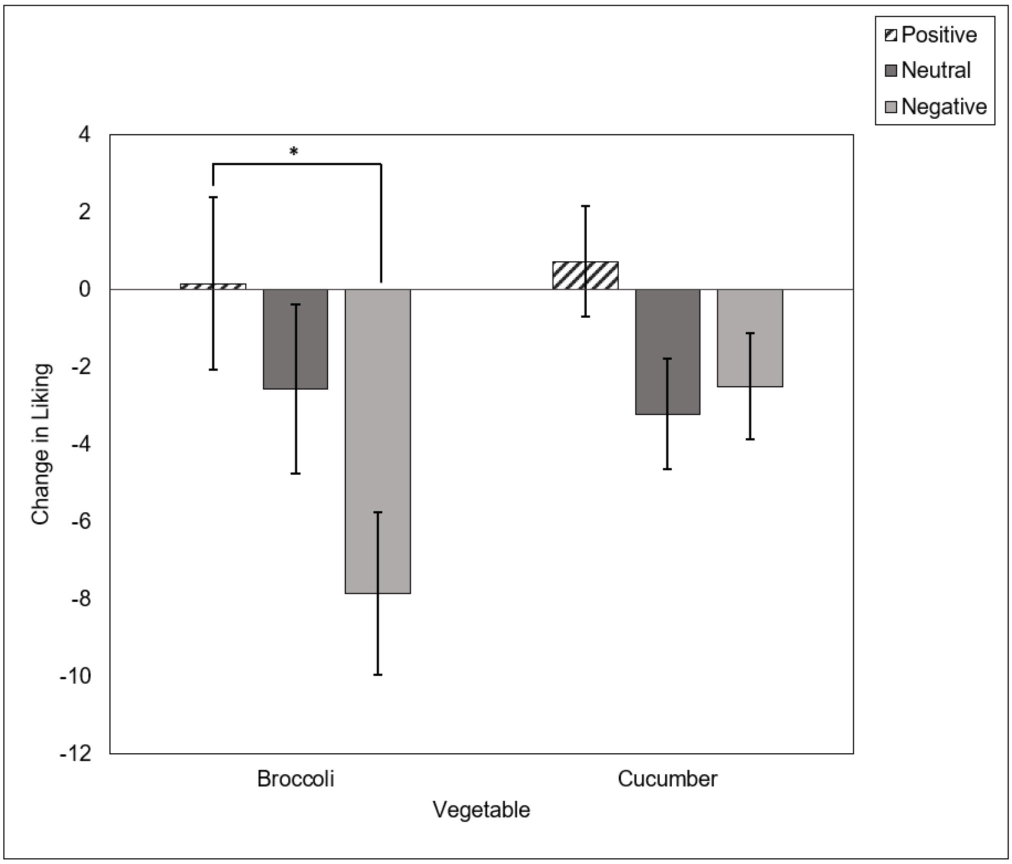

Figure 3.1. Estimated marginal means of change in liking scores for broccoli and cucumber split by condition. Change in liking of broccoli was significantly decreased in the negative condition, compared to the positive condition for broccoli. Error bars indicate standard error of the mean. *p < .05.

3.3.4. Change in Desire to Eat

One-way ANCOVA, controlling for baseline desire to eat scores, revealed there was no significant main effect of condition on the change in desire to eat broccoli (F(2, 201) = 1.32, p = .27, η_p^2 = .01) and cucumber (F(2, 201) = 1.16, p = .32, η_p^2 = .01; Table 3.2).

Table 3.2: Estimated marginal means (standard error) of change in desire to eat scores for broccoli and cucumber split by condition

	Positive (n = 65)	Negative (n = 73)	Neutral (n = 67)
Desire to eat broccoli	0.07 (0.20)	-0.34 (0.19)	0.03 (0.20)
Desire to eat cucumber	0.03 (0.16)	0.05 (0.15)	-0.26 (0.16)

3.4. Discussion

This study examined the effect of models' FEs while consuming raw broccoli, on women's change in liking and desire to eat a modelled vegetable (raw broccoli) and a non-modelled vegetable (cucumber). Partially supporting our hypotheses, exposure to models eating broccoli whilst conveying negative FEs resulted in a greater reduction in liking ratings of the modelled vegetable, compared to an increase in liking ratings in the positive condition. However, this effect did not generalise to the non-modelled vegetable (cucumber). Furthermore, positive FEs had no significant effect on liking, compared to the control condition, and participants' desire to eat any of the foods was not affected by the manipulation. Hence, the findings suggest a selective effect, whereby exposure to negative FEs reduces the liking of the modelled vegetable.

One explanation of why the change in liking of broccoli was more negative after exposure to models eating broccoli with negative FEs, is that avoiding foods associated with disgust is an adaptive response, to prevent ingestion of harmful substances (Curtis, 2011). This has concerning implications for the liking of nutritious foods. For example, an individual observing a co-eater showing dislike whilst eating a vegetable could decrease their liking of this vegetable. However, this effect does not appear to generalise to the liking of other vegetables. As omnivores, our diet would be highly restricted if we excluded all similar foods that we saw someone once disliking. Since broccoli and cucumber look different, the absence of a generalised effect could be explained by individuals paying particular attention to exactly what the model is eating, and their behaviour inhibits ingestion only of that food. Research in real-life eating occasions is needed to examine the effect of observing another eater show dislike whilst eating nutritious food on the observers' actual intake of these foods.

Contrary to hypotheses, exposure to models eating broccoli whilst conveying positive FEs, did not result in a greater increase in change in liking or desire to eat ratings for any foods. One explanation for this could be that positive FEs do not demonstrate food enjoyment convincingly. Indeed, only a small number of participants in the positive condition (16.9%) thought that the models really felt positive about eating raw broccoli. This could be because smiling whilst tasting a food is not a typical reaction to liked tastes. Instead, naturalistically, liked tastes elicit low intensity, relaxed and soothed facial responses (Wendin et al., 2011). Therefore, displaying exaggerated smiles whilst eating a vegetable might not accurately convey an individual's enjoyment of food to other adults. In contrast, disliked tastes do elicit intense, disgust-like facial responses (Danner et al., 2014; Horio, 2003; Wendin et al., 2011) and in the negative condition over half of participants believed the models did not enjoy the food they were eating. Another explanation could be that the risk associated with ingesting a disgusting food is greater than the possibility of enjoying a food and thus we pay more attention to, or are more likely to adjust our behaviour in response to, negative FEs. Indeed, avoiding disgusting foods is protective (Curtis, 2011), thus participants might have been more inclined to adjust their eating behaviour after seeing a negative FE, rather than a positive FE, to protect themselves from harm.

A further interesting finding was that subjective food liking was influenced by models' FEs, but desire to eat was not, which contradicts our predictions and previous research (Barthomeuf et al., 2009, 2012). One explanation of why liking, but not wanting was influenced, could be that the manipulation conveyed models' hedonic liking of broccoli, but not necessarily their wanting of the broccoli. For example, models did not convey greater wanting of the broccoli, such as expending greater energy to obtain it. Therefore, the effect on liking, but not desire to eat, may reflect the hedonic nature of the manipulation used in this study. Another explanation could be that the desire to eat broccoli was already low at baseline. Consistent with previous research, exposure to negative FEs does not reduce the eating desire of food that participants already have a low desire to eat (Rousset et al., 2008). Although there was possibility to reduce eating desire in this study, the low baseline desire to eat might explain the absence of a significant effect of negative FEs on participant's desire to eat broccoli.

The current findings demonstrate that positive FEs do not seem to be effective for influencing young adult women's subjective green vegetable liking and desire to eat. However, models' positive FEs were commonly perceived to be pretend, which could have influenced their effect on eating behaviour. It is noteworthy that these pretend positive FEs did not have negative effects on participants' eating behaviour, suggesting that they were merely not helpful, rather than harmful. Furthermore, almost half of participants did not correctly identify how models felt about eating the broccoli. This suggests that the manipulation does not accurately convey adults' food enjoyment, which might have reduced the effectiveness of the manipulation and thus influenced the results. Therefore, future research should expose participants to real-life food enjoyment or dislike, to establish whether naturalistic facial reactions whilst eating influence young adults eating behaviour. Additionally, the measurement of subjective wanting and liking in this study is limited. For example, measuring participants' subjective ratings of their desire to eat might not reflect their actual motivational desire to consume the food. Thus, research measuring food intake is needed to determine whether reductions in food liking translate to actual food consumption. Furthermore, given the cross-sectional design of this study, more research is needed to determine whether acute changes in liking have a long-term effect on eating behaviour.

The present study was sufficiently powered to detect important effects, using an efficient experimental design. One limitation of these findings is that they are only relevant to women. Though research has suggested larger modelling effects for women (Vartanian et al., 2015), it is unclear whether gender would interact with the effect of models' FEs on eating behaviour. Thus, further research is needed with samples comprising sufficient numbers of men to explore gender effects in the modelling of eating behaviour. The online nature of the study meant that actual food intake could not be directly and objectively measured. Indeed, research measuring food intake is required to determine whether others' FEs whilst eating influence adults' actual food consumption, to elucidate whether observing others FEs whilst eating is a useful strategy to encourage healthier eating behaviour. One noteworthy strength of this study was the novel use of video stimuli, which allowed participants to observe the dynamic nature of others' FEs whilst eating. This method is more ecologically valid than the previously used static images of models (Barthomeuf et al., 2009, 2012).

In conclusion, this study demonstrated that exposing young adult women to videos of others expressing negative FEs whilst eating raw broccoli, decreased their liking of the modelled vegetable, but not the non-modelled vegetable, or their desire to consume either vegetable. This highlights the power of negative FEs towards food in reducing food liking. Further work is needed to establish whether observing specific FEs shown by models eating nutritious foods influences the actual consumption of vegetables, and whether there are longer term effects on eating behaviour. Research examining whether gender interacts with the effect of modelling on eating behaviour is required. Investigating these questions will help to determine whether exposure to others' FEs might provide a useful method for nudging healthier eating behaviour.

Chapter 4: The effect of models' positive facial expressions whilst eating a raw vegetable on children's acceptance and consumption of the modelled vegetable

This study reported in this chapter has been published as:
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The content in this chapter is mostly the same as in the published paper, but minor adjustments to presentation have been made to remain consistent with the thesis.

4.1. Abstract

Research has shown that seeing positive FEs towards food increased children's desire to eat foods rated as disliked. However, the effect of adults' positive FEs whilst eating a raw vegetable on children's acceptance and intake of nutritious foods that are less preferred (e.g., vegetables) remains to be established. This study aimed to examine the effect of models' FEs eating raw broccoli on children's acceptance and intake of raw broccoli. 111 children aged 4-6 years (64 male, 47 female) were randomised to watch a video of unfamiliar adult models eating raw broccoli with a positive or neutral FE, or a non-food control video. Children's acceptance and intake of raw broccoli was assessed. Data about parent and child characteristics was provided by parents. There was a main effect of FE type on children's frequency of tastes (p = .03) and intake of broccoli (p = .02). Children who were exposed to models eating broccoli with positive FEs had greater frequency of tastes (p = .04) and intake of broccoli (p = .03), than children in the control condition, but not compared to children in the neutral FE condition (p > .05). There was no effect of positive FEs on children's willingness to try broccoli (p > .05). These findings suggest that observing others enjoy a commonly disliked vegetable can encourage children's tastes and intake of the vegetable. Thus, exposing children to others enjoying vegetables could be a useful strategy for encouraging healthier eating in children. Further work is needed to determine whether a single exposure is sufficient and whether these effects are sustained over time.

4.2. Introduction

Children typically consume fewer vegetables than recommended (Health Survey for England, 2018; Keats et al., 2018; Kupka et al., 2020). Vegetables are often bitter in taste and innately less preferred (Wardle & Cooke, 2008), thus encouraging vegetable intake by children is challenging. Since poor dietary behaviour during childhood can persist into adulthood, it is important to identify methods of increasing children's vegetable acceptance as early as possible to establish healthy dietary behaviours (Craigie et al., 2011).

Social learning plays a role in guiding children's eating behaviour; children may observe and model another's eating behaviour (Bandura, 1977). Modelling appears to reduce food neophobia in children, as children consume more novel food after observing an adult model eating the food (Addessi et al. 2005; Harper & Sanders, 1975). Through vicarious learning, children may imitate a behaviour after observing positive consequences (Bandura, 1977), e.g., a model's conveyance of food enjoyment using a statement (e.g., "this is yummy") can increase children's F&V acceptance (Appleton et al., 2019; Hendy & Raudenbush, 2000). For example, preschool children have been found to be more accepting of novel fruit when teachers made enthusiastic comments about the fruit (Hendy & Raudenbush, 2000). Furthermore, 7–10-year-old children showed higher liking and carrot intake after observing characters mention their liking of carrots (Appleton et al., 2019). This demonstrates that positive information about a models' enjoyment of food has a greater impact on encouraging children's acceptance of the modelled fruit or vegetable than modelling alone.

Food enjoyment is also conveyed through FEs. Children may look to others for guidance when exposed to new foods they are unsure about. Smile signals from adults can encourage children's approach behaviour to an unfamiliar toy (Klinnert et al., 1986), thus observing positive FEs towards eating food may encourage approach and acceptance of novel food. Limited research exploring the effect of models' FEs towards food on the eating behaviour of others shows that exposure to positive FEs can influence eating behaviour (Barthomeuf et al., 2009, 2012). Exposing adults and children to static images of adults looking at a bowl of food with a pleasure, disgust, or neutral FE has shown that adults' pleasure and neutral FE towards food increases adults' and children's desire to eat foods rated as disliked (Barthomeuf et al., 2009, 2012). Thus, observing adults enjoying, or at least not disliking, typically less preferred but nutritious foods, such as vegetables, may be a useful strategy to increase children's vegetable acceptance and intake. Determining whether positive FEs are particularly useful for increasing disliked food desirability, in comparison to neutral FEs, remains to be established.

This study examined the effect of adults' FEs whilst eating raw broccoli on children's acceptance and intake of a typically less preferred vegetable. Children aged 4-6 years were examined because emotion recognition develops significantly between 3-4 years (Pons et al., 2004), and 4-6-year-olds have the capacity to understand and cooperate with online procedures. Furthermore, food neophobia peaks between 2-6 years, thus children aged 4-6 years are less likely to try new foods, particularly vegetables (Dovey et al., 2008). Investigating others' FEs in isolation (e.g., without statements about food tastiness) will improve understanding of the role of FEs in modelling of eating and contribute to developing strategies to help children learn pleasure from nutritious foods (Marty et al., 2018). Based on previous literature, it was hypothesised that children's acceptance (willingness to try, and frequency of tastes) and intake of raw broccoli would be higher after exposure to models eating raw broccoli with positive FEs, compared to models consuming raw broccoli with neutral FEs, or a non-food control video.

4.3. Method

4.3.1. Participants

A power calculation (G*Power 3; Faul et al., 2007) indicated that to detect a significant main effect of condition with $d = 0.6$, (based on research examining intervention effects on children's vegetable intake; Farrow et al., 2019), 80% power, $\alpha = 0.05$, a minimum of 108 children were required. In total, 117 4-6-year-olds and their parents were recruited from the UK via online advertisements and social media between October 2020 and February 2021 (see Appendix A-3 for example poster). Children with food allergies, food intolerances, or medical conditions affecting eating behaviour were excluded. Ethical approval was obtained from Aston University Research Ethics Committee (#1688; Appendix B-3). Parents provided informed consent for their own and their child's participation and children provided verbal assent (Appendix C5 & C-6).

4.3.2. Design

In a between-subjects design, children were randomly assigned to one of three conditions (positive, neutral or control) in which they were shown one of three stimuli (see 4.3.3.4. for details).

4.3.3. Measures

4.3.3.1. Children's vegetable acceptance and intake

Children's acceptance and intake of raw broccoli was measured after the manipulation. Raw broccoli was used due to its bitter taste, and bitterness is innately less preferred (Wardle & Cooke, 2008). Broccoli is also likely to be unfamiliar to children in its raw form. Broccoli acceptance was measured as the willingness to try broccoli and the frequency of tastes of broccoli. Willingness to try broccoli was assessed by measuring children's greatest observed engagement with broccoli on a 7-point scale (Table 4.1; Blissett et al., 2012; Blissett et al., 2016). For example, if a child placed raw broccoli in their mouth but did not swallow it, 'placed in mouth' (score = 5) was recorded as the greatest observed engagement. If the child verbally refused the broccoli but then went on to touch it, 'touched' (score = 3) was recorded as the greatest observed engagement. Higher engagement scores indicated greater willingness to try broccoli. The frequency of children's tastes (defined as any occurrence of oral exposure to the broccoli) was determined by counting the number of times broccoli was 'placed in mouth', 'swallowed but refused', and 'swallowed and accepted'. Broccoli intake was measured as the grams of broccoli consumed; parents weighed the broccoli in grams pre- and post- intake and reported the weights to the researcher.

Table 4.1: 7-point scale of children's willingness to try broccoli

Behaviour Category	Description of Behaviour	Example
(1) Physical refusal	Any occurrence of the child physically refusing the broccoli	Turning head away from offered broccoli
(2) Verbal refusal	Any occurrence of the child verbally refusing the broccoli	Child said "I don't want it"
(3) Touched	Any occurrence of the child physically touching the broccoli, but no further interaction with it	Picks up broccoli but puts it back in the bowl
(4) Smelled	Any occurrence of the child smelling the broccoli, such as by picking it up and bringing it to the nose, but no further interaction with it	Smelling the broccoli after picking it up
(5) Placed in mouth	Any occurrence of the child placing the broccoli to or inside the mouth, but no further interaction or its consumption	Putting broccoli into the mouth without biting it, holding it inside the mouth, but refused to swallow
(6) Swallowed but refused	Any occurrence of the child chewing and swallowing some of the broccoli but refused further or expressed dislike	Biting off a piece of broccoli, chewing and swallowing it but refuse another bite
(7) Swallowed and accepted	Any occurrence of the child chewing and swallowing some of the broccoli without a negative reaction	Biting off a piece of broccoli, chewing and swallowing it and eating another piece

4.3.3.2. Demographics and Lifestyle Questionnaire

Demographic information was gathered; child sex and age, and parent gender, age, ethnicity, education level and number of children was assessed (Blissett et al., 2019; Appendix D-12). Parents reported their child's height and weight, to calculate BMI. BMI z scores (zBMI) were used in analyses to adjust for sex and age. Information about parent and children's food allergies, food intolerances, or medical conditions affecting eating behaviour were used to exclude participants. Parent and child habitual F&V intake was assessed, to check for differences between conditions: e.g., "how many servings of vegetables do you/ your child normally eat a day?" and "think back carefully, how many servings of vegetables did you/ your child eat yesterday?" (Thomas et al., 2016; Appendix D-13). Parents reported if their child had tried raw broccoli before, to assess children's familiarity with raw broccoli.

4.2.3.3. Questionnaires measuring child individual differences

Parents completed several questionnaires about their child's characteristics: typical eating behaviour; food neophobia; sensory processing; anxiety; empathy; and autistic traits. Children differ in these traits, which have been associated with selective eating behaviours. These traits were examined to check participants did not differ in these measures between conditions. See Appendix D-14 – D-19.

4.2.3.3.1. Child Food Neophobia Scale (CFNS; Pliner, 1994)

Children's willingness to eat novel foods (food neophobia) was measured using a reduced 6-item CFNS (e.g., 'my child does not trust new foods'). Parent responses are on a 7-point Likert scale ranging from 1 (disagree strongly) to 7 (agree strongly). Higher scores indicate greater child food neophobia. Food neophobia has been associated with lower intake and variety of F&V in children, so was measured to examine associations with outcome measures and differences in children's neophobia between conditions (Cooke et al., 2003; Perry et al., 2015). The CFNS has good internal consistency (Cooke et al., 2006; Perry et al., 2015), and construct and behavioural validation (Pliner, 1994). Internal consistency in this study was excellent (α = 0.94).

4.2.3.3.2. Children's Eating Behaviour Questionnaire (CEBQ; Wardle et al., 2001)

Children's typical eating behaviour was measured using 4 subscales of the CEBQ: food responsiveness (5 items, e.g., 'my child is always asking for food'), enjoyment of food (4 items, e.g., 'my child loves food'), satiety responsiveness (5 items, e.g., 'my child gets full up easily') and food fussiness (6 items, e.g., 'my child refuses new food at first'). Parent responses are on a 5-point Likert scale from 1 (never) to 5 (always). Subscales measuring food approach (enjoyment of food and food responsiveness) and food avoidance (satiety responsiveness and food fussiness) have been associated with food acceptance, so were measured to examine associations with outcome measures (Blissett et al., 2019; Cooke et al., 2004; Fildes et al., 2015). The CEBQ has been shown to have good internal consistency, high test-retest reliability (Wardle et al., 2001) and construct validity (Carnell & Wardle, 2007). Subscales had good internal consistency in this study (α = 0.79 – 0.89).

4.2.3.3.3. Sensory Experiences Questionnaire (SEQ; Baranek et al., 2006)

Sensory hyper- and hypo-responsive patterns in social and non-social contexts were measured using the 21-item SEQ (e.g., 'avoids textures'). Parent responses are on a 5-point Likert scale ranging from 0 (almost never) to 4 (almost always) with higher scores signifying more sensory processing problems. Sensory sensitivity is associated with lower F&V intake (Coulthard & Blissett, 2009) and selective eating behaviour (Farrow & Coulthard, 2012), thus sensory processing was assessed to examine baseline differences between conditions. The SEQ has good internal consistency (Baranek et al., 2006) and excellent test-retest reliability (Little et al., 2011). Cronbach's alpha was 0.78 in this study.

4.2.3.3.4. Empathy Questionnaire (EmQue; Rieffe et al., 2010)

Empathy was assessed using the 20-item EmQue (e.g., 'when another child cries, my child gets upset too'). Parent responses are on a 3-point Likert scale (0 = never, 1 = sometimes, 2 = often). High empathy is associated with greater modelling of eating behaviour (Robinson et al., 2011), thus differences between conditions in empathetic traits were examined. The EmQue has adequate internal consistency, and good criterion and concurrent validity (Rieffe et al., 2010). Cronbach's alpha was 0.82 in this study.

4.2.3.3.5. Preschool Anxiety Scale (PAS; Spence et al., 2001)

Child anxiety was measured using the 28-item PAS (e.g., 'has trouble sleeping due to worrying'). Parent responses were on a 5-point Likert scale from 0 (not true at all) to 4 (very often true). Anxiety has been associated with selective eating behaviour in children, thus, differences in anxiety between conditions were assessed (Farrow & Coulthard, 2012). The PAS has adequate internal consistency (Broeren & Muris, 2008) and construct validity (Spence et al., 2001). Internal consistency was good in this sample ($\alpha = 0.88$).

4.2.3.3.6. Child Autism-Spectrum Quotient (AQ-10 Child; Allison et al., 2012)

Children's autistic traits were measured using the short version of the Autism-Spectrum Quotient (10-items, e.g., 's/he is good at social chit-chat'). Responses are scored as 1 and 0, indicating autistic traits or not, respectively. Scores above 6 are indicative of ASD. ASD is characterised by a deficit in facial processing (Webb et al., 2017) and is associated with selective eating behaviour (Bandini et al., 2010). Thus, differences between conditions in autistic traits were examined. The AQ-10 Child has good internal reliability, excellent predictive validity and correlates with the 50-item child AQ (Allison et al., 2012). Cronbach's alpha was 0.58 in this study.

4.3.3.4. Experimental Stimuli

Each of the three stimuli comprised 6 randomised video clips of unfamiliar adult models (*M* video clip length = 10.6 seconds; SD = 1.95). Overall, stimuli lasted approximately 1 min in length (positive = 62 seconds; neutral = 57 seconds; control = 60 seconds). Stimuli were intentionally short to avoid boredom effects. Each of the 6 video clips in the stimuli featured a model facing forward, eating one piece of raw broccoli, and displaying a positive FE (positive condition) or neutral FE (neutral condition). Each control video clip showed a model putting pens away into a pencil case whilst expressing a neutral FE (control condition). Videos had no sound, to remove its potential influence on eating behaviour. Models were adults (3 men, 3 women) aged 20-26-years-old, comprising White and Asian ethnicities (White British = 4; Asian British = 2). Each stimulus featured the same 6 models. For an example video clip of an adult model putting pens away with a neutral FE please see https://doi.org/10.17036/researchdata.aston.ac.uk.00000552 (Figure 4.1). See Chapter 2 for detail about the validation of the video clips used in positive and neutral stimuli.

To validate the non-food control stimulus, twenty-one adult participants (20 women; 1 man), with a mean age of 20.4 years (range = 18-28), rated how 8 models (4 men, 4 women) felt towards about putting pens away (positive, negative, or neutral) and whether the model liked putting pens away (like, dislike, neutral). For 6 models (3 men, 3 women), neutral was the modal response for how models felt about putting pens away, however, two models (1 man, 1 woman) had a modal response of negative, thus were not suitable for the control stimulus. As a result, these 2 models/videos were excluded from the control stimulus. To ensure consistency between the number of models shown in each stimulus, the excluded models were also removed from positive and neutral stimuli. FaceReader 7.0 software (Noldus, 2016) also confirmed that control videos conveyed the intended neutral valence (*M* = -0.27, SD = 0.14).

Figure 4.1. Example of an adult model putting pens away with a neutral FE

4.3.4. Procedure

Parents completed an online questionnaire about their own and their child's characteristics. Parents were then contacted via email to arrange an online video session. For the session, parents were asked to prepare a bowl of raw broccoli (roughly 30g, 5 florets) and to record the weight. Sessions took place between 10am – 7pm, on any day of the week suitable for participants, using the online platform Zoom. Screen share was used to show children the study materials. First, parents reported the time since their child had last eaten. Children gave verbal consent and rated their hunger using the Teddy Picture Rating Scale (from 1 'very hungry' to 5 'not hungry at all/ very full'; Bennett & Blissett, 2014). Children then watched the randomly assigned video (positive, neutral or control) and after, were asked to report how they thought the models felt about eating broccoli or putting pens away, using a 3-point smiley face scale (positive, neutral, or negative), to check that they were engaged during the video. Next, children were told they would be given a snack to try if they would like to and that the researcher would turn off their camera and microphone whilst they were given the snack. When ready to move on from the snack, children were told to put their thumb up, and then the researcher would return. Parents then gave their child the raw broccoli snack, which was consumed ad libitum. Parents were told not to pressure or encourage their child to eat the snack. Children's interaction with the broccoli was video recorded through Zoom. Parents reweighed the broccoli and told the researcher the pre- and post- broccoli weights (parents were asked to covertly weigh the broccoli each time, to avoid influencing their child's eating behaviour). Finally, parents and children could ask questions and were debriefed and thanked for their participation. Children received a certificate and parents received a £5 online shopping voucher after participating. Sessions lasted approximately 10 minutes.

4.3.5. Video analysis

Recorded videos of the children consuming broccoli were used to analyse willingness to try broccoli and the frequency of tastes. Also, to adjust for potential differences in parental behaviour between conditions, the frequency of parental prompts to eat were recorded, which were defined as any direction from the parent towards the child trying the food (e.g., encouragement: "do you want to try it?", or pressure to eat: "eat this now"). All videos were coded in full by a single observer (KLE), from the time of presentation of the broccoli to the time the child indicated they were ready to move on (*M* duration = 97.8s, SD = 94.5, range = 8.0 – 434.0s). A proportion (10%) of the videos were coded by a second coder (JB). Intra-class correlation coefficients indicated excellent inter-rater reliability: parental prompts = 0.92; greatest engagement = 0.97; frequency of tastes = 0.99.

4.3.6. Statistical analysis

SPSS Version 26 was used for statistical analyses. Differences between conditions on child sex (Chi-square tests), demographic measures and habitual F&V intake (one-way ANOVA) were assessed. Child hunger was correlated with outcome measures as a potential covariate (Pearson's correlations). One-way ANOVA examined differences between conditions in CEBQ subscales, food neophobia, sensory processing, empathy, anxiety, and autistic traits. CEBQ subscales and food neophobia scores were correlated with outcome measures as potential covariates (Pearson's correlations). The frequency of parental prompts was examined for differences between conditions (one-way ANOVA). One-way ANOVA/ANCOVA explored the main effect of condition on broccoli acceptance and intake and Bonferroni corrected t-tests followed up significant main effects of condition.

4.4. Results

4.4.1. Sample characteristics

In total, 117 parents and children participated. Participants were excluded due to inadequate experimental control (e.g., not following instructions or the presence of siblings eating broccoli; n = 5) and intake data not being provided (n = 1). Hence, the final sample included 111 participants. Parents (109 women, 2 men) had a mean age of 37.1 years (range = 28-50). Parental ethnic background was 93.7% White, 2.7% Indian and 3.6% mixed ethnicities. Parental highest educational level achieved: 44.1% postgraduate qualification, 40.5% undergraduate degree, 12.6% A level (or equivalent), 1.8% GCSE (or equivalent), and 0.9% ‘other’. Children (64 males, 47 females) had a mean age of 5.5 years (65.6 months; range = 49 – 83 months) and a mean BMI z-score of 0.20 (range = -3.99 – 3.70). BMI z-scores could not be calculated for 5 children due to missing height and weight data from parents.

Sample characteristics were analysed; there were no significant differences between conditions in parent or child demographics, habitual F&V intake, hunger rating or the number of minutes since the child had last eaten (all *p*s > .05; Table 4.2). Child sex did not differ significantly between conditions ($X^2(2, N = 111) = 1.01$, $p = .58$). There was no significant effect of child sex on broccoli intake ($t(107) = 0.70$, $p = .48$), willingness to try ($t(102) = 0.53$, $p = .60$), or frequency of tastes ($t(94) = -1.14$, $p = .26$). Child hunger did not correlate with broccoli intake ($r(109) = -0.10$, $p = 0.30$), willingness to try ($r(104) = -0.05$, $p = 0.61$), or frequency of tastes ($r(96) = -0.04$, $p = 0.72$). Parental prompts were not significantly associated with broccoli intake ($r(102) = -0.02$, $p = 0.86$). There were no significant differences between conditions on questionnaires measuring child individual differences (all *p*s > .05; Table 4.3). Finally, correlations revealed that the CEBQ subscales and food neophobia scores were not significantly associated with dependent variables, except for a significant negative relationship between parental ratings of child food fussiness and broccoli intake ($r = -0.21$, $p < 0.05$; Table 4.4).

Table 4.2: Mean (SD) sample characteristics for participants in each condition (one-way ANOVA)

		Positive (n = 39)	Neutral (n = 38)	No-Food (n = 34)	*F*	*p*
Parent	Age (years)	37.55 (4.04)	36.92 (4.19)	36.74 (3.99)	0.41	0.67
	Vegetable intake	2.88 (1.34)	3.16 (1.15)	2.54 (1.14)	2.28	0.11
	Fruit intake	2.15 (1.05)	1.92 (1.11)	1.91 (1.22)	0.57	0.57
Child	Males (%)	64.10	52.60	55.90	-	-
	Age (months)	67.97 (9.42)	63.61 (10.70)	64.97 (10.32)	1.87	0.16
	BMI (z-score)	0.21 (1.41)	0.12 (1.57)	0.29 (1.35)	0.12	0.89
	Vegetable intake	2.59 (1.17)	2.36 (1.16)	2.37 (1.15)	0.49	0.61
	Fruit intake	2.83 (1.05)	2.41 (0.92)	2.47 (0.87)	2.21	0.12
	Hunger rating	2.82 (1.28)	2.79 (1.40)	3.03 (1.24)	0.35	0.70
	Minutes since child last ate	100.64 (71.07)	82.95 (84.31)	87.06 (77.89)	0.55	0.58

Table 4.3: Mean (SD) individual differences for child participants in each condition (one-way ANOVA)

	Positive (n = 39)	Neutral (n = 38)	No-Food (n = 34)	*F*	*p*
CEBQ Enjoyment of Food	3.91 (0.67)	3.89 (0.59)	3.88 (0.73)	0.02	0.98
CEBQ Satiety Responsiveness	2.82 (0.64)	2.75 (0.68)	2.86 (0.56)	0.29	0.75
CEBQ Food Fussiness	2.80 (0.69)	3.03 (0.60)	2.78 (0.74)	1.52	0.22
CEBQ Food Responsiveness	3.12 (0.83)	2.89 (0.60)	2.99 (0.80)	0.90	0.41
CFNS	22.33 (9.14)	24.82 (8.19)	22.76 (9.82)	0.82	0.45
SEQ	0.56 (0.31)	0.63 (0.40)	0.64 (0.37)	0.60	0.55
AQ-10	2.15 (1.98)	2.32 (1.73)	1.62 (1.16)	1.68	0.19
PAS	16.10 (14.00)	20.74 (13.21)	18.79 (8.84)	1.34	0.26
EmQue	17.21 (5.28)	18.82 (5.01)	19.38 (5.38)	1.74	0.18

Note. Children's Eating Behaviour Questionnaire (CEBQ); Child Food Neophobia Scale (CFNS).; Autism-Spectrum Quotient (AQ-10); Empathy Questionnaire (EmQue); Preschool Anxiety Scale (PAS); Sensory Experiences Questionnaire (SEQ).

Table 4.4: Pearson Correlation coefficients for broccoli intake, willingness to try, frequency of tastes and CEBQ subscales

	1	2	3	4	5	6	7
1. Broccoli intake	-						
2. Willingness to try	.49**						
3. Frequency of tastes	.62**	.45**					
4. Enjoyment of Food	.17	.16	.07				
5. Satiety Responsiveness	-.12	-.18	-.05	-.68**			
6. Food Fussiness	-.21*	-.18	-.12	-.66**	.45**		
7. Food Responsiveness	.07	.01	-.002	.52**	-.46**	-.29**	
8. Food Neophobia	-.18	0.14	-.12	-.62**	.43**	.86**	-.31**

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

4.4.2. Experimental session

Few parents prompted their child to eat (positive n = 10; neutral n = 10; control n = 8). Parents who prompted their child did so no more than 4 times in each condition, and number of parental prompts did not differ between conditions ($F(2, 103) = 0.22$, $p = .80$). Most children (67.6%) correctly identified how the models felt (positive = 87.2%; neutral = 55.3%; control = 58.8%). Excluding children who did not accurately identify how the models felt, did not change the overall pattern of results below.

4.4.3. Acceptance of raw broccoli

5 participants were excluded from video analysis due to recordings being inadequate for measuring children's willingness to try raw broccoli (e.g., could not see child's interaction with the broccoli), thus the sub-sample for this analysis consisted of 106 children. Sixty-seven percent of children swallowed at least one bite of the raw broccoli. One-way ANOVA showed there was no significant main effect of condition on the willingness to try broccoli ($F(2, 103) = 1.78$, $p = .18$, $\eta_p^2 = .03$; Figure 4.2).

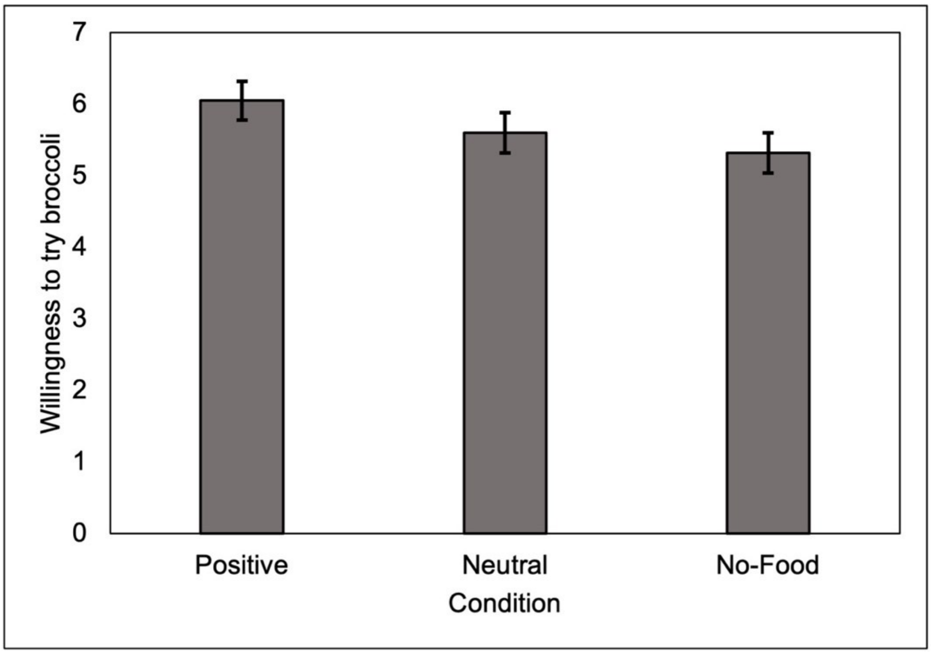

Figure 4.2: Mean willingness to try raw broccoli split by condition (standard error).

Thirteen participants were excluded from video analysis due to inadequate recording for measuring children's frequency of tastes (e.g., could not determine the number of oral exposures), thus the sub-sample for this analysis consisted of 98 children. For the frequency of tastes, one-way ANOVA revealed a significant main effect of condition ($F(2, 95) = 3.67$, $p = .03$, $\eta_p^2 = .07$; Figure 4.3), whereby frequency of tastes was significantly higher in the positive compared to the no-food condition ($p = .04$), but not the neutral condition ($p = .11$). Neutral and no-food conditions did not differ significantly ($p = 1.00$).[2]

[2] $p = 1.00$ due to Bonferroni correction

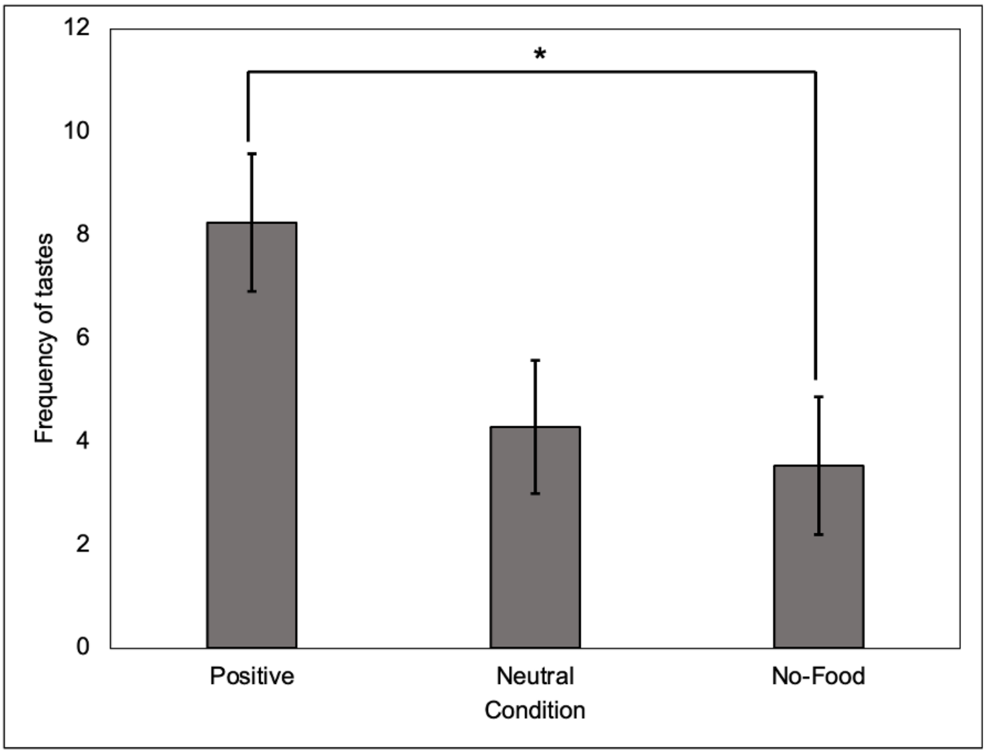

Figure 4.3: Mean frequency of tastes split by condition (standard error). *p < .05.

4.4.4. Broccoli intake

Raw broccoli was novel for 87.4% of participants. Few children had tried raw broccoli before (positive n = 4; neutral n = 4; control n = 6) and excluding these children did not change the overall pattern of results below. One-way ANCOVA controlling for food fussiness showed that there was a significant main effect of condition on broccoli intake ($F(2, 107) = 3.90$, $p = .02$, $\eta_p^2 = .07$; Figure 4.4). Bonferroni corrected t-tests showed that broccoli intake was significantly higher in the positive, compared to the no-food condition ($p = .03$), but not the neutral condition ($p = .10$). Neutral and no-food conditions did not differ significantly in their effects on broccoli intake ($p > 0.05$).

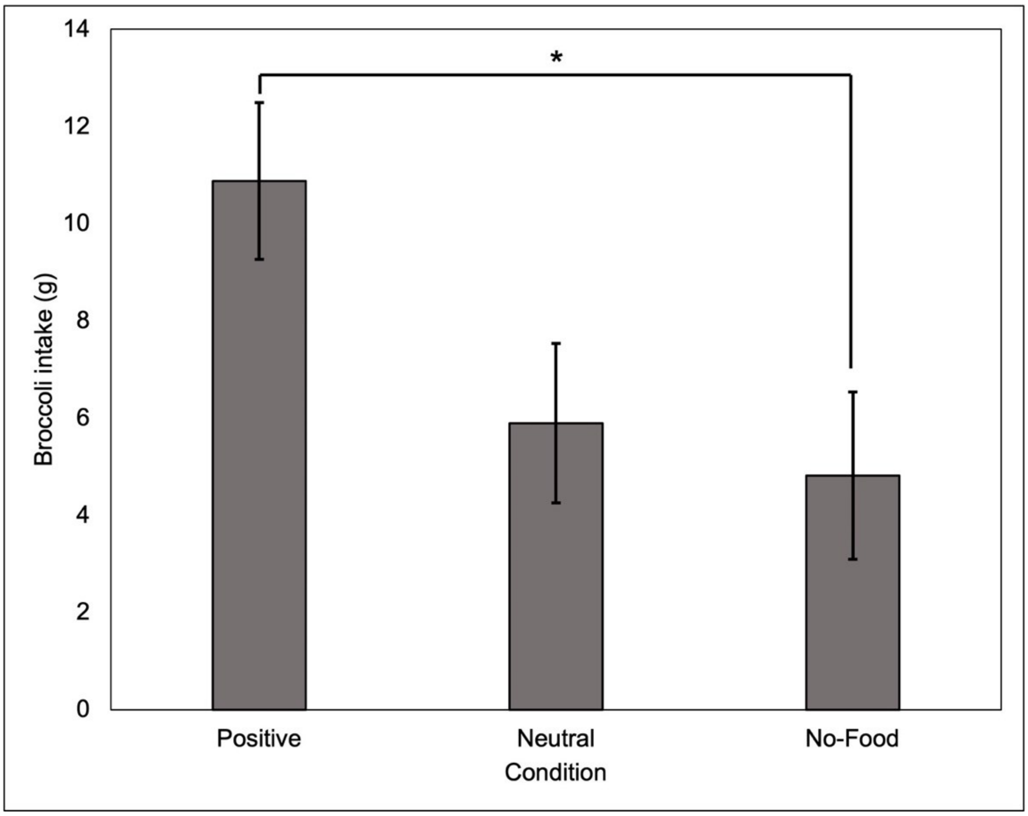

Figure 4.4: Estimated marginal means of amount (g) of broccoli consumed split by condition (standard error). *p < .05.

4.5. Discussion

This study aimed to test the effect of models' FEs whilst eating raw broccoli on children's acceptance and intake of raw broccoli. The findings indicate that 4-6-year-old children who were exposed to unfamiliar adult models expressing positive FEs whilst eating broccoli had significantly more tastes and intake of raw broccoli than children who were exposed to a no-food control video. However, contrary to the hypotheses, models' FEs whilst eating broccoli did not significantly influence initial willingness to try broccoli.

Children who were exposed to adults showing enjoyment whilst eating broccoli consumed on average more than double the amount of broccoli in the positive condition (11g), than children in the control condition (5g). This finding is consistent with research which showed that exposure to pleasure FEs from adult models increased children's desire to eat disliked foods (Barthomeuf et al., 2012) and builds on this by demonstrating that observing positive FEs whilst eating food can increase children's actual intake of a typically less preferred nutritious food.

One explanation for the beneficial effect of positive FEs whilst eating could be that conveying food enjoyment gives the observer information about the safety and palatability of food. This is particularly important when food is novel for children, to protect from ingestion of harmful foods (Dovey et al., 2008). Raw broccoli was novel for most participants, thus children may have eaten more broccoli after watching adults enjoy eating it, because they believed it was enjoyable to eat. However, it is unlikely that eating behaviour was influenced by the perceived safety of food, as most children were willing to try raw broccoli regardless of condition and they were in a safe environment at home. Thus, information about food tastiness rather than safety may be more influential for children in this age range and context.

Unlike intake and frequency of tastes, children's willingness to try broccoli was not significantly influenced by models' FEs. One explanation could be a lack of sensitivity in the measure; most children tried and swallowed the broccoli, irrespective of condition, meaning they scored highly on the scale, even if they consumed little. However, the frequency of tastes was influenced by models' FEs; children showed greater frequency of tastes of broccoli after exposure to models enjoying broccoli, a behaviour which is clearly linked with greater broccoli intake. Thus, positive FEs appear useful for increasing children's tastes and intake of broccoli and given that positive modelling can reduce food neophobia in children (Greenhalgh et al., 2009; Hendy & Raudenbush, 2000), which is associated with lower intake and variety of vegetables (Cooke et al., 2003; Perry et al., 2015), positive modelling may be a useful intervention tool to increase vegetable acceptance. However, since most children tried the broccoli, examining the moderating effect of food neophobia in future work, in a sample which includes more reticent eaters, may help to determine whether positive FEs increase vegetable acceptance and intake for children who are less willing to try vegetables.

There was no difference in children's broccoli intake or the frequency of tastes between positive and neutral conditions. It is possible that children modelled the adults' eating behaviour simply because they observed the models eating the food, as found previously (Addessi et al., 2005; Harper & Sanders, 1975). However, because there was no significant difference between neutral and control conditions, the presence of positive FEs whilst eating food was more important for influencing children's eating behaviour than mere presence of the model eating. Recruiting a larger sample to increase power would help to elucidate this point. Nonetheless, these findings demonstrate the importance of observing others having a positive eating experience on children's eating and highlight the need to include appropriate control conditions to establish the effectiveness of positive FEs for increasing vegetable intake.

This study was conducted remotely using an online platform (Zoom), due to restrictions during the COVID-19 pandemic. This approach was shown to be a viable methodology for examining children's eating and had several advantages. Firstly, it enabled recruitment of families from across the UK, instead of limiting recruitment to local families with time and capacity to travel. Secondly, remote testing reduced the time burden for researcher and participants: there was no travel time and testing could occur outside of the working day. Thirdly, children engaged well in the online study, possibly due to familiarity with using online platforms since the COVID-19 pandemic, and being relaxed in their own home, providing greater ecological validity of eating environment. Fourth, parents and children followed instructions well, and recording eating episodes using Zoom produced good quality video recordings. A further strength of the study was improvement on the use of static images (Barthomeuf et al., 2009, 2012) by using video stimuli, which allowed children to observe dynamic FEs whilst eating. Indeed, exposure to videos of positive peer modelling have been found to increase preschool children's intake of a modelled vegetable (Staiano et al., 2016), thus, video stimuli are an effective method for exposing children to individuals FEs whilst consuming food.

However, the remote method used in this study had some limitations, such as excluding data from sessions where siblings ate broccoli alongside the participant, because siblings can influence children's eating (Salvy et al., 2008). Another limitation was the presence of, and comments from the parents. However, the number of parental prompts did not differ between conditions, so were unlikely to have affected the results. Limitations were also that most parents were white mothers with a university education, thus did not represent families where F&V is often low. Since parent and child habitual F&V intake was reasonably high, children may have been more likely to try raw broccoli due to familiarity with vegetables (e.g., cooked broccoli) and bitter tastes. Therefore, this study may underestimate the effect of positive FEs on vegetable intake by children who are less familiar with vegetables. Overall, this suggests that more work is needed to establish whether the present findings apply to individuals who need these interventions the most.

This study is the first to demonstrate that exposing 4-6-year-old children to video stimuli of unfamiliar adults expressing positive FEs whilst eating raw broccoli, more than doubles children's intake of raw broccoli. Given this, exposure to adults enjoying food may be a useful strategy for encouraging healthier eating behaviour in children. The emphasis on food pleasure from others can help children to learn pleasure from nutritious foods (Marty et al., 2018), which is an important focus for public health campaigns (Haines et al., 2019). These initial findings could be the basis of a simple intervention encouraging parents to show food enjoyment using FEs, during family eating occasions. However, more work is needed to establish whether these effects are sustained over time, whether a single exposure to positive modelling is adequate, and whether the effect would be similar for familiar but disliked foods.

Chapter 5: The moderating effect of food neophobia on the relationship between models' facial expressions whilst eating a vegetable on children's vegetable tastes and intake

In Chapter 4, we showed that children had more tastes and consumed more than double the amount of raw broccoli after observing adults eating raw broccoli with positive FEs. Children differ in their willingness to try new foods, thus, feeding practices that are successful for many children may not be effective for those who are less willing to try novel food. Hence, this chapter presents a secondary analysis of the data from Chapter 4, which aimed to examine the moderating effect of food neophobia on the effect between viewing adults' eating raw broccoli with positive FEs and children's consumption of raw broccoli. Moderation analyses show that food neophobia moderated the effect of models' positive FEs (compared to control), on children's tastes and intake of raw broccoli, whereby children who scored low and medium in food neophobia had more tastes and greater intake of raw broccoli after exposure to models' eating raw broccoli with positive FEs, compared to children in the control condition. There was no effect of models' positive FEs on broccoli tastes or intake for children who scored high in food neophobia. Food neophobia did not moderate the effect of models' neutral FEs, compared to positive FEs or the control condition, on children's tastes and intake of raw broccoli. Therefore, exposing children to adults enjoying vegetables is a useful strategy to encourage vegetable consumption by most children, but not by children who are high in food neophobia.

5.1. Introduction

There are various characteristics that are associated with differences in children's processing of others' FEs and eating behaviour, such as sensory processing, anxiety, and autistic traits. Whilst investigation of all these characteristics as potential moderators is beyond the scope of this thesis, one candidate characteristic is food neophobia. Food neophobia peaks during development between 2 and 6 years old (Dovey et al., 2008). Though rejecting unfamiliar food is an evolutionary adaptive trait that protects from ingestion of harmful food (Dovey et al., 2008), it can be detrimental to children's diet quality since it interferes with the acceptance of vegetables (Cooke et al., 2003; Perry et al., 2015). Thus, it is essential to identify effective methods to increase children's willingness to try new foods during this developmental period, particularly for those who are more reticent eaters.

One way in which children learn to accept new food is through social modelling. As suggested by social learning theory, children observe and model the eating behaviour of others (Bandura, 1977). Indeed, research has demonstrated that children consumed more of a novel food after watching an adult model eat the food (Addessi et al. 2005; Harper & Sanders, 1975). Furthermore, children are more likely to model a behaviour after observing positive consequences, such as seeing that a food is enjoyable to eat (Bandura, 1977). Exposure to models who verbally convey their enjoyment of food (e.g., "mmm this is yummy") has been found to increase children's acceptance of novel food (Greenhalgh et al., 2009; Hendy, 2002; Hendy & Raudenbush, 2000). For example, children were found to be more accepting of novel fruit after exposure to positive comments about the fruit made by teachers (Hendy & Raudenbush, 2000) and female peers (Hendy, 2002). Furthermore, children consumed more novel food after a peer made positive comments about the food (Greenhalgh et al., 2009). These findings demonstrate that exposing children to positive statements about a models' food enjoyment is more effective for promoting children's willingness to eat novel food, compared to modelling alone.

Another way in which an eater can convey their enjoyment of food is through FEs. Research has demonstrated that exposing children to static images of adults expressing a pleasure FE whilst looking at food, increased children's desire to eat foods rated as disliked (Barthomeuf et al., 2009). Watching adults enjoy eating foods which are commonly less preferred, such as vegetables, is a promising way of encouraging children's vegetable acceptance (Edwards et al., 2022). In Chapter 4, we exposed 4-6-year-old children to adult models consuming raw broccoli whilst expressing a positive FE. Children had more tastes and greater intake of raw broccoli after observing models with positive FEs whilst eating raw broccoli, compared to children in the control condition, in fact, doubling their intake. Whilst this shows that exposing children to adults showing their enjoyment of a commonly disliked vegetable encourages children's tastes and intake of the vegetable, it is not known whether this strategy would be effective for children scoring high on measures of food neophobia (i.e., those most unlikely to taste and consume raw broccoli). Previous research has indicated that the effectiveness of feeding practices such as modelling and prompting to eat on children's willingness to eat new foods varies as a function of children's eating traits such as food responsiveness (Blissett et al., 2016), suggesting that feeding practices that are successful for many children may not be effective for those who are more challenging to feed.

In summary, children differ in their willingness to try new foods, and food neophobia relates to fears about the safety and palatability of food (Dovey et al., 2008). Therefore, it is possible that modelling could be less helpful for children with high food neophobia, perhaps because they are more resistant to information that confirms the safety of food (e.g., observing someone eating a bitter vegetable, free from any negative consequence), or because they might have already learned not to trust information from others about the tastiness of food (e.g., observing a parent pretend that a food is very palatable and enjoyable, when it is not). Thus, it is important to examine the moderating effect of children's food neophobia to determine whether modelling is a useful strategy for more reticent eaters for who vegetable acceptance is typically low.

The data for this paper comes from our original experimental study examining effects of positive FEs on the frequency of children's tastes and intake of broccoli (Chapter 4). The present study is a secondary analysis of these data, which aimed to examine the moderating role of food neophobia on the effect between models' positive FEs whilst eating raw broccoli on children's tastes and intake of raw broccoli. It was hypothesised that exposure to models expressing positive FEs whilst eating raw broccoli would lead to greater broccoli intake by children scoring low and medium, but not high, in food neophobia.

5.2. Method

5.2.1. Participants

One-hundred and seventeen children (4-6-years) and their parents were recruited from the UK using social media and online advertisements. See Chapter 4 for details about eligibility criteria and ethical approval. Parents provided informed consent for their own and their child's participation.

5.2.2. Design

A between-subjects design was used. Children were randomly allocated to one of three conditions (positive, neutral or control) where they were shown one of three stimuli (videos) of unfamiliar adult models consuming broccoli whilst expressing a positive FE (positive condition); consuming broccoli whilst expressing a neutral FE (neutral condition); or putting pens away into a pencil case whilst expressing a neutral FE (control condition). For more details of the stimuli used, please see Chapter 4.

5.2.3. Measures

5.2.3.1. Parental Questionnaire

Parents completed an online questionnaire about their own and their child's characteristics, administered through Qualtrics (an online survey platform). Parent and child demographic information (Blissett et al., 2019), and habitual F&V consumption was gathered to examine differences between conditions (Thomas et al., 2016). Additionally, parents completed several questionnaires about their child's characteristics: typical eating behaviour (CEBQ), autistic traits (AQ-10 Child), anxiety (PAS), empathy (EmQue), and sensory processing (SEQ). Children did not differ in these traits between conditions and so these characteristics are not discussed further (see Chapter 4, sections 4.3.3.2 and 4.3.3.3. for details). Food neophobia was measured using the CFNS and was assessed as a moderator variable.

5.2.4. Procedure

Following completion of the parental questionnaire, an online video session was arranged with the researcher. Sessions took place on the online platform Zoom, between 10am and 7pm, on any day of the week. Children provided verbal consent to participate. Parents were asked how long it had been since their child had last eaten, and children rated how hungry they felt from 1 'very hungry' to 5 'very full' using the Teddy Picture Rating Scale (Bennett & Blissett, 2014). Next, children watched the randomly assigned video (positive, neutral, or control) and reported whether they thought the models felt positive, neutral, or negative, about eating broccoli (positive and neutral condition), or putting their pens away (control condition). Following this, parents gave children a pre-prepared snack of raw broccoli (roughly 30g, 5 florets). Parents were asked not to pressure or encourage their child to eat the snack. Children consumed the snack ad libitum, whilst being videorecorded through Zoom. Once the child informed the researcher that they were ready to move on, parents removed the snack to be covertly reweighed. Finally, parents and children had the opportunity to ask questions and were debriefed and thanked for their participation. A certificate and £5 shopping voucher were provided after participation.

5.2.5. Statistical analysis

Data were analysed using SPSS version 26. No significant differences between conditions were found for sample characteristics (all *p*s > .05). It makes theoretical sense for food fussiness scores to be associated with both food neophobia and broccoli intake, as demonstrated in section 4.4.1. Thus, driven by both theory and data, and for consistency with the analytic approach used in Chapter 4, food fussiness scores were entered as a covariate in analyses where broccoli intake was the outcome. See Chapter 4, section 4.4.1 for details of covariate checks.

The frequency of children's tastes of raw broccoli was assessed by counting the number of tastes children had of raw broccoli. A taste was defined as any occurrence of oral exposure to broccoli. Data for children's willingness to try broccoli was also examined but was not used as an outcome measure in this study, since most children tried raw broccoli, thus intake and frequency of tastes are more sensitive measures of children's eating. Data for raw broccoli intake was measured as the grams of raw broccoli consumed; parents reported the pre- and post- broccoli weights to the researcher.

Food neophobia was examined as a moderator of the effect between condition and broccoli tastes and intake (separately). Moderation analyses were conducted using PROCESS version 3.5 (Hayes, 2020). Where a significant moderation was detected, interactions were calculated by PROCESS for low (-1SD), medium (*M*), and high (+1SD) values of the moderator.

5.3. Results

5.3.1. Sample characteristics

One-hundred and seventeen parents and children participated. Six participants were excluded for inadequate experimental control (e.g., not following instructions; n = 5), or intake data not being recorded (n = 1). The final sample comprised 111 parents and children. Parents (109 women, 2 men) had a mean age of 37.1 years (range = 28-50). Children (64 males, 47 females) had a mean age of 5.5 years (65.6 months; range = 49 – 83 months) and a mean BMI z-score of 0.20 (range = -3.99 – 3.70). Most children had not tried raw broccoli before (87.4%); excluding children who had tried raw broccoli (positive n = 4; neutral n = 4; control n = 6) did not affect the overall pattern of results below, so these participants remained in analyses. Food neophobia scores did not differ significantly between conditions ($M = 23.32$, SD = 9.03; $F(2, 110) = 0.82$, $p = .45$) and were not significantly associated with broccoli tastes ($r(109) = -0.12$, $p = .26$) or broccoli intake ($r(109) = -0.18$, $p = .06$). Children's food neophobia was categorised as low (-1SD = 14.34; positive n = 8; neutral n = 5; control n = 7), medium (*M* = 23.40; positive n = 25; neutral n = 26; control n = 22), and high (+1SD = 32.46; positive n = 6; neutral n = 7; control n = 5). See Chapter 4, section 4.4.1. for more detail about sample characteristics.

5.3.2. Frequency of tastes

Children's food neophobia significantly moderated the effect of models' positive FEs on the frequency of raw broccoli tastes, compared to the control condition (b = -.42, t = -2.11, p = .04; Figure 5.1). Children who scored low and medium in food neophobia had significantly more tastes of raw broccoli after exposure to positive FEs, compared to those in the control condition (b = 8.14, t = 3.29, p < .01; b = 4.37, t = 2.36, p = .02, respectively). However, there was no significant difference between exposure to positive FEs and control for those high in food neophobia (p > 0.05). Finally, food neophobia did not moderate the effect of model's neutral FEs on the frequency of raw broccoli tastes, compared to the positive condition (b = -.08, t = -.38, p = .70) or the control condition (b = -.34, t = -1.61, p = .11).

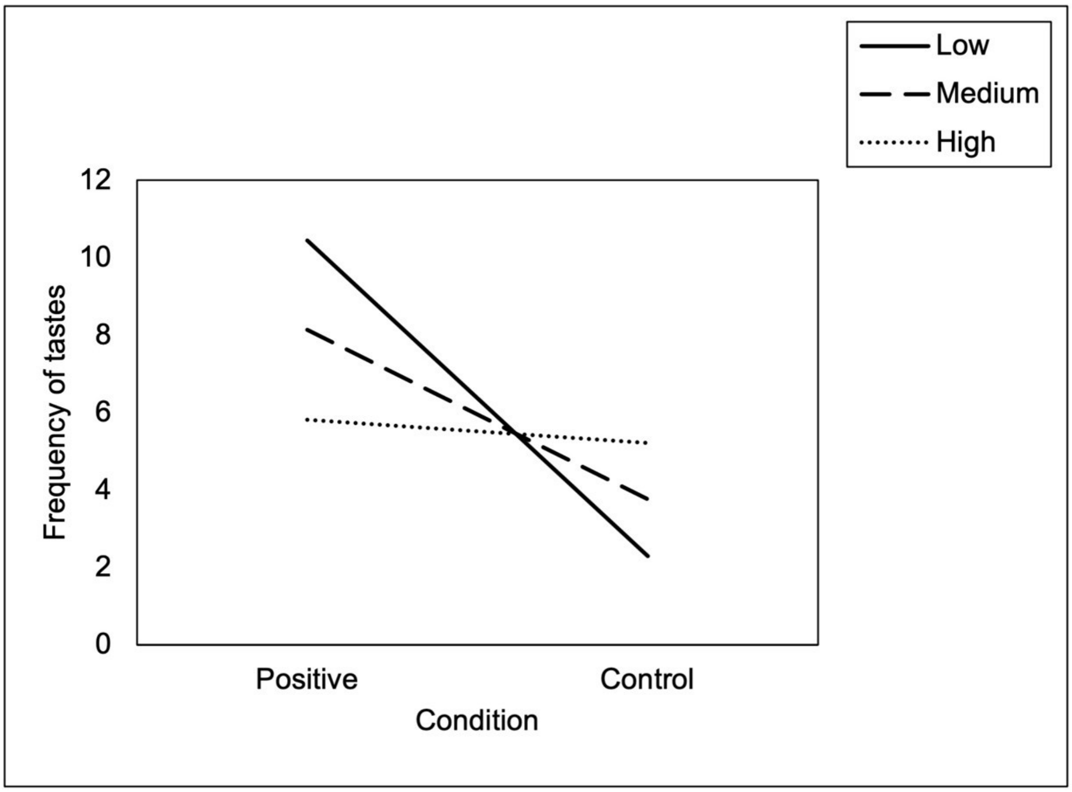

Figure 5.1. Simple slopes analysis of the effect of model's positive FEs, compared to control, on tastes of broccoli when children's food neophobia is low, medium, and high.

5.3.3. Broccoli intake

Parental ratings of food fussiness significantly correlated with broccoli intake (r = -0.21, p = .03), thus food fussiness was included as a covariate for the following moderation analyses. Children's food neophobia significantly moderated the effect of models' positive FEs on raw broccoli intake compared to the control condition (b = -.56, t = -2.27, p = .03; Figure 5.2). Children who scored low and medium in food neophobia ate significantly more broccoli after exposure to positive FEs, compared to those in the control condition (b = 10.75, t = 3.48, p < .001; b = 5.67, t = 2.32, p = .02, respectively). However, there was no significant effect of positive FEs (versus control) on broccoli intake for children who scored high in food neophobia (p > .05). Food neophobia moderated the effect of model's neutral FEs on raw broccoli intake, compared to the control condition (b = -.55, t = .26, p = .04), however, probing the significant interaction at low, medium, and high values of food neophobia revealed no significant effect on broccoli intake. Finally, food neophobia did not moderate the effect of model's positive FEs on raw broccoli intake, compared to the neutral condition (b = -.01, t = -.05, p = .96).

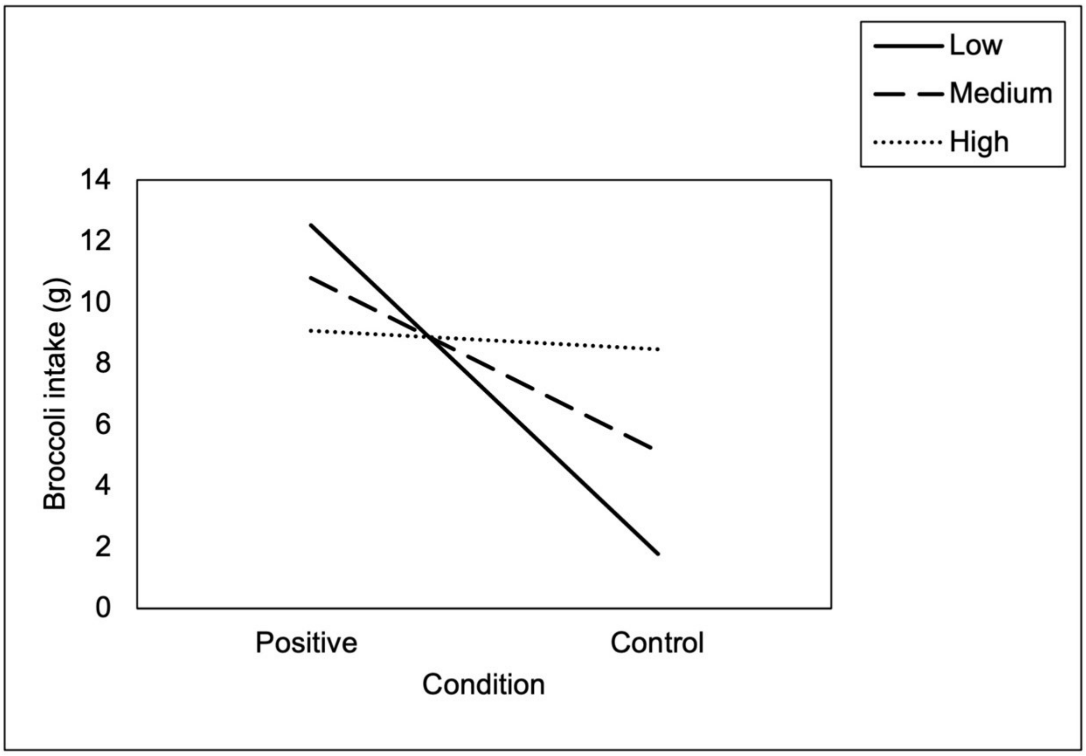

Figure 5.2. Simple slopes analysis of the effect of model's positive FEs, compared to control, on intake of broccoli when children's food neophobia is low, medium, and high.

5.4. Discussion

This study aimed to investigate whether food neophobia moderated the effect of models' positive FEs whilst eating raw broccoli, on children's tastes and intake of raw broccoli. The findings demonstrate that exposure to unfamiliar adults expressing positive FEs whilst eating broccoli resulted in more tastes and a greater intake of raw broccoli, compared to children in the control condition, but only for children who scored low and medium in food neophobia. Exposure to positive FEs had no effect on children's eating of broccoli for children with high food neophobia. Furthermore, food neophobia did not moderate the effect of models' positive FEs on intake when compared to neutral FEs.

Children who scored low in food neophobia had more tastes of raw broccoli, and consumed, on average, more than six times the amount of raw broccoli in the positive condition (12.5g), compared to children with low food neophobia in the control condition (2g). Furthermore, in the positive condition, children who scored medium in food neophobia had more tastes of raw broccoli and ate more than double the amount of raw broccoli on average (11g), than children in the control condition (5g). This is consistent with previous research which showed that modelling increases children's intake of novel food (Addessi et al., 2005; Greenhalgh et al., 2009; Hendy, 2002; Hendy & Raudenbush, 2000), and builds on this by showing that information about the tastiness of food (through positive FEs) can increase some children's intake of a bitter vegetable. Providing children with information about the tastiness of food helps to reduce concerns about food palatability, which are related to developmental peak in food neophobia (Dovey et al., 2008). This further highlights the importance of children learning pleasure from nutritious food by having positive eating experiences with others (Kremer-Sadlik & Morgenstern, 2022; Marty et al., 2018). Therefore, conveying the palatability of food through positive FEs is a useful method to encourage vegetable consumption by young children who are not highly neophobic.

Whilst positive modelling was effective for most children in this study, findings showed that exposure to model's positive FEs did not influence the eating of broccoli for children who were rated as high in food neophobia, suggesting that positive modelling is not an effective strategy for more reticent eaters. Previous studies which have examined the power of modelling on novel food acceptance have failed to examine the role of food neophobia in this relationship (Addessi et al., 2005; Greenhalgh et al., 2009; Hendy, 2002; Hendy & Raudenbush, 2000), and these important findings raise the important point that we may need difference tailored intervention strategies for those children who have high levels of food neophobia. Surprisingly, children who were rated as high in food neophobia still consumed broccoli, however, positive modelling was not responsible for encouraging their consumption. One explanation of why children with high food neophobia are not influenced by positive modelling could be that they have already learned not to trust information about the tastiness of food from adults. Research has shown that children aged 4 years are less likely to trust a source about food if they were previously found to be inaccurate, compared to a source without a history of inaccuracy (Nguyen et al., 2016). It is also surprising that broccoli consumption in the control condition was greater for children with high food neophobia, than children with low food neophobia. Therefore, another explanation for these findings could relate to limitations of parent-reported food neophobia. Indeed, parents might have reported their children to be less willing to try foods than they are, thus explaining why children with high food neophobia were willing to consume the broccoli. However, further research is needed to investigate whether parent-reported food neophobia is overestimated. To overcome limitations of parent report, future research could assess children's actual willingness to try novel food, by presenting them with a selection of new foods (Pliner, 1994). Moreover, there were few children in the control condition scoring high ($n = 5$) and low ($n = 7$) in food neophobia. The small number of children with high food neophobia in this study could be because parents of children with high food neophobia avoid taking part in research where their child is given raw broccoli to eat. Thus, these findings must be interpreted cautiously due to the small sample size. It is also possible that children with high food neophobia need repeated exposures to positive modelling to increase vegetable intake, rather than one exposure. Therefore, future research should investigate whether children with high food neophobia need more exposures to positive modelling to establish whether it is effective. Future research that focuses on children with high food neophobia is required, to determine which strategies are effective to promote vegetable acceptance in those children most reticent to try them.

Findings showed that food neophobia did not moderate the effect of model's neutral FEs, when compared with models eating broccoli with positive FEs (e.g., positive modelling versus simple modelling), or the control condition (e.g., simple modelling versus control). Previous analyses of these data in Chapter 4 showed no significant difference in children's eating of broccoli between positive and neutral conditions or between neutral and control conditions, suggesting that it is the combination of viewing positive FEs alongside consumption of the food which determines its effectiveness, in comparison to not viewing consumption or a positive FE at all. Simply observing others eating the food was not sufficient to encourage significant increases in children's broccoli consumption irrespective of the degree of their food neophobia.

One noteworthy strength of this study is the inclusion of food fussiness as a covariate in intake analyses. Thus, we can be more confident that the effects observed are due to food neophobia, specifically, rather than an overlap with more general fussy eating. However, there is an instrument-based overlap between items measuring children's food neophobia and food fussiness, meaning that including food fussiness as a covariate could be problematic. Since removing food fussiness as a covariate did not change the pattern or significance of results, it was retained in relevant analyses. Whilst we measured children's familiarity with raw broccoli, we did not record familiarity and liking of cooked broccoli. It is possible that some children were more inclined to try raw broccoli because they regularly eat and like cooked broccoli, but we do not know how this varied between conditions or by degree of neophobia. Additional strengths and limitations of the experimental study are discussed in Chapter 4, section 4.5.

In conclusion, this study presents novel findings which demonstrate the moderating effect of food neophobia on the effect of positive modelling and children's eating of vegetables. Together the findings of Chapters 4 and 5 suggest that exposing children to positive modelling could be an effective strategy to encourage children's consumption of vegetables, but is not helpful for children who are high in food neophobia. These initial findings demonstrate the importance of examining individual differences in food neophobia, and suggest that interventions to encourage healthy eating should be tailored towards the individual characteristics of the child.

Chapter 6: The effect of repeated exposures to models' positive facial expressions on children's vegetable acceptance and consumption

In Chapter 4, exposure to adults eating raw broccoli with positive FEs results in children tasting and eating more broccoli compared with children who were exposed to a non-food video. However, whether children need repeated, versus a single, exposure to positive FEs to increase vegetable consumption, and whether this generalises to a non-modelled vegetable, remains to be examined. Hence, the study presented within this chapter aimed to examine the effect of a single exposure of positive modelling versus repeated exposure to positive modelling on children's acceptance and intake of a modelled and non-modelled vegetable, after one week. Children aged 5-6 years (*N* = 153; 81 males, 72 females) were randomised to receive a single or repeated exposure to a video of adults eating raw broccoli with positive FEs, or a no-food control video. Children's acceptance, intake, and liking of a modelled (raw broccoli) and non-modelled vegetable (raw mangetout) was measured. Data about parent and child characteristics was gathered. Findings showed that children had greater raw broccoli consumption at the second session, following repeated exposure to positive FEs, compared to when they had received a single exposure to positive FEs. However, there was no effect on children's broccoli acceptance, and no generalised effect of positive FEs on consumption of the non-modelled vegetable. Whilst there was a main effect of food neophobia on children's vegetable intake, food neophobia did not moderate the effect of models' FEs whilst eating a raw vegetable on children's vegetable consumption. Therefore, children require repeated exposure to adults enjoying a raw vegetable to encourage longer-term vegetable consumption.

6.1. Introduction

Observing positive consequences of a behaviour encourages children to model that behaviour (Bandura, 1977). For example, children have greater desire to eat disliked food after exposure to adults' looking at food with positive FEs (Barthomeuf et al., 2012). Moreover, exposing children to adults eating vegetables with positive FEs has been found to increase children's eating of the modelled vegetable (see Chapter 4). Therefore, watching adults enjoying less preferred foods (e.g., vegetables) has an immediate effect on increasing children's consumption of the modelled food.

Whilst Edwards and colleagues (2022; Chapter 4) established that a single exposure to adults enjoying a vegetable encouraged children's vegetable intake at that occasion, we do not know whether that single effect would last beyond the context of that eating episode, or whether repeated exposures to food enjoyment are needed. Determining whether parents need to smile each time they eat a vegetable, or whether demonstrating their enjoyment on one occasion is sufficient, is essential for understanding whether longer exposure enhances the effect of positive FEs on vegetable consumption. Interventions using repeated exposures to a positive modelling video, combined with reward, have been found to increase children's vegetable intake and liking (Horne et al., 2004; Horne et al., 2009; Lowe et al., 2004). However, since modelling alone was not examined, and the effect of repeated exposure was not compared to a single exposure of modelling, the frequency of positive FE exposures that are required to influence children's vegetable consumption remains to be investigated.

Separately, most research examines the effect of modelling on consumption of the modelled food. It is also important to consider whether the effect of modelling generalises to the acceptance and intake of similar, non-modelled vegetables. Based on classical conditioning principles, it is plausible that learning one food is safe or enjoyable to eat, will generalise to a similar food (e.g., other food of the same colour). For example, children may be more likely to consume another vegetable (e.g., mangetout) if they have watched someone enjoying a different, but similar, vegetable (e.g., broccoli – another green vegetable). However, it is also possible that vegetable consumption will not generalise in this context, since food of the same colour could also be poisonous, and children are particularly suspicious of novelty in plant form (Wertz & Wynn, 2014b). Thus, children might need to see others consuming each type of food, particularly when it is a plant, to promote consumption. Research has demonstrated mixed findings, with some studies showing that modelling vegetable intake increases the intake and liking of non-modelled vegetables (Farrow et al., 2019; Horne et al., 2011), and others showing that positive modelling does not influence liking, and can lead to lower intake of a non-modelled vegetable (Appleton et al., 2019). Hence, further investigation is essential to establish whether positive FEs are useful for encouraging vegetable acceptance and intake more broadly, or whether their effects are limited to the modelled vegetable.

This study aimed to examine the effect of a single exposure of positive modelling versus repeated exposure to positive modelling, on acceptance and intake of a modelled and non-modelled vegetable, after one week. Based on previous literature, it was hypothesised that children's acceptance (measured as both willingness to try and frequency of tastes), intake and liking of a modelled vegetable would be higher at the first and second session (one week later) when exposed to models consuming a modelled vegetable with positive FEs, compared to when exposed to a non-food control video. Repeated exposure to models consuming a modelled vegetable with positive FEs was hypothesised to strengthen this effect, such that those children exposed to positive FEs repeatedly would show greater acceptance, intake and liking of the modelled vegetable than children in either the single exposure condition or the control condition. Based on previous literature, it was also hypothesised that exposure to models consuming a modelled vegetable with positive FEs would generalise to a greater acceptance, intake and liking of a non-modelled vegetable, with acceptance and intake of the non-modelled vegetable being higher in both the single and repeated positive conditions, compared to control. Based on findings in Chapter 5, food neophobia was examined as an exploratory moderator on the effect of models' FEs whilst eating a raw vegetable on children's vegetable consumption.

6.2. Method

6.2.1. Participants

A power calculation (G*Power 3; Faul et al., 2007) for planned Bonferroni corrected t-tests to detect differences between conditions with d = 0.6 (based on research examining the effect of positive FEs on children's vegetable intake; Chapter 4), 80% power, and α = 0.02, revealed that a minimum of 150 children were required. In total, 161 5-6-year-olds and their parents were recruited in the UK via social media, online advertisements, and schools, between July 2021 and March 2022 (see Appendix A-4 for example poster). Children aged 5-6 years were examined because emotion recognition develops significantly between 3-4 years (Pons et al., 2004). Also, 5-6-year-olds have the capacity to understand and cooperate with online procedures (i.e., multiple sessions and repeated video exposures). Children were eligible to participate if they had not tried raw broccoli and raw mangetout before. Children with food allergies or medical conditions affecting eating behaviour were excluded. Children were not eligible to take part if a household member had an allergy to fruit or vegetables. Ethical approval was obtained from Aston University Research Ethics Committee (#1790;

Appendix B-4). Parents provided informed consent for their own and their child's participation, and children provided verbal assent (Appendix C-7 & C-8).

6.2.2. Design

A mixed design with 2 factors was used: condition (between-subjects factor; single positive exposure, repeated positive exposure, control) and time (within-subjects factor; session one versus session two). Using the randomise feature in Qualtrics when parents completed the questionnaire, children were randomly allocated to conditions. Children were exposed to a video of unfamiliar adult models consuming raw broccoli while conveying a positive FE (single and repeated positive conditions), or to a non-food control video of unfamiliar adult models putting pens away while conveying a neutral FE (control condition). Between sessions one and two, children in the repeated positive condition received 5 additional exposures to unfamiliar adult models consuming raw broccoli with positive FEs.

6.2.3. Measures

6.2.3.1. Children's vegetable acceptance, intake, and liking

Children's acceptance, intake and liking of raw broccoli and raw mangetout was measured after the manipulation during both sessions. Raw mangetout was selected as the non-modelled vegetable because of its similarity to raw broccoli in colour and energy density (mangetout = 38kcal and broccoli = 35kcal, per 100g). Broccoli and mangetout acceptance was measured as the willingness to try, and the frequency of tastes, for each vegetable. Willingness to try was assessed by measuring children's greatest observed engagement with each vegetable on a 7-point scale (Table 6.1; Blissett et al., 2012; Blissett et al., 2016). For example, if a child placed a vegetable in their mouth but did not swallow it, 'placed in mouth' (score = 5) was recorded as the greatest observed engagement for that vegetable. If the child verbally refused a vegetable but then went on to touch it, 'touched' (score = 3) was recorded as the greatest observed engagement. If a child did not interact with a vegetable (i.e., no refusal or engagement), this was recorded as missing data. Higher engagement scores indicated greater willingness to try the vegetable. The frequency of children's tastes of each vegetable (defined as any occurrence of oral exposure to the vegetable) was determined by counting the number of times broccoli was 'placed in mouth', 'swallowed but refused', and 'swallowed and accepted'. Intake of each vegetable was measured as the amount consumed (in grams); parents weighed each vegetable in grams pre- and post-intake and reported the weights to the researcher. Children's liking of each vegetable was measured using a 3-point thumbs up and down scale representing 'I like it', 'okay', and 'I don't like it' (van der Heijden et al., 2020).

Table 6.1. 7-point scale of children's willingness to try vegetables

Behaviour Category	Description of Behaviour	Example
(1) Physical refusal	Any occurrence of the child physically refusing the vegetable	Turning head away from offered vegetable
(2) Verbal refusal	Any occurrence of the child verbally refusing the vegetable	Child said "I don't want it"
(3) Touched	Any occurrence of the child physically touching the vegetable, but no further interaction with it	Picks up the vegetable but puts it back in the bowl
(4) Smelled	Any occurrence of the child smelling the vegetable, such as by picking it up and bringing it to the nose, but no further interaction with it	Smelling the vegetable after picking it up
(5) Placed in mouth	Any occurrence of the child placing the vegetable to or inside the mouth, but no further interaction or its consumption	Putting the vegetable into the mouth without biting it, holding it inside the mouth, but refusing to swallow
(6) Swallowed but refused	Any occurrence of the child chewing and swallowing some of the vegetable but refused further or expressed dislike	Biting off a piece of the vegetable, chewing and swallowing it, but refusing another bite
(7) Swallowed and accepted	Any occurrence of the child chewing and swallowing some of the vegetable without a negative reaction	Biting off a piece of the vegetable, chewing and swallowing it, and eating another piece

6.2.3.2. Demographics and Lifestyle Questionnaire

Parents provided demographic information; child sex and age, and parent gender, age, ethnicity, education level and number of children were assessed (Blissett et al., 2019; Appendix D-12). Parents reported their child's height and weight, to calculate BMI. BMI z scores (zBMI) were used in analyses to adjust for sex and age. Information about parent and children's food allergies, food intolerances, or medical conditions affecting eating behaviour were used to exclude participants. Parent and child habitual F&V intake was assessed, to check for differences between conditions (e.g., "how many servings of vegetables do you/ your child normally eat a day?" and "think back carefully, how many servings of vegetables did you/ your child eat yesterday?"; adapted from Thomas et al., 2016, Appendix D-13). Children's familiarity with broccoli and mangetout was assessed to check for differences between conditions. In the questionnaire, parents reported how often their child ate cooked broccoli and mangetout, and how much they liked each vegetable. In addition, at the second session, parents reported how many times their child had eaten broccoli and mangetout (cooked or uncooked) since the first session, to check for differences between conditions.

6.2.3.3. Questionnaires measuring child individual differences

Parents completed several questionnaires about their child's characteristics: typical eating behaviour (CEBQ); food neophobia (CFNS); and sensory processing (SEQ). Children differ in these traits, which have been associated with selective eating behaviours. These traits were examined to check participants did not differ in these measures between conditions. Measures demonstrated good internal consistency in this study: CEBQ α = 0.79 – 0.91; CFNS α = 0.94; SEQ α = 0.86. See Chapter 4 for more detail about these questionnaires.

6.2.3.4. Experimental Stimuli

In single and repeated positive conditions, children were exposed to a positive video which included unfamiliar adults consuming raw broccoli with positive FEs. In the control condition, children watched a video of unfamiliar adult models putting pens away with neutral FEs. See Chapter 4 for details about the positive and control videos used in this study.

A second positive video was also created for the repeated positive condition, to avoid children becoming habituated to, or bored of seeing the same video; positive videos were alternated each day. For the additional positive video, 6 different models (3 women, 3 men) were recruited. Models had a mean age of 23.9 years (range = 22-34 years) and a range of ethnicities: White British (n = 4); Indian (n = 1); and Mixed Black Caribbean and White Irish (n = 1). Each model was video recorded whilst consuming one piece of raw broccoli; models showed a single piece of broccoli to the camera before putting it into their mouth, chewing and swallowing it, whilst displaying a positive FE. Individual videos lasted for the time taken to consume one piece of broccoli (*M* = 12.17 seconds, SD = 3.60). Overall, the additional video lasted 74 seconds.

To validate the second set of positive videos, a pilot study was conducted and FaceReader 7.0 was used (Noldus, 2016). Twenty healthy volunteers (14 women; 6 men) with a mean age of 24.5 years (range 21-31) selected whether they thought the model felt positive, negative, or neutral whilst consuming the raw broccoli, and rated it on a 100mm VAS from 'negative' (0mm) to 'positive' (100mm). Participants also rated whether they thought each model liked eating the broccoli (liked, disliked, neutral), and which emotion best described how they felt about eating it (neutral, happy, surprised, sad, scared, angry, disgust or fear). Results showed the modal response for each video clip was that all models felt positive and happy towards eating broccoli and liked it. The mean intensity score for all videos was 72.14 (SD = 6.04). Furthermore, FaceReader 7.0 software confirmed that additional positive stimulus videos conveyed the intended positive valence (*M* = 0.53, SD =

0.08). Thus, all videos of models eating broccoli were deemed suitable for the additional positive stimulus.

6.2.4. Procedure

Parents completed an online questionnaire about their own and their child's characteristics. Parents were emailed to arrange 2 online video-based test sessions with their child, one-week apart, using the online platform Zoom. Sessions were on any day of the week between 10am-7pm. Session one followed the same procedure for all conditions. Parents were asked to prepare a bowl of raw broccoli and a bowl of raw mangetout (8 pieces of each vegetable, roughly 30g each) and record the weight of each bowl of vegetables. Children were shown study materials using the screen share feature. At session one, parents reported the time since their child had last eaten. Verbal consent was provided by the child, and they rated their hunger from 1 'very hungry' to 5 'not hungry at all/ very full' (Teddy Picture Rating Scale, Bennett & Blissett, 2014). Children then watched the randomly assigned video (positive or control) and reported how they thought the models felt about eating broccoli or putting pens away (3-point smiley face scale: positive, neutral, or negative), to check task engagement. Next, the researcher informed the child they would be given a snack to try if they wanted to and that the researcher would turn off their camera and microphone whilst they were given the snack. Parents gave their child the raw broccoli and raw mangetout snacks, to consume ad libitum. Parents were asked not to encourage or pressure their child to eat the snacks. Children's interactions with the vegetables were video recorded using Zoom. Children put their thumb up to the camera when ready to move on from the snack, and then the researcher returned. Parents then reweighed both vegetables and reported the pre- and post- weights of each vegetable to the researcher. The researcher asked parents to covertly weigh the vegetables to avoid influencing their child's eating behaviour.

In the single positive exposure and control conditions, the families were not required to carry out any further activity until the second session a week later. However, parents and children who were randomly allocated to the repeated positive condition were asked to complete an additional daily task on 5 separate days, between sessions one and two. The task involved children watching a positive video and answering a simple question about the video (e.g., "was anyone in the video wearing glasses?"). As a minor incentive, each day they watched these videos, children received a new letter, which after viewing all 5 videos, made a word ('panda'), that they could relay to the researcher at the end of the study. Parents received an extra £5 shopping voucher for completing the additional task.

For all conditions, the second session followed the same procedure as session one, but without watching the video. At session two, parents also reported their children's intake of broccoli and mangetout (cooked or uncooked) since session one. Finally, parents and children had the opportunity to ask questions and were debriefed and thanked for their participation. Children received a certificate and parents received a £15 online shopping voucher for taking part. Each session lasted approximately 10 minutes.

6.2.5 Video analysis

Recorded videos of the children consuming the vegetables were used to analyse willingness to try, and the frequency of tastes of broccoli and mangetout. To adjust for potential differences in parental behaviour between conditions, the frequency of parental prompts to eat were recorded, which were defined as any direction from the parent towards the child trying the food (e.g., encouragement: “do you want to try it?”; or pressure to eat: “eat this now”). Videos from the first session were coded by KLE, and videos from the second session were coded by a second coder (ZA). Videos were coded from the time the vegetables were presented, to the time the child indicated they were ready to move on (*M* duration = 150 seconds, SD = 150, range = 8-1170 seconds). Additionally, ZA coded a proportion (10%) of the first session videos, and KLE coded a proportion (10%) of the second session videos to determine coder reliability. Intra-class correlation coefficients indicated excellent inter-rater reliability: willingness to try broccoli = 0.986 and mangetout = 0.996; frequency of tastes of broccoli = 0.990 and mangetout = 0.998. Discrepancy was discussed for parental prompts until agreement was reached. Intra-class correlation coefficients for parental prompts indicated good inter-rater reliability (0.786).

6.2.6. Statistical analysis

6.2.6.1. Covariate analyses

SPSS Version 26 was used for statistical analyses. Differences between conditions for child sex (Chi-square), demographics measures and habitual F&V intake (one-way ANOVA) were assessed. Differences between conditions for children’s habitual intake of cooked broccoli and mangetout were examined (Chi-square). Children’s hunger rating and the time since they last consumed food before each session were examined for differences between conditions (one-way ANOVA/ Chi-square). One-way ANOVA examined differences between conditions in children’s typical eating behaviour (CEBQ subscales), food neophobia and sensory processing. One-way ANOVA assessed differences between conditions for the frequency of parental prompts and the frequency of broccoli and mangetout intake between the two sessions. Measures that differed significantly between conditions were included as covariates in main analyses.

6.2.6.2. Main analyses

Mixed ANOVA examined vegetable acceptance, intake and liking with condition (single positive, repeated positive, and control) and time (session one and session two). Bonferroni corrected t-tests followed up significant main effects of condition and independent t-tests followed up significant interactions.

6.2.6.3. Exploratory moderation analysis

Food neophobia was examined as a moderator of the interaction between time and condition on children's intake of broccoli and mangetout (separately). Moderation analyses were conducted using 3x3x2 ANOVA. Bonferroni corrected t-tests followed up significant main effects of condition and independent t-tests followed up significant interactions.

6.3. Results

6.3.1. Sample characteristics

A total of 161 parents and children participated. Participants were excluded due to inadequate experimental control (e.g., not following instructions or the presence of siblings; n = 8). Hence, the final sample included 153 participants. Parents (149 women, 4 men) had a mean age of years 38.4 (range = 28-48) and mean BMI was in the overweight range (mean = 25.6, SD = 5.9). Parent ethnic background was 79.1% White, 11.8% Asian, 3.9% mixed ethnicities, 2.0% Black, 2.6% 'other ethnic group', and 0.7% 'prefer not to say'. Parental highest educational level achieved: 43.1% undergraduate, 35.9% postgraduate qualification, 15.0% A level (or equivalent, 3.9% GCSE (or equivalent) and 2.0% 'other'. Most of the sample reported having more than one child (83%). Children (81 males, 72 females) had a mean age of 5.88 years (70.50 months; range = 61-83 months) and a mean BMI z-score of 0.20 (range = -3.84 – 3.89). BMI z-scores could not be calculated for 17 children due to missing height and weight data from parents, or incorrect data reported. Sample characteristics were analysed; there were no significant differences between conditions for parent or child demographics, or for habitual F&V intake (all *p*s > .05; Table 6.2). Child sex was not significantly different between conditions ($X^2(2, N = 153) = 5.32, p = .07$). There was no main effect of child sex on children's broccoli or mangetout intake, willingness to try, frequency of tastes, or liking (all *p*'s > .05). Children's habitual intake of cooked mangetout differed significantly between conditions ($X^2(4, N = 153) = 11.99, p = .02$)[3], but habitual intake of cooked broccoli did not ($X^2(8, N = 153) = 14.78, p = .06$; Table 6.3). There was no significant difference between conditions for parent-reported child liking

[3] Including habitual intake of cooked mangetout as a covariate did not change the significance of main analyses.

of cooked broccoli (X^2(10, N = 154) = 12,76, p = .24) or cooked mangetout (X^2(8, N = 154) = 10.78, p = .22). Finally, there were no significant differences between conditions for CEBQ subscales, food neophobia, or sensory processing (all ps > .05; Table 6.4).

Table 6.2: Mean (SD) sample characteristics for participants in each condition (one-way ANOVA)

		Single Positive (n = 52)	Repeated Positive (n = 51)	No-Food (n = 50)	*F*	*p*
Parent	Age (years)	38.29 (3.72)	38.43 (4.42)	38.39 (4.16)	0.02	.98
	BMI	24.56 (4.93)	27.10 (7.31)	24.98 (4.76)	2.82	.06
	Vegetable intake	2.41 (1.15)	2.68 (1.47)	2.69 (1.41)	0.69	.51
	Fruit intake	2.02 (0.88)	1.74 (1.14)	2.07 (1.05)	1.56	.21
Child	Males (%)	44.2	49.0	66.0	-	-
	Age (months)	70.25 (6.40)	70.96 (7.05)	70.30 (7.62)	0.16	.85
	BMI (z-score)	0.35 (1.61)	0.24 (1.76)	-0.02 (1.62)	0.60	.55
	Vegetable intake	2.06 (1.14)	2.33 (1.06)	2.14 (0.93)	0.94	.40
	Fruit intake	2.38 (0.92)	2.25 (1.09)	2.32 (1.06)	0.22	.81

Table 6.3: Habitual consumption of cooked broccoli and cooked mangetout, split by condition (Chi-square)

	Single Positive (n = 52)	Repeated Positive (n = 51)	Control (n = 50)	X^2	*p*
Cooked broccoli					
Never	12	6	6	14.78	.06
Once a month	10	13	5		
Once a week	24	17	29		
Several times a week	6	14	10		
Everyday	0	1	0		
Cooked mangetout					
Never	32	38	26	11.99	.02*
Once a month	20	11	18		
Once a week	0	2	6		
Several times a week	0	0	0		
Everyday	0	0	0		

*p < .05.

Table 6.4: Mean (SD) individual differences for child participants in each condition (one-way ANOVA)

	Single Positive (n = 52)	Repeated Positive (n = 51)	Control (n = 50)	*F*	*p*
CEBQ Enjoyment of Food	3.76 (0.84)	3.79 (0.69)	3.88 (0.69)	0.32	.73
CEBQ Satiety Responsiveness	2.84 (0.70)	3.06 (0.64)	2.92 (0.61)	1.53	.22
CEBQ Food Fussiness	2.99 (0.85)	2.91 (0.80)	2.94 (0.83)	0.16	.85
CEBQ Food Responsiveness	3.00 (0.83)	2.96 (0.83)	2.89 (0.80)	0.24	.79
CFNS	25.27 (9.96)	25.31 (9.38)	24.52 (8.87)	0.11	.89
SEQ	0.75 (0.44)	0.63 (0.48)	0.54 (0.44)	2.78	.07

Note. Children's Eating Behaviour Questionnaire (CEBQ); Child Food Neophobia Scale (CFNS); Sensory Experiences Questionnaire (SEQ).

6.3.2. Experimental sessions

There was no significant difference between conditions for the time since children last consumed food before session one (X^2(10, *N* = 153) = 12.68, *p* = .24) or session two (X^2(10, *N* = 153) = 17.13, *p* = .07). Children's hunger rating did not differ significantly between conditions at session one (*F*(2, 152) = 0.38, *p* = .68) or session two (*F*(2, 152) = 2.62, *p* = .08). In the positive condition, most children correctly identified how the models felt (80.6%). In the control condition, accuracy was below chance with children reporting that they thought models felt positive (48.0%), neutral (46.0%), or negative (6.0%).

6.3.3. Compliance with experimental procedure

Sessions one and two were 7 days apart for most participants (86.9%), however, due to unforeseen circumstances (e.g., ill health), some participants had to reschedule their second session (n = 20), however, all sessions were between 6-9 days apart. There was no significant difference between the number of times children consumed broccoli (*F*(2, 152) = 0.69, *p* = .51) or mangetout (*F*(2, 152) = 0.92, *p* = .40) between sessions one and two. Few parents prompted their child to eat in session one (single positive n = 16; repeated positive n = 10; control n = 16) or session two (single positive n = 14; repeated positive n = 6; control n = 8), and parental prompts did not differ significantly between conditions in session one (*F*(2, 145) = 1.67, *p* = .19) or session two (*F*(2, 150) = 1.35, *p* = .26).

Fifty-one children were allocated to the repeated positive condition and three children were exposed to the positive video less than the required 6 times (i.e., once during session one, and five times separately between sessions one and two). To minimise the risk of bias, an intention-to-treat analysis was used (McCoy, 2017), meaning that these three participants were included in analyses.

6.3.4. Main Analysis: Vegetable acceptance

Most children swallowed at least one bite of the broccoli and mangetout at session one (63.7% and 71.6%, respectively), and at session two (61.1% and 69.3%, respectively). For children's willingness to try broccoli, a 3x2 mixed ANOVA revealed there was no significant main effect of condition (*F*(2, 129) = 1.31, *p* = .27, η_p^2 = .020) or time (*F*(1, 129) = 0.46, *p* = .50, η_p^2 = .00), and the two-way interaction between time and condition was not significant (*F*(2, 129) = 0.25, *p* = .78, η_p^2 = .00). For children's willingness to try mangetout, a 3x2 mixed ANOVA revealed there was no main effect of condition (*F*(2, 143) = 1.36, *p* = .26, η_p^2 = .02) or time (*F*(1, 143) = 0.51, *p* = .48, η_p^2 = .00), and the two-way interaction between condition and time was not significant ($F(2, 143) = 0.03$, $p = .97$, $\eta_p^2 = .00$). See Table 6.5 for means.

There were few instances where the researcher could not code the type of vegetable tasted (session one n = 4 & session two n = 11). The number of tastes where the vegetable could not be identified were recorded, and these scores were not included in main analyses. For children's number of broccoli tastes, a 3x2 mixed ANOVA revealed there was no significant main effect of condition ($F(2, 146) = 1.00$, $p = .37$, $\eta_p^2 = .01$) or time ($F(1, 146) = 0.27$, $p = .60$, $\eta_p^2 = .00$), and the two-way interaction between condition and time was not significant ($F(2, 146) = 0.40$, $p = .67$, $\eta_p^2 = .01$). For children's number of mangetout tastes, a 3x2 mixed ANOVA showed there was no main effect of condition ($F(2, 144) = 1.56$, $p = .21$, $\eta_p^2 = .02$) or time ($F(1, 144) = 0.44$, $p = .83$, $\eta_p^2 = .00$), and no significant two-way interaction between condition and time ($F(2, 144) = 2.28$, $p = .11$, $\eta_p^2 = .03$). See Table 6.5 for means.

Table 6.5. Mean willingness to try and number of tastes of broccoli and mangetout in sessions one and two, split by condition (standard error of the mean)

		Single Positive	Repeated Positive	Control
Session one				
Willingness to try	Broccoli	5.60 (0.28)	5.64 (0.28)	4.95 (0.30)
	Mangetout	6.00 (0.28)	5.41 (0.29)	5.63 (0.28)
Number of tastes	Broccoli	3.18 (0.68)	3.37 (0.69)	1.96 (0.69)
	Mangetout	9.14 (1.48)	4.08 (1.49)	6.15 (1.51)
Session two				
Willingness to try	Broccoli	5.43 (0.31)	5.47 (0.32)	5.00 (0.33)
	Mangetout	6.08 (0.27)	5.48 (0.28)	5.78 (0.27)
Number of tastes	Broccoli	3.02 (0.67)	3.49 (0.68)	2.47 (0.68)
	Mangetout	7.22 (1.43)	5.65 (1.44)	6.94 (1.46)

6.3.5. Main Analysis: Vegetable intake

For broccoli intake, a 3x2 mixed ANOVA revealed there was no significant main effect of condition ($F(2, 150) = 1.45$, $p = .24$, $\eta_p^2 = .02$) or time ($F(1, 150) = 0.13$, $p = .72$, $\eta_p^2 = .00$), however, there was a significant two-way interaction between condition and time ($F(2, 150) = 3.37$, $p = .04$, $\eta_p^2 = .04$; Figure 6.1). For children's broccoli intake at session one, independent t-tests revealed there was no significant difference between the repeated positive condition ($M = 5.74$, SD = 8.33), and the single positive condition ($M = 5.46$, SD = 7.08; $t(101) = -0.18$, $p = .86$). Broccoli intake at session one did not differ significantly between the control condition ($M = 4.02$, SD = 8.12) and the repeated positive condition ($t(99) = 1.05$, $p = .30$) or the single positive condition ($t(100) = 0.96$, $p = .34$). However, at session two, independent t-tests revealed broccoli intake was significantly higher in the repeated positive condition ($M = 7.06$g, SD = 9.86), compared to the single positive condition ($M = 3.62$g, SD = 6.37; $t(101) = -2.11$, $p = .04$). Broccoli intake in the control condition ($M =$

4.00, SD = 8.12) did not differ significantly compared to the repeated positive condition ($t(99) = 1.70$, $p = .09$) or the single positive condition ($t(100) = -.27$, $p = .79$)

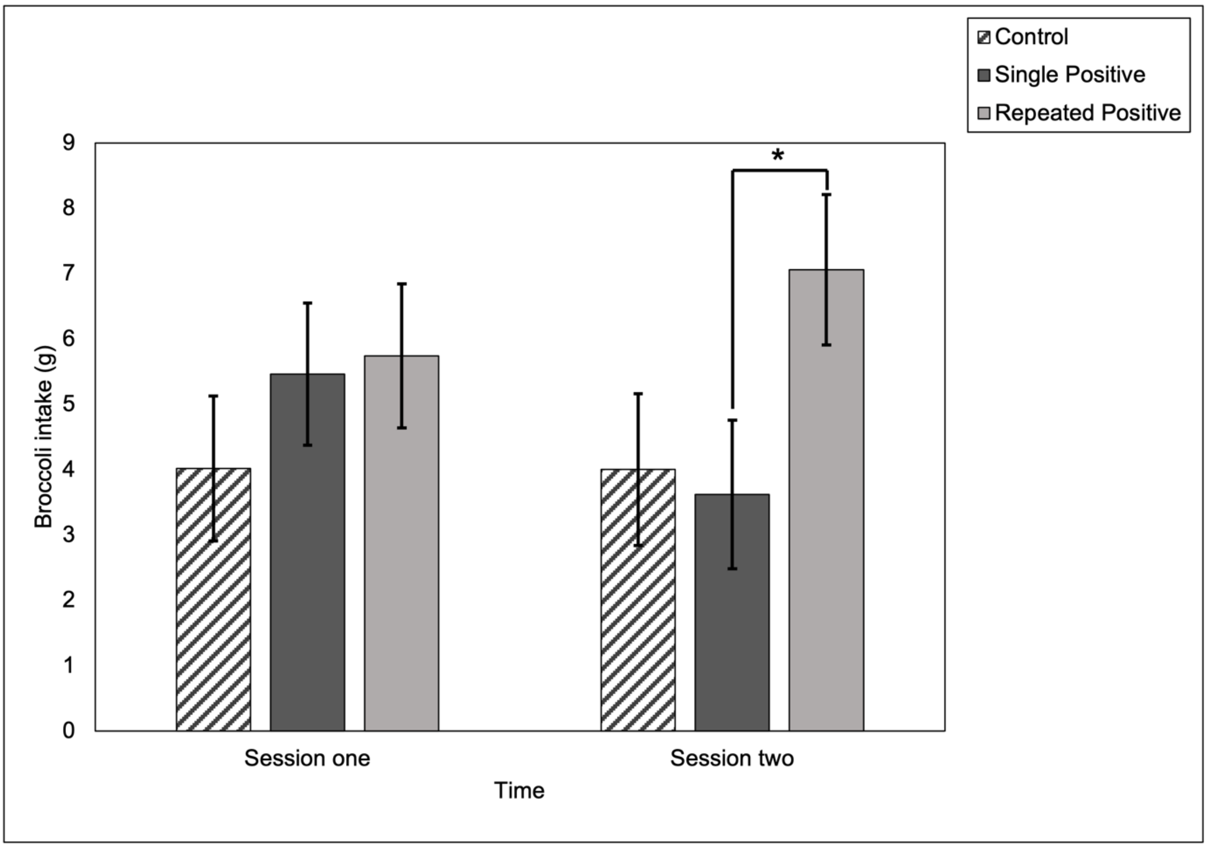

Figure 6.1. Mean broccoli intake (g) split by condition and time. Children in the repeated positive condition consumed significantly more broccoli than children in the single positive condition. Error bars indicate standard error or the mean. *$p < .05$.

For mangetout intake, a 3x2 mixed ANOVA revealed a significant main effect of condition ($F(2, 150) = 3.71$, $p = .03$, $\eta_p^2 = .05$). Bonferroni corrected t-tests showed mangetout intake was significantly higher in the single positive condition, compared to the repeated positive condition (9.8g vs 4.9g; $p = .02$), but not the control condition (7.3g; $p = .52$). Repeated positive and control conditions did not differ significantly in their effects on mangetout intake ($p = .55$). For mangetout intake, there was no significant main effect of time ($F(1, 150) = 0.25$, $p = .62$, $\eta_p^2 = .00$) and the two-way interaction between time and condition was not significant ($F(2, 150) = 0.92$, $p = .40$, $\eta_p^2 = .01$).

6.3.6. Main Analysis: Vegetable liking

For broccoli liking, a 3x2 mixed ANOVA revealed a significant main effect of condition ($F(2, 150) = 4.75$, $p = .01$, $\eta_p^2 = .06$) but not a significant main effect of time ($F(1, 150) = 3.88$, $p = .05$, $\eta_p^2 = .03$). Following up the main effect of condition, Bonferroni corrected t-tests showed broccoli liking was significantly higher in the repeated positive condition, compared to the single positive condition (2.00 vs 1.56, $p < .01$; Figure 6.2), but not the control condition (1.72; $p = .15$). Single positive and control conditions did not differ significantly in their effects on broccoli liking ($p = .89$). There was no significant two-way interaction between time and condition on broccoli liking ($F(2, 150) = 2.36$, $p = .09$, $\eta_p^2 = .03$). For mangetout liking, a 3x2 ANOVA revealed no significant main effect of condition ($F(2, 149) = 0.42$, $p = .66$, $\eta_p^2 = .01$) or time ($F(1, 149) = 0.21$, $p = .65$, $\eta_p^2 = .00$), and the two-way interaction between time and condition was not significant ($F(2, 149) = 2.80$, $p = .06$, $\eta_p^2 = .04$).

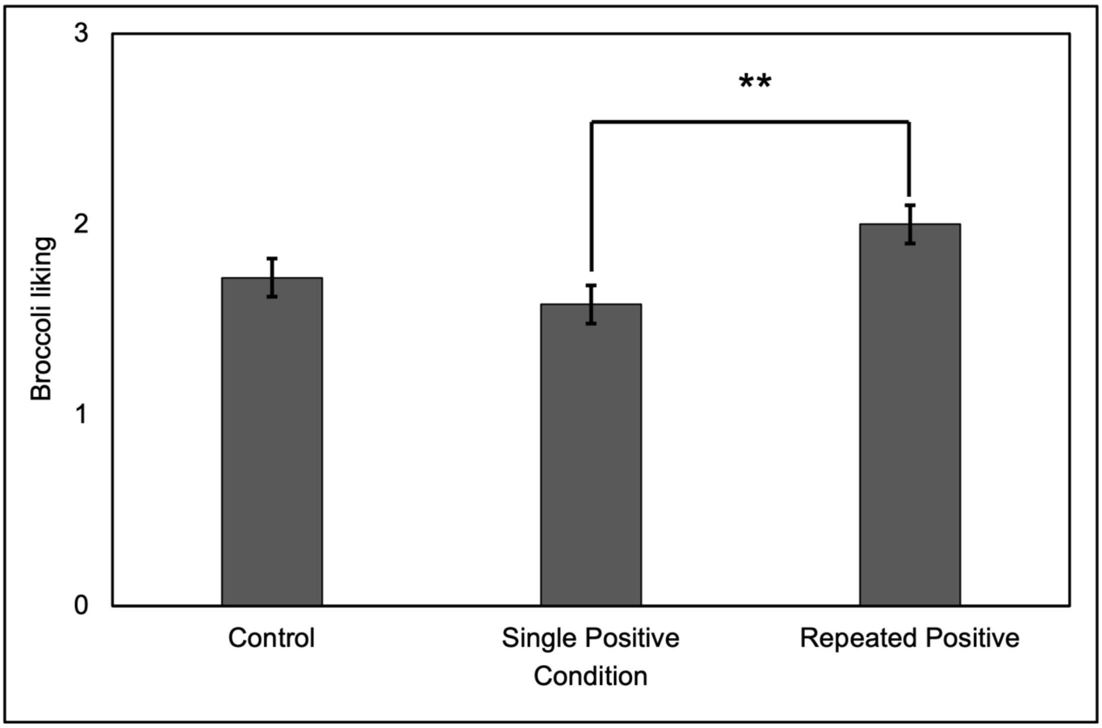

Figure 6.2. Mean broccoli liking split by condition (standard error). ** $p < .01$.

6.3.7. Exploratory Moderation Analysis: Food neophobia

The moderating effect of food neophobia was examined using 3x3x2 mixed ANOVA. Children's food neophobia scores were split into tertile groups, categorised as low (single positive n = 20; repeated positive n = 16; control n = 16), medium (single positive n = 12; repeated positive n = 17; control n = 21), and high (single positive n = 20; repeated positive n = 18; control n = 13).

For broccoli intake, a 3x3x2 ANOVA revealed there was no significant main effect of condition ($F(2, 144) = 1.97$, $p = .14$, $\eta_p^2 = .03$) or time ($F(1, 144) = 0.14$, $p = .71$, $\eta_p^2 = .00$). The main effect of food neophobia group was significant ($F(2, 144) = 5.20$, $p < .01$, $\eta_p^2 = .07$;

Figure 6.3). Bonferroni corrected t-tests showed that broccoli intake was significantly lower for children who scored high in food neophobia (*M* = 2.31g), compared to children with low (*M* = 6.67g, $p < .01$) and medium food neophobia (*M* = 5.95g, $p = .04$). Broccoli intake was not significantly different between children with low and medium food neophobia ($p > .05$). There was a significant two-way interaction between condition and time ($F(2, 144) = 3.40$, $p = .04$, $\eta_p^2 = .05$). A breakdown of this significant interaction can be found in section 6.3.5. Food neophobia group did not significantly interact with condition ($F(4, 144) = 1.05$, $p = .39$, $\eta_p^2 = .03$), or time ($F(2, 144) = 0.44$, $p = .65$, $\eta_p^2 = .01$). The three-way interaction between food neophobia group, condition, and time was not significant ($F(4, 144) = 0.36$, $p = .84$, $\eta_p^2 = .01$).

For mangetout intake, a 3x3x2 ANOVA revealed a significant main effect of food neophobia group ($F(2, 144) = 5.06$, $p < .01$, $\eta_p^2 = .07$; Figure 6.3), but there was no significant main effect of condition ($F(2, 144) = 2.96$, $p = .06$, $\eta_p^2 = .04$) or time ($F(1, 144) = 0.51$, $p = .48$, $\eta_p^2 = .00$). For the main effect of food neophobia group, Bonferroni corrected t-tests showed that mangetout intake was significantly higher for children who scored low in food neophobia (*M* = 10.4g), compared to children with medium (*M* = 6.0g, $p = .045$) and high food neophobia (*M* = 5.2g, $p = .01$). Mangetout intake was not significantly different between children with medium and high food neophobia ($p > .05$). Food neophobia group did not significantly interact with condition ($F(4, 144) = 0.57$, $p = .68$, $\eta_p^2 = .02$), or time ($F(2, 144) = 0.77$, $p = .47$, $\eta_p^2 = .01$). The three-way interaction between food neophobia group, condition, and time was not significant ($F(4, 144) = 1.18$, $p = .32$, $\eta_p^2 = .03$).

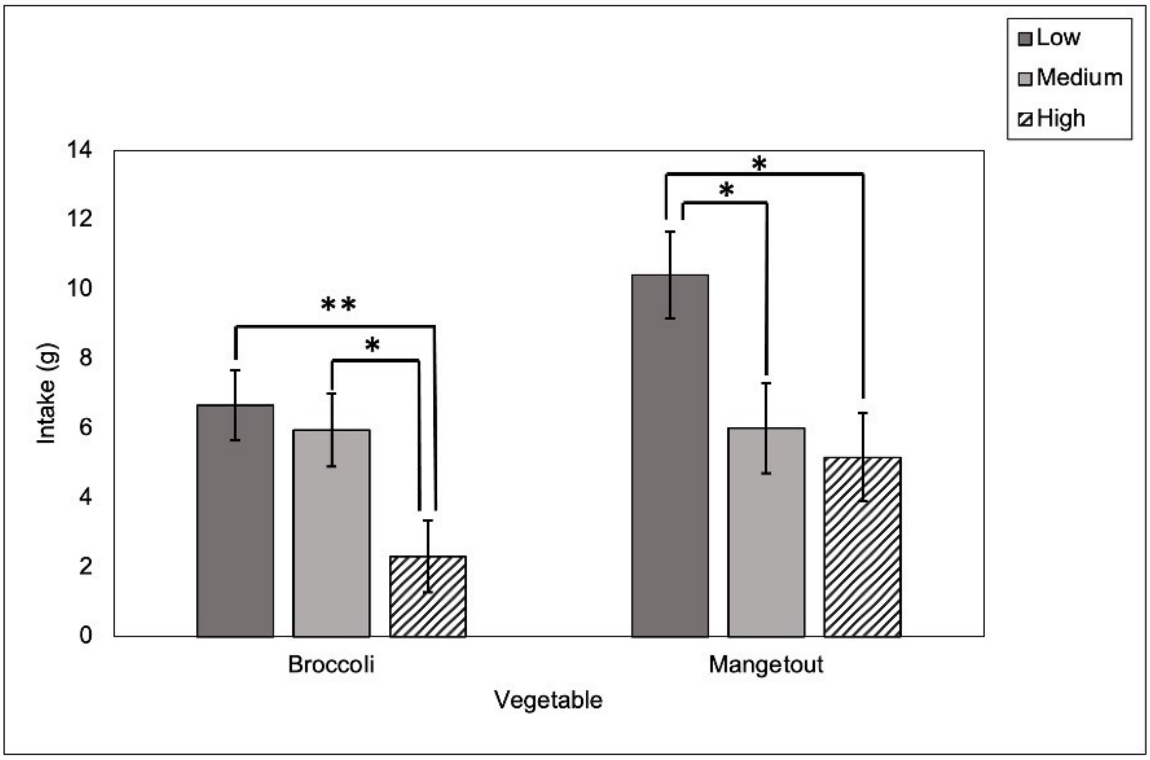

Figure 6.3. Mean broccoli and mangetout intake split by food neophobia group (standard error). *p < .05, **p < .01.

6.4. Discussion

This study aimed to examine the effect of single versus repeated exposure to adults consuming raw broccoli while conveying positive FEs, on children's acceptance, intake and liking of a modelled and non-modelled vegetable, after one week. The findings partially supported the hypotheses, showing that children who were repeatedly exposed to adults' positive FEs after one-week consumed more of the modelled vegetable (broccoli), compared to children who only received a single exposure to positive FEs. Hypotheses concerning the benefits of repeated exposure to positive FEs on acceptance and liking of the modelled and non-modelled vegetables were not supported.

After one week, children who were repeatedly exposed to adults showing enjoyment whilst eating broccoli had greater raw broccoli intake (7g), than children who only received a single exposure (4g), and children in the control condition (4g). This is consistent with previous research which showed that repeated exposures to modelling increased children's vegetable consumption (Horne et al., 2004; Horne et al., 2009; Lowe et al., 2004), and builds on these findings by showing that repeated exposures can be administered over short time periods (one week).

Additionally, these findings showed that a single exposure to adults enjoying broccoli was not sufficient for a delayed effect on vegetable intake; children required repeated exposure. This builds on the findings in Chapter 4, which showed an immediate effect of a single exposure to adults' positive FEs on children's broccoli intake. However, the present findings contrast with previous research which found that a single exposure to positive modelling increased children's vegetable intake one-week later (Staiano et al., 2016). Although modelling food enjoyment on several occasions is more effortful, our findings imply that it is an effective and practical method to encourage vegetable intake by children, but that it is necessary to show this enjoyment repeatedly. For example, exposing children to food enjoyment is a simple strategy which can be carried out in various environments, such as at home (e.g., by parent models) or school (e.g., by teacher models). However, more research is needed to determine whether these effects generalise when models are familiar to the child, and to ascertain whether there is a point at which intake is permanently enhanced, without the need for further exposures to positive modelling. Overall, the results demonstrate the effectiveness of repeated positive modelling to encourage children's vegetable intake, and further highlight the importance of exposing children to positive eating environments (Marty et al., 2018).

Furthermore, it appears that the immediate effect of positive FEs from Chapter 4 was not replicated in the present study. However, it was not possible to fully determine this effect since at the first time point, single and repeated positive conditions were the same (all children had watched the positive video only once). Additionally, session one in this study is not a direct replication of the session in Chapter 4 because children are given two vegetable snacks. Therefore, it is not possible to ascertain whether the effects of single exposures to positive FEs on intake of an individual vegetable that were demonstrated in Chapter 4 are replicated or not in this study. Indeed, presenting children with both vegetable snacks at the same time could have influenced vegetable consumption. The presentation of the two snacks created a 'choice' scenario for children which may have resulted in different behaviour than that which could be observed when there is only one food option. For example, it is possible that children could be satiated by eating mangetout, before they have tried the broccoli. Thus, the competition of a different, potentially more palatable vegetable, could have influenced the amount of broccoli children consumed.

Unlike intake, children's acceptance (when measured as indices of willingness to try and the number of tastes, rather than actual intake) and their liking of the modelled vegetable were not influenced by models' positive FEs. This may be partially explained by the fact that, consistent with the findings in Chapter 4, most children were willing to try the vegetables, regardless of condition. Thus, the absence of an effect on willingness to try could be explained by a lack of sensitivity of the measure, because most children scored highly irrespective of the amount they consumed. However, contrary to the findings in Chapter 4, there was no effect of models' positive FEs on children's frequency of vegetable tastes, suggesting that effects on intake were not manifesting in more frequent tastes, but perhaps larger bites. One explanation that there was no effect of positive FEs on vegetable acceptance could have been due to children already having high familiarity with vegetables. Indeed, children's habitual vegetable intake was reasonably high in this sample, meaning they might have already learned to accept novel and bitter tastes into their diet. Therefore, future research is needed with samples of children who are less familiar with vegetables, to establish whether exposure to positive FEs increases vegetable acceptance in those children most in need of intervention.

Unexpectedly, children were found to have greater broccoli liking in the repeated positive condition, compared to the single positive condition, but this was not dependent on time. Children in the repeated positive condition rated broccoli as 'okay', compared to children in the single positive condition who 'did not like it'. Findings showed that the effect of time, and the interaction between time and condition, were approaching significance for broccoli liking, and the effect sizes were small to medium. Since previous research has shown that children's liking of low-energy dense food predicts their actual intake (Keller et al., 2022), it is possible that with a larger sample, a statistically significant effect would have been achieved, to mirror the findings on broccoli intake. It is also possible that no significant interaction was discovered due to limitations of the liking scale used. In this study, children rated their liking of each vegetable using a thumbs up and down scale, rather than the commonly used smiley face scale (van der Heijden et al., 2020). Whilst it was not appropriate to use a smiley face scale in this study (i.e., children might have chosen the face that 'matched' the one in the video), children might not have understood the scale, and it might not have accurately reflected their vegetable liking. Indeed, previous research has detected an effect of positive modelling on vegetable liking when liking was measured using a smiley face scale (Appleton et al., 2019; Farrow et al., 2019). Thus, limitations of the scale could explain the lack of significant effects of the condition by time interaction on broccoli liking.

Results showed that positive FEs did not have a generalised effect on children's eating of a non-modelled vegetable, which is consistent with some previous research (Appleton et al., 2019). One explanation for this could be that children's concerns about food palatability, which relate to food neophobia (Dovey et al., 2008), were not reduced because they did not observe the model consuming the mangetout. This suggests that social learning plays an important role in guiding children's eating. Another explanation that there was no generalised effect could be due to an artefact of vegetable type. Indeed, children might have consumed more mangetout, regardless of condition, because they found it to be more palatable than raw broccoli. Each vegetable was matched in colour, food group and energy-density, and was novel for participants in its raw form. However, since 'target' vegetable type was not counterbalanced across conditions, the absence of a generalised effect could be due to limitations of the experimental design. One unexpected finding was that children consumed more mangetout in the single positive condition, than the repeated positive condition, which was not dependent on time. This finding is unclear because at session one, single and repeated positive conditions were identical in procedure. Both parent-reported and self-reported liking of mangetout was not different between conditions, suggesting that liking cannot explain this finding. Whilst children's habitual intake of cooked mangetout was different between conditions, it was not between single and repeated positive conditions, suggesting that children's familiarity with mangetout is not likely to explain the results. Therefore, to fully establish the generalised effect of positive FEs, research is needed using a wider buffet of vegetables and an experimental design where target vegetable type is counterbalanced.

Exploratory analyses showed that whilst there was a main effect of children's food neophobia on children's vegetable consumption, this did not interact with the effect of models' positive FEs and time on children's vegetable consumption. However, meaningful interpretations based on statistical significance are not appropriate since this study was not sufficiently powered for a three-way interaction. Irrespective of condition and time, children with low and medium food neophobia consumed more than double the amount of raw broccoli than children with high food neophobia. Furthermore, children with low food neophobia consumed more than double amount of raw mangetout than children with high food neophobia. This suggests that positive modelling could be less effective for children with high food neophobia, however, a larger sample size is needed to fully establish this. Based on the small to medium effect sizes detected, the findings suggest that with a larger sample size, food neophobia could moderate the effect of positive modelling on children's vegetable consumption. This highlights the need for research to recruit children with high food neophobia specifically, to determine whether modelling is effective for these children.

The remote methodology used has several strengths and was found to be advantageous, similarly to Chapter 4. In addition to, and perhaps because of, the convenience for families and researchers, another key advantage of the remote design was the high compliance of participants attending both sessions, and completion of the daily repeated exposures. Indeed, there might have been greater attrition if the study was conducted in the laboratory. Secondly, the remote methodology allowed participants to take part in their home environment, which is more ecologically valid eating environment than a laboratory setting. Thirdly, administering the daily task online allowed parents and children to flexibly complete these to suit their schedules. The online sessions reduced the time burden for participants and the researcher (e.g., travelling to the laboratory), which is particularly onerous when attending multiple sessions. Although video recordings using Zoom were mostly of good quality, one limitation was occasional data loss due to not being able to code video recordings (e.g., camera not positioned optimally to view all child eating behaviour). Another limitation was that the sample comprised mostly families of White ethnicity where parents had a university education and children had relatively high habitual vegetable intake. Thus, the findings may not generalise to other populations. Additionally, the study design was limited since the delayed effect of positive FEs on vegetable consumption could only be assessed in the single positive condition, because children did not observe food enjoyment for one-week. The delayed effect of positive FEs could not be examined in the repeated positive condition because children had recently watched the positive video shortly before their second session. Thus, the effect of repeated exposure to positive FEs could be explained by a recency effect, rather than a repeated exposure effect. Therefore, future research is needed to determine the delayed effect of repeated exposure to others' food enjoyment (i.e., measuring food intake one-week after children finish receiving repeated exposures to food enjoyment). Examining this will disentangle the effect of recency versus repeated exposure to food enjoyment on children's vegetable intake.

This study presents novel findings that repeatedly exposing children (5-6 years), to adults enjoying eating raw broccoli, results in greater raw broccoli intake after one week. Whilst a single exposure to adults eating broccoli with positive FEs may have the potential to have immediate effects on broccoli intake (Chapter 4), these findings demonstrate there is no delayed effect of a single exposure to positive FEs and that children need repeated exposures to others enjoying vegetables. Overall, exposing children to others' vegetable enjoyment appears a practical and useful strategy to encourage children's eating of modelled vegetables. However, since the effect did not generalise to a similar, non-modelled vegetable in this study, children may need to observe others' enjoyment towards multiple vegetables. Further research is now required to determine the longer-term effects of positive FEs on vegetable intake, and whether these effects generalise when models are familiar (e.g., parents).

Chapter 7: General discussion

This chapter provides an overview and discussion of the findings presented in this thesis. Firstly, the initial aims of this thesis are summarised, followed by a summary and discussion of the findings from each chapter. This thesis showed that the effect of positive FEs was different for children and young adults, with Chapters 2 and 3 showing there was no effect on young adults' desire to eat vegetables, and Chapters 4-6 indicating that exposure to positive FEs increased children's modelled vegetable intake. Chapter 4 showed an immediate effect of a single exposure to adults' positive FEs on children's vegetable consumption, but Chapter 6 demonstrated that children required repeated exposure, to see effects at one-week. Chapter 5 indicated that exposure to others' positive FEs increased vegetable intake by most children, but not for children with high food neophobia. Across populations (Chapters 2, 3 & 6), there was no generalised effect of adults' FEs to a modelled vegetable on individuals' eating of a non-modelled vegetable. Next, the implications for theory and practical implications of these findings are discussed. Methodological strengths and limitations of the studies in this thesis are then discussed. Finally, recommendations for future research are presented, and an overall conclusion drawn.

7.1. Thesis aims

The primary aim of this thesis was to examine the effect of others' FEs whilst eating a raw vegetable on children and young adults' eating of a modelled vegetable, and to determine whether this effect generalises to a non-modelled vegetable. Secondly, this thesis aimed to examine whether a single exposure to positive FEs was sufficient for encouraging children's vegetable consumption, or whether children require repeated exposure to positive FEs. Secondary aims included investigating facial mimicry as a mediator of the relationship between models' FEs whilst eating a vegetable, and young adults' consumption and liking of vegetables. Furthermore, this thesis aimed to investigate whether food neophobia moderated the effect of models' FEs whilst eating a vegetable, on children's vegetable acceptance and intake. Figure 7.1 summarises the effect of others' FEs on eating behaviour, and the moderating effect of food neophobia, which are demonstrated in the chapters of this thesis. The findings will also be summarised and discussed in the following section.

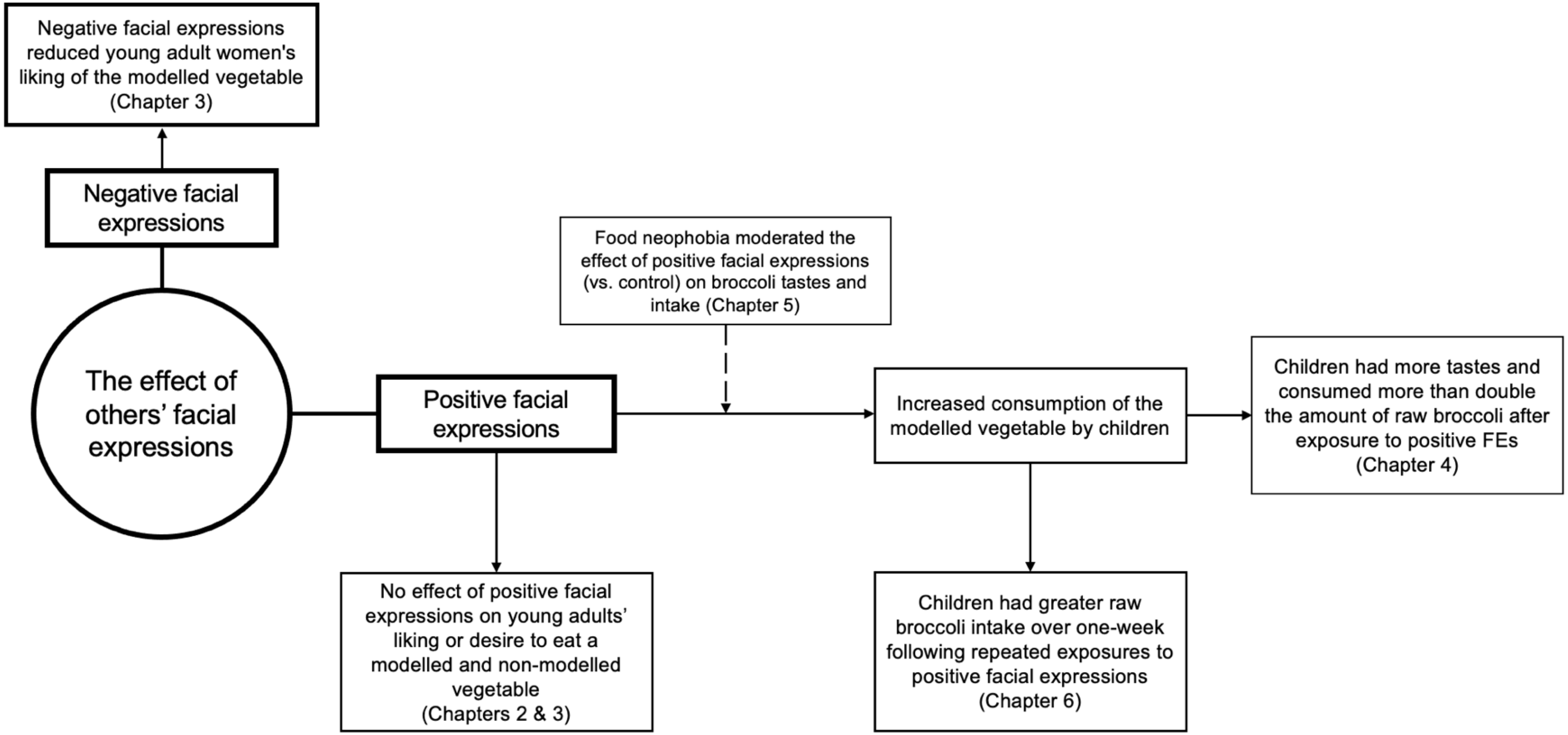

Figure 7.1. This model provides a summary and overview of the effect of others' FEs on eating behaviour (solid arrows) and the moderating effect of food neophobia (dashed arrow) demonstrated in this thesis. Non-significant effects found in this thesis are not included in the model for clarity.

7.2. Summary of chapter findings

Chapter 2 aimed to examine the effect of models' FEs whilst eating a vegetable on young adults' consumption and change in liking of a modelled vegetable (raw broccoli), and to determine whether this effect generalises to the consumption and liking of a non-modelled vegetable (cucumber). Findings showed no effect of models' FEs whilst eating raw broccoli on young adults' intake and change in liking of the modelled vegetable and non-modelled vegetable. This was contrary to hypotheses and previous research (Barthomeuf et al., 2009, 2012). However, this study was terminated early because of COVID-19 restrictions, meaning a sufficient sample size could not be recruited. Thus, drawing meaningful conclusions based on statistical significance from this data is not appropriate. Additionally, Chapter 2 aimed to address the secondary aim of this thesis, to investigate the mediating role of facial mimicry in the relationship between models' FEs whilst eating and young adult's eating behaviour. Research has suggested that behavioural mimicry partly mediates the modelling of eating (Cruwys et al., 2015), however, Chapter 2 found no mediating effect of facial mimicry. Again, it is difficult to draw conclusions about the role of facial mimicry in the modelling of eating from this data since the study was not sufficiently powered. Furthermore, the absence of facial mimicry could have been due to limitations of the measurement tool, FaceReader (see section 7.4). Because of the methodological challenges of using FaceReader, particularly during the COVID-19 global pandemic lockdown, the role of facial mimicry in this relationship was not pursued further. In summary, Chapter 2 provided no statistically significant evidence for the effect of models' FEs whilst eating a vegetable on young adults' eating behaviour, nor the mediating role of facial mimicry. The premature completion of this study meant that inferences about these findings are not appropriate.

Since the study in Chapter 2 could not be completed, a similar experimental study using online methodology was conducted, to address the primary aims of this thesis. Chapter 3 examined the effect of models' FEs on young adult women's change in liking and desire to eat a modelled (raw broccoli) and non-modelled vegetable (cucumber). Observing models conveying negative FEs whilst eating raw broccoli reduced liking ratings of the modelled vegetable, compared to adults who were exposed to models with positive FEs. However, this effect did not generalise to the non-modelled vegetable, and there was no effect on the change in desire to eat either vegetable. This suggests that watching others show dislike whilst consuming a raw vegetable reduces women's liking of the modelled vegetable, in the absence of a significant change to their desire to consume the vegetable. This highlights the power of observing disgust reactions towards food, in reducing food liking of the modelled vegetable. However, this effect does not generalise to a non-modelled vegetable.

Chapter 4 aimed to address the primary aim of this thesis by examining the effect of models' FEs eating raw broccoli on children's acceptance and intake of raw broccoli. Findings showed that children had more tastes and consumed more than double the amount of the modelled vegetable (raw broccoli) after watching adults eating broccoli with positive FEs. Therefore, exposing children to adults showing their enjoyment of eating a vegetable has an immediate effect on encouraging children's tastes and intake of the vegetable.

Chapter 5 included a secondary analysis of data from Chapter 4 to address the secondary aim of this thesis, to examine the moderating role of food neophobia on the effect of models' FEs on children's vegetable consumption. Food neophobia was found to moderate the effect of models' positive FEs (versus control) on children's raw broccoli tastes and intake. Children with low and medium food neophobia had more tastes and intake of raw broccoli after watching adults eating broccoli with positive FEs, compared to children in the control condition. This shows that exposing children with low and medium food neophobia to adults' showing enjoyment whilst eating a vegetable encourages children's vegetable consumption. However, there was no effect of models' positive FEs on broccoli consumption for children with high food neophobia, suggesting that these children do not model eating behaviour in the same way as other children.

Chapter 4 provided evidence of the immediate effect of models' positive FEs on children's vegetable consumption. However, it is possible that a single exposure to positive FEs is not sufficient, and children need multiple exposures to others enjoying eating vegetables to facilitate changes to vegetable consumption. Hence, Chapter 6 examined the effect of exposure to others' positive FEs whilst eating a raw vegetable after one week, and investigated whether repeated exposure to food enjoyment was required, or whether one exposure was sufficient. Chapter 6 demonstrated that children required repeated exposure to adults' eating a vegetable with positive FEs after one-week; in this study, a single exposure was not sufficient. However, it was not possible to determine whether the effect of positive FEs demonstrated in Chapter 4 was fully replicated in Chapter 6. This is because at session one, single and repeated positive conditions were identical, so a difference in intake between these conditions was not expected. Also, the competition of another vegetable snack could have influenced children's intake. Furthermore, Chapter 6 sought to examine the generalised effect of models' positive FEs on children's eating of a non-modelled vegetable. Consistent with Chapters 2 and 3, and some previous research (Appleton et al., 2019), Chapter 6 showed no effect of models' positive FEs on children's consumption of a non-modelled vegetable. This shows that the effect of positive modelling does not generalise to the promotion of children's consumption of other vegetables.

7.3. Discussion of findings

The overarching aim of this thesis was to better understand the effect of others' FEs in the modelling of eating behaviour. The present results add to the extant literature which demonstrates the powerful influence of social modelling on eating behaviour (Cruwys et al., 2015; Vartanian et al., 2015). Furthermore, this thesis indicates the importance of food enjoyment, conveyed by FEs, in determining the modelling of eating. Supporting Social Learning Theory (Bandura, 1977), the present results demonstrate that children are more likely to imitate a behaviour if positive consequences are observed (e.g., positive FE), and young adults are less likely to imitate a behaviour if negative consequences are observed (e.g., negative FE). This highlights the important role that both observational learning and food enjoyment play in guiding eating behaviour. The specific role of neutral, negative, and positive FEs, and the role of food neophobia, in the modelling of eating are discussed below.

7.3.1. Neutral facial expressions

Previous research has shown mixed findings of the effect of neutral FEs on eating desire, with one study showing no effect (Barthomeuf et al., 2009), and three studies showing that neutral FEs influence the desire to eat foods (Barthomeuf et al., 2012; Rizzato et al., 2016; Rousset et al., 2008). This thesis showed there was no effect of exposure to models eating broccoli with neutral FEs, compared to the effect of models eating broccoli with positive or negative FEs (Chapters 2-4). This extends previous research by showing it is FEs specifically influencing eating behaviour, rather than simply the presence of an eater (modelling effect). However, it is possible that neutral FEs convey food enjoyment to some extent; for example, the absence of food disliking indicates the food is acceptable even if not highly palatable. This could explain why a statistically significant difference between neutral FEs, with positive and negative FEs was not retrieved across studies. Furthermore, this suggests that neutral FEs are not appropriate for a control condition, thus, limiting the design of Chapters 2 and 3. Since a no-food control condition was not included, the specific effect of positive and negative FEs in the modelling of eating behaviour cannot be fully established. This highlights the importance of including a no-food control condition, as in Chapter 4, to fully determine the role of FEs in the modelling of eating behaviour. Nonetheless, Chapter 4 findings suggest that it is the combination of modelling (observing someone eat a vegetable) and positive or negative consequence (FE showing food enjoyment) which is important for influencing vegetable consumption.

7.3.1. Negative facial expressions

An important contribution of this thesis is to our understanding of the effect of negative FEs in the modelling of eating. Chapter 3 demonstrated that observing others' food dislike, expressed through negative FEs, reduced young adult women's liking of the modelled vegetable. This supports previous research which has shown that written information about food dislike reduces adults' subjective liking of a snack (Robinson & Higgs, 2012). Chapter 3 extends these findings by showing that food dislike can be conveyed through negative facial reactions whilst eating, and that it can influence young adults' liking of nutritious food specifically. This demonstrates the power and potential harm of observing food dislike on young adults' liking of vegetables. However, the harmful effect of negative FEs on healthy eating more generally appears limited. Indeed, Chapter 3 showed that there was no generalised effect of exposure to negative FEs on participants' liking of the non-modelled vegetable. This suggests that learning about the safety of food is specific to the modelled vegetable, or a particular context. This is beneficial from an evolutionary perspective, for humans to maximise the potential of consuming safe and palatable food and avoiding harmful and unpalatable food. However, to fully establish the effect of observing food dislike on young adults' vegetable consumption, research measuring actual food consumption in real-life eating occasions is required.

Contrary to hypotheses and previous research (Barthomeuf et al., 2009, 2012), Chapter 3 showed no effect of negative FEs on participants' change in desire to eat. One explanation for this unexpected finding could be that desire to eat broccoli was low at baseline. Indeed, research has shown that exposure to negative FEs does not decrease the desire to eat foods which individuals already have a low desire to eat (Rousset et al., 2008). Whilst there was a possibility to reduce eating desire in Chapter 3, the low baseline desire to eat broccoli could explain the lack of an effect of negative FEs on desire to eat. Another explanation relates to the hedonic nature of the experimental manipulation. Indeed, models showed their hedonic liking of broccoli, but not necessarily their wanting (i.e., models consumed the broccoli irrespective of their liking). This could reflect adults' eating behaviour, in which food is consumed due to its nutritional content (i.e., it is 'good' for you), irrespective of liking. Therefore, the absence of an effect on desire to eat could be an artefact of the vegetable used or relate to weaknesses of the manipulation. Examining the effect of negative FEs on more desirable vegetables (i.e., non-bitter vegetables) could elucidate whether negative FEs have a selective effect on food liking but not eating desire, or whether findings were due to study limitations.

The findings of this thesis also provide important understanding about the power of disgust (versus pleasure) reactions towards food. Chapter 3 showed an effect of negative FEs, but not positive FEs, on food liking. One explanation is that avoiding disgusting foods is an adaptive response that protects from ingestion of harmful substances (Curtis, 2011). Therefore, individuals could be more inclined to adjust their eating behaviour in response to negative FEs, than positive FEs, since there is greater risk associated with consuming a disgusting food than the possibility of enjoying a food. Whilst paying attention to others' food dislike is a protective trait, this could have negative consequences on real-life eating occasions. For example, observing an eating companion showing negative FEs whilst eating a vegetable could decrease the observer's liking of the vegetable. These findings were based on an adult population since it would not be ethical to show children disgust reactions towards vegetables. However, given the power of negative FEs and because children are less willing to try vegetables, these findings could generalise to child populations. For example, if a child sees their parent showing disgust whilst eating broccoli, this could have negative consequences on children's acceptance of broccoli. Indeed, exposing children to negative modelling of novel food intake is difficult to reverse (Greenhalgh et al., 2009), which suggests the harmfulness of children observing food dislike. Although the effect of negative FEs has not been examined in child populations, the findings suggest that observing disgust reactions to vegetables could have harmful consequences on the subsequent eating of vegetables. However, more research is needed to determine whether these findings translate to actual vegetable consumption.

7.3.3. Positive facial expressions

Previous research has shown that exposure to others' positive FEs towards food increases children's desire to eat disliked food (Barthomeuf et al., 2012). Building on this, Chapters 4-6 indicate that exposing children to adults consuming a raw vegetable with positive FEs can increase consumption of the modelled vegetable. This demonstrates that the effect of positive FEs extends to the actual consumption of a typically disliked nutritious food, which could have important implications for promoting healthy eating by children. Furthermore, Chapters 4-6 extend previous research which has conflated the effect of positive FEs with the effect of verbal positive statements (Appleton et al., 2019; Staiano et al., 2016). Thus, this thesis demonstrates the effect of positive FEs specifically, on children's vegetable consumption.

A significant contribution of this thesis is the emphasis of food enjoyment for promoting children's vegetable intake (Chapters 4-6). This supports research suggesting that children need positive eating experiences to learn enjoyment of nutritious food (Haines et al., 2019; Marty et al., 2018) and extends this to suggest that observation of others' enjoyment is an important facilitator of vegetable intake. Eating experiences during childhood, such as positive mealtime interactions, can help children learn pleasure from nutritious foods (Marty et al., 2018). Indeed, exposing children to positive facial reactions whilst eating could be an effective way to create a positive eating environment. Most public health campaigns promote nutritious food based on its nutritional content, which is less helpful for children (Haines et al., 2019). Therefore, as suggested by Haines and colleagues (2019), emphasising the pleasures gained from consuming nutritious food is a useful focus for public health campaigns.

The findings of this thesis also provide evidence that exposing children to others' food enjoyment (via positive FEs), is a practical and effective strategy to encourage vegetable consumption. Chapter 4 indicates an immediate effect of models' positive FEs, and Chapter 6 builds on this by showing there is no delayed effect of a single exposure to positive FEs, but that longer exposure enhances the effect of positive FEs on vegetable consumption. This supports previous research which showed that repeated exposure to modelling increased children's vegetable consumption, and extends these findings by specifically comparing the effect of a single exposure, with the effect of repeated exposure (Horne et al., 2004; Horne et al., 2009; Lowe et al., 2004; Zeinstra et al., 2017). It is also possible that children will not need constant and repeated exposure to positive modelling. Exposing children to food enjoyment could be a gateway to encourage initial vegetable consumption, but other positive experiences, such as positive post ingestive effects or extrinsic rewards (e.g., stickers), could help to maintain vegetable consumption over time. Thus, whilst social learning is initially important to guide children's vegetable consumption, more research is needed to ascertain if, and when, other mechanisms take over from positive modelling to encourage long-term vegetable consumption.

In addition, Chapter 6 showed no effect of positive FEs on a non-modelled vegetable. Though contrary to hypotheses, there have been mixed findings in the literature about the generalised effect of positive modelling (Appleton et al., 2019; Farrow et al., 2019). This lack of generalisation is adaptive since safe and poisonous plants can look similar (e.g., the same colour). From a young age, children determine the edibility of plants using social information (i.e., observing an adult consuming fruit from a plant; Wertz & Wynn, 2014a). Avoiding plants in the absence of social information about safety has a clear evolutionary advantage to avoid ingestion of toxic food (Wertz & Wynn, 2014b). Thus, the findings of this thesis contribute to our understanding about children's reticence towards novel plants and suggest that the influence of observing others' enjoyment of a vegetable is specific to the eating of that vegetable. This suggests that children may need to observe others' enjoyment of eating multiple vegetables to make a substantial difference to children's vegetable intake.

Nonetheless, exposing children to enjoyment of food by smiling whilst eating is a simple and inexpensive strategy which can be easily carried out in various environments. Indeed, the findings of Chapters 4-6 could extend to other environments, such as parental modelling in the home environment or caregiver modelling in preschool settings. Modelling is a commonly used parental feeding strategy (Blissett et al., 2012), thus parents could combine their consumption of vegetables with showing food enjoyment (e.g., smiling whilst they eat). It is possible that these findings will translate to other environments due to the high ecological validity of the methodology; children consumed the vegetable snacks in their home environment. However, it is possible that children responded more favourably, such as consuming more vegetables, in response to unfamiliar models, due to social desirability. Thus, since Chapters 4-6 used unfamiliar adult models, research examining the effect of positive familiar models is required to elucidate the generalisability of the present findings to other environments. An additional benefit of these studies is that modelling was administered remotely using videos. This has positive implications for the generalisability of the findings to other settings. For example, adults showing food enjoyment could be used in marketing and intervention materials that could be delivered in numerous ways (e.g., in schools or through media). Indeed, modelling interventions that have been carried out in food settings (e.g., Food Dudes) have been found to increase children's vegetable consumption (Horne et al., 2004; Horne et al., 2009; Lowe et al., 2004; Marcano-Olivier et al., 2021). Thus, the findings of Chapters 4-6 have potential practical applications for encouraging children's vegetable consumption in various settings.

Though exposing children to positive FEs is beneficial for encouraging children's vegetable consumption (Chapters 4-6), this finding was not consistent across populations, since positive FEs were found to have no effect on young adults' eating behaviour in Chapters 2 and 3. This is surprising since humans are a reward-driven species (i.e., core survival behaviours are tied into reward circuitry). Thus, signalling reward through others' liking of a food should be sufficient to encourage the observers' liking and desire to consume the food. However, the inconsistent findings across populations could relate to developmental differences in emotional understanding. It is possible that adults in Chapter 2 and 3 were not influenced by positive FEs because they thought the models were pretending to like broccoli. Indeed, smiling whilst eating is not a typical reaction to liked tastes (Wendin et al., 2011). In contrast, children in this thesis might not have developed the ability to detect pretence because they were aged 4-6-years old. During childhood, the ability to recognise and understand emotions develops significantly (Pons et al., 2004). Children develop the understanding that emotional expressions might not reflect felt emotion at around 7 years old (Pons et al., 2004). Therefore, it is unlikely that 4-6-year-old children in this thesis were able to detect, or question, whether the positive FEs were real or pretend. This suggests that positive FEs may only be effective for young children and highlights the influence of emotional understanding in the positive modelling of eating. However, it is also possible that the beneficial effect of positive FEs found in Chapters 4-6 do not generalise to younger children. Indeed, Frazier and colleagues (2012) discovered that younger children (below 3.5

years), did not show the same preference for positive peer models as older children. Although the studies in this thesis were not sufficiently powered to detect age effects, positive FEs might be less helpful for younger children, but research is needed to examine this. Additionally, the inconsistent effect of positive FEs across populations could relate to differences in study methodology. For example, children watched the video of models eating in the presence of the researcher, unlike adults who watched the video alone. Thus, adults might not have paid as much attention as children to the manipulation, because they were unsupervised. However, it is also possible that the effect of positive FEs in Chapters 4 and 6 relates to social desirability effects, for example, children wanted to please the researcher so were more likely to consume the vegetables. Therefore, methodological differences could explain the inconsistent effect of positive FEs across populations.

7.3.4. Food neophobia

Children vary in their willingness to try new foods, and it is possible that feeding practices that are successful for many children may not be effective for those who are less willing to try novel food. Previous research has shown that exposing children to positive modelling is effective for increasing novel food consumption (Greenhalgh et al., 2009; Hendy, 2002; Hendy & Raudenbush, 2000). Chapter 5 builds on this by demonstrating that differences in children's food neophobia influences the effectiveness of positive modelling as a strategy to encourage vegetable consumption. Findings showed that children with low and medium food neophobia had more tastes and intake of raw broccoli after watching adults eating broccoli with positive FEs. Taken together with the findings from Chapter 4, exposing children to adults' showing enjoyment whilst eating a vegetable appears an effective strategy for promoting children's eating of vegetables. Moreover, this provides an important understanding of effective strategies to encourage vegetable intake by children during the developmental peak in food neophobia, when vegetable acceptance is typically low (Dovey et al., 2008). From an evolutionary perspective, it makes sense that food neophobia and positive modelling interact. Food neophobia relates to concerns about food palatability (Dovey et al., 2008), thus, providing children with information that shows food is tasty (through positive FEs), helps to reduce these concerns and encourage children's vegetable intake.

However, positive modelling appears less helpful for children with high food neophobia. Chapter 5 showed that children with high food neophobia did not increase their broccoli intake after exposure to positive FEs, suggesting that children who are less willing to try new food do not model eating behaviour in the same way as other children. This novel finding provides an important contribution to the literature, indicating that the effectiveness of positive modelling depends on the individual characteristics of the child. Furthermore, Chapter 5 extends previous research which has not looked at how differences in children's food neophobia influences the positive modelling of eating (Greenhalgh et al., 2009; Hendy, 2002; Hendy & Raudenbush, 2000). Children with high food neophobia can be challenging to feed, which promotes negative mealtime interactions with parents (Dovey et al., 2008). Thus, simply showing food enjoyment is not powerful enough to overcome these negative experiences. During these eating occasions, it is possible that children with high food neophobia have learned not to trust information from others about food palatability (Nguyen et al., 2016), which could explain why children with high food neophobia do not model others eating. However, this is concerning since vegetable consumption is often low for children with high food neophobia (Cooke et al., 2003; Perry et al., 2015). Thus, more research is needed to determine which strategies are effective for encouraging vegetable consumption by those children who are often less willing to try vegetables.

In contrast to findings in Chapter 5, Chapter 6 showed that food neophobia did not moderate the effect of models' positive FEs on children's vegetable intake. However, since this analysis was exploratory and not sufficiently powered, it is possible that a statistically significant moderation effect would be yielded with a larger sample size. Findings showed that children with high food neophobia consumed less broccoli and mangetout than those with low food neophobia. However, it is not clear from the sample in Chapter 6 whether positive modelling is effective for children with high food neophobia.

In summary, Chapter 5 demonstrates that food neophobia moderates the effect of models' positive FEs on children's tastes and intake of the modelled vegetable, however, no moderation effect was found in Chapter 6. Observing adults enjoying eating vegetables appears an effective strategy to encourage vegetable consumption, as demonstrated in Chapter 4. Whilst positive modelling does not seem an effective strategy to promote vegetable intake by children with high food neophobia, more research specifically recruiting children with high food neophobia is required. Overall, this highlights the need to examine children's individual characteristics, and suggests that future interventions to promote healthy eating should be tailored to the characteristics of the child.

7.4. Methodological strengths and limitations

The research presented in this thesis has several strengths. One noteworthy strength of this thesis is that all studies used an experimental design, which allowed causality to be inferred. Furthermore, key strengths of this thesis include the methodologies used. The use of video stimuli in all studies presented in this thesis is an improvement on the static stimuli used in previous research (Barthomeuf et al., 2009, 2012; Rizzato et al., 2016). Static stimuli lack ecological validity, as they do not represent the actual intake of food, or the dynamic nature of facial reactions whilst eating. Indeed, observing adults producing FEs whilst eating food is more representative of a real-life eating situation. Using video stimuli also presented several advantages for the study designs used in this thesis. Recorded videos of models allowed standardisation of the experimental manipulation, as it ensured that all participants were exposed to the same models expressing the same facial reactions whilst eating, which would not have been possible with live models. One potential limitation of the experimental manipulation was an imbalance between the intensity of positive and negative FEs, since they are usually low and high (respectively). However, across Chapters 2 and 3, adult participants rated the intensity of models' positive and negative FEs as high and similar in intensity, thus it was not likely to have influenced results. Whilst this methodology is beneficial for experimental research, recorded videos still have limited ecological validity since watching pre-recorded videos of others eating does not occur in real-life eating occasions. Thus, research conducted in real-life eating situations is needed to establish the effect of naturalistic facial reactions whilst eating. Moreover, the online and remote design used in Chapters 3-6 meant that using live models would have been difficult, particularly during the COVID-19 pandemic. Instead, video stimuli allowed participants (adults and children) to be exposed to the experimental manipulation remotely. Therefore, using video stimuli to convey models' FEs whilst eating appears appropriate and advantageous for use in experimental research that requires standardised experimental manipulation.

Due to COVID-19 restrictions, Chapters 4-6 used a novel remote methodology for examining children's food consumption. Since these studies could not be conducted in schools or the laboratory, they were conducted remotely using the online video chat platform, Zoom. This approach proved to be effective and presented several advantages. Firstly, remote testing reduced the time burden for the researcher and participants since there was no travel time and testing could occur outside of the working day. Furthermore, remote testing allowed the recruitment of families from across the UK, rather than recruitment being limited to local families with the time and capacity to travel. Thus, remote studies are more accessible for participants which is beneficial for recruiting more diverse samples. Finally, compliance with study instructions by parents and children was excellent across studies, with minimal data loss due to participants not following instructions. This was possibly due to familiarity with using online platforms during the COVID-19 pandemic and being relaxed in their own home. Overall, the remote methodology provided a practical and efficient alternative to face-to-face testing, presenting a more ecologically valid eating environment for participants.

Despite the strengths of using remote methodology, there are also some limitations. Firstly, the presence and comments from other family members could have influenced children's eating behaviour. Though instructed not to, there were occasions where parents encouraged or pressured their child to consume the vegetable. Parental prompts to eat can influence children's food acceptance (Blissett et al., 2012), thus, the number of parental prompts in each session was recorded. Since there was no difference in the number of prompts between conditions in Chapters 4-6, it was unlikely to have affected the results. Furthermore, there were occasions where siblings consumed the same vegetable as the child, alongside them. Siblings can influence children's eating (Salvy et al., 2008), therefore, data was excluded from sessions where this occurred. Future research using remote methodology should ensure stringent instructions for parents to avoid the presence of other family members and parental prompts to eat. Another limitation is that children could have been aware that the researcher was watching them eat. Although the researcher turned off their camera and microphone, children were told to indicate when they had finished eating with a thumbs up to the camera. Thus, children's vegetable consumption could have been influenced by social desirability.

Another limitation in Chapters 4-6 was the experimental design used, since the control condition only included models putting pens away with neutral FEs. Whilst the condition controlled for the mere presence of an adult, it is possible that children's vegetable consumption was influenced due to the models' positive FEs alone, rather than the combination of observing vegetable consumption and positive FEs. Therefore, future research that includes a non-food control condition with models putting pens away with positive FEs is required, to establish whether it is the positive FE specifically that is encouraging children's vegetable intake. In addition, there were limitations of the methodology used to measure facial mimicry in Chapter 2. FaceReader software was used as a novel methodology to objectively measure participants' emotional responses whilst watching others eating, to assess facial mimicry between the models and participants. However, it presented several limitations. Firstly, the sensitive and stringent recording conditions required make FaceReader laborious to use and result in data loss. These issues are consistent with those of previous research (Danner et al., 2014; Hofling et al., 2020). Additionally, the intensity of emotional responses measured by FaceReader were very low, which could be due to sensitivity issues with FaceReader (Hofling et al., 2020). Finally, Hofling and colleagues (2020) discovered a 2 second latency delay when measuring emotional responses using FaceReader. This is problematic when measuring facial mimicry since it occurs rapidly. Overall, using FaceReader to measure facial mimicry does not appear an appropriate or practical methodology.

Furthermore, the measurement of eating behaviour in Chapter 3 is limited. Due to the online nature of Chapter 3, participants' subjective liking and desire to eat food was assessed. Although research has examined participant's subjective desire to eat food (Barthomeuf et al., 2009, 2012), this measure is limited in that subjective ratings of desire to eat might not reflect participants' motivational wanting for a food. Participants rated their desire to eat food based on seeing the word (e.g., 'cucumber'), rather than seeing an image of cucumber itself. Not seeing an image of the food might have reduced participants wanting of the food and thus, exposing participants to food images would have been more ecologically valid. Furthermore, research examining the effect of others' FEs on actual vegetable intake is required, since it could not be elucidated in Chapter 2 due to COVID-19 restrictions.

Limitations of the study foods used in this thesis should also be noted. Whilst broccoli in its raw form was a novel presentation for most children, familiarity with cooked broccoli could have influenced findings. For example, children might have consumed more broccoli due to familiarity with bitter tastes. To overcome potential familiarity effects, future research examining the effect of models' FEs on children's intake of a truly novel vegetable (i.e., novel in all types of presentation) should be examined. It is also possible that the palatability of vegetables influenced study findings. Indeed, participants might have consumed more of the non-modelled vegetable (mangetout) because it is more palatable than the modelled vegetable (broccoli). However, the experimental design is limited since the palatability of study vegetables was not determined before data collection. Thus, future research that includes a pilot study to examine the palatability of study vegetables is required. Moreover, this highlights the need for research that counterbalances the type of modelled and non-modelled vegetable used, to reduce potential palatability effects on vegetable consumption. Nonetheless, both modelled and non-modelled vegetables in this thesis were matched in colour, energy-density, and presentation (raw) to limit differences in palatability and reduce effects of appearance on eating behaviour. Furthermore, some of the questionnaires used in this thesis indicated reliability which was below acceptable. In Chapters 2-6, the 10-item Autism-Quotient (child and adult versions) demonstrated poor reliability. Whilst other research has shown it to be a reliable and valid measure (Allison et al., 2012), it may not be appropriate for use in non-clinical samples. Indeed, Taylor and colleagues (2020) found poor internal reliability of the AQ-10 in non-clinical adult samples. These findings can explain the poor reliability of the AQ-10 in this thesis and suggest that it might not be psychometrically robust for use in non-clinical populations. Therefore, findings pertaining to the AQ-10 (e.g., differences in autistic traits between conditions) should be interpreted with caution. In addition, the AASP demonstrated low reliability in Chapters 2 and 3. Whilst this is a commonly used measure of adult sensory processing, findings which relate to the AASP should be interpreted with caution.

Finally, the generalisability of findings in this thesis are limited. Participants were recruited from Western, educated, industrialised, rich, and democratic (WEIRD) societies, meaning the findings might not generalise other populations (Henrich et al., 2010). For example, findings might not represent families where F&V intake is often low. Recruiting

WEIRD samples is a common weakness in psychological research and future studies should aim to ensure more representative samples are recruited.

7.5. Future directions

The evidence presented in this thesis has highlighted several areas for future research. Firstly, research that investigates the effect of models' FEs on actual food consumption in adults is required, to establish whether findings in Chapter 3 translate to food intake. Though this was the aim of Chapter 2, the insufficient sample recruited meant the effect of others' FEs on food intake could not be determined. Indeed, food acceptability is associated with food intake (de Graaf et al., 2005), however, research investigating whether this effect translates to food consumption in young adults is needed. Secondly, since few children in these samples scored high in food neophobia, research is needed to specifically identify and recruit children with high food neophobia. This will help to explore the findings of Chapter 5 and 6, and better understand whether modelling is an effective strategy for children with high food neophobia, or whether tailored interventions are required. Furthermore, the findings in this thesis are based on children observing unfamiliar models consuming broccoli. It is possible that these findings will generalise to familiar models (e.g., parents), however, that remains to be investigated. Though modelling is a commonly used parental feeding strategy (Blissett et al., 2012), there has been little experimental research examining parental modelling (Larsen et al., 2015). Thus, future research should investigate the effect of parents' positive FEs on children's eating of vegetables. Another focus for future research is to determine the longer-term effect of repeated positive modelling. Whilst Chapter 6 examined the effect after one-week, whether this strategy has longer-term effectiveness, and whether children need continuous exposure to others' food enjoyment to increase children's vegetable consumption, remains to be examined. Moreover, research is needed to establish whether findings in Chapter 6 were the result of repeated exposure to food enjoyment, rather than a recency effect of observing food enjoyment. Future research should examine the delayed effect of repeated exposure to positive FEs by measuring children's vegetable intake one-week after repeated exposure to others' food enjoyment stops. The focus of raw, green vegetables (e.g., raw broccoli) in this thesis was beneficial for examining the effect of others' FEs on vegetable consumption. Using raw broccoli was advantageous since it is not commonly eaten raw, and bitter vegetables are often less preferred. This was more beneficial than using a palatable vegetable (e.g., carrots) which are typically well liked, meaning the effect of positive FEs on vegetable consumption might not have been detected due to ceiling effects.

However, future research should consider whether raw, green vegetables are appropriate to address the research question. For example, raw broccoli might be less appropriate when examining the role of food neophobia in the modelling of eating behaviour, since cooked broccoli is commonly eaten, thus, selecting a more novel vegetable would be more suitable. Also, it could be more appropriate to use a sweeter and more palatable vegetable when examining whether FEs could influence vegetable intake in individuals with high food neophobia, since encouraging initial vegetable acceptance by these populations is important but challenging. In addition to food neophobia, this thesis ensured that individual differences which have been previously found to affect eating behaviour and facial processing did not differ between condition or groups, for example, sensory processing, autistic traits, anxiety, and empathy. Though it was beyond the scope of this thesis to examine the moderating role of each trait, this should be investigated in future research to establish whether positive modelling is an effective strategy for those who need it most (i.e., individuals high in traits associated with selective eating behaviour). Another focus for future research is to determine the mechanisms by which modelling of eating behaviour occurs. For example, it is possible that mimicry occurred between the model and participants' facial reactions, and this affiliation between the model and observer promoted vegetable consumption. Whilst it is not suitable to use automated technology, like FaceReader, to examine participant's FEs whilst eating, an alternative approach could be for a Facial Action Coding Scheme trained researcher to code participant facial reactions. Thus, research examining the role of facial mimicry in the modelling of eating behaviour is required. Finally, this thesis specifically demonstrates the influence of others' FEs on the modelling of eating behaviour. Facial reactions are not always authentic, for example, parents might pretend that they enjoy eating a vegetable to encourage their child to eat it, even if the parent does not like it themselves. Based on Chapter 3 findings, it is plausible that children might be less willing to try a food if they can detect their parents' dislike. Therefore, future research that experimentally examines the effect of adults' inauthentic FEs (i.e., exposure to adults pretending they enjoy eating food) on children's vegetable consumption is required. Investigating this will help to determine whether children can detect adults' pretence of food enjoyment, and also whether inauthentic FEs are effective or counterproductive for promoting vegetable acceptance.

It is also important to consider how social modelling fits into the wider context of promoting vegetable consumption, such as during family mealtimes. For instance, during mealtimes, children are often presented with multiple food groups, which might be more palatable than vegetables. Thus, exposure to food enjoyment could be less effective when there are competing and more palatable food items present. Mealtimes often involve other family members, such as siblings, who can influence children's eating (Salvy et al., 2008). Whereas, some families do not eat meals together, making it difficult to engage in positive modelling. However, exposing children to food enjoyment is not restricted to the home environment; children could be exposed to positive modelling in school or childcare settings. In addition, parents might use multiple feeding strategies during an eating occasion. Combining modelling with other feeding practices, such as rewards and repeated exposure, has been shown to increase children's vegetable consumption (Holley et al., 2015). Thus, combining positive modelling with other feeding strategies could enhance the effect on vegetable consumption. Overall, it appears that observing food enjoyment is not a 'one size fits all' approach and research is needed to investigate the effectiveness of observing food enjoyment in the home environment on children's vegetable acceptance, to determine whether it is a useful strategy in the broader family mealtime context.

7.6. Conclusion

In conclusion, this thesis shows that observing others' FEs whilst eating a vegetable influences the modelling of eating behaviour. Findings demonstrate the adverse impact that negative FEs can have, and the beneficial impact that positive FEs can have, on the eating of vegetables. This highlights the importance of children having positive eating experiences with vegetables to encourage their consumption. These eating experiences should promote food enjoyment (e.g., via positive FEs), and avoid food dislike (e.g., via disgust FEs). Emphasising vegetable enjoyment as early as possible is important to encourage healthy dietary behaviours. This thesis also indicates that the effectiveness of modelling can vary as a function of individual differences in children's food neophobia. Therefore, interventions to encourage children's vegetable consumption should be tailored to the individual characteristics of the child. Overall, this thesis provides a significant contribution to our understanding of the effect of others' FEs in the modelling of eating behaviour by children and young adults. Future research that builds on the research reported in this thesis is required.

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Appendix A: Recruitment materials

Appendix A-1: Chapter 2 - Example study poster

PEACh

Aston University
Birmingham

Volunteers needed for research

Emotions and Food

Approximately 50 minutes and FREE FOOD!

Participants will be asked to complete:

- **Questionnaires**
- **Video task whilst being recorded**

Participants must not have current or previous eating disorders, diabetes or food allergies.

Participants cannot wear glasses for the recording. Contact lenses are fine.

Entered in a prize draw to win a

£50 Amazon voucher

Contact Katie for more information: edwardk2@aston.ac.uk

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Appendix A-2: Chapter 3 - Example study poster

Appendix A-3: Chapter 4 - Example study poster

PEACh

Aston University

ARE YOU A PARENT OF A 4-6 YEAR OLD, LIVING IN THE UK?

2-PART ONLINE STUDY

1. Short questionnaire for parents (approx. 15 mins):
- You will answer questions about you and your child's characteristics

2. Parent and child online session
- 10 minute video chat session on Zoom
- You will be asked to chop and weigh raw broccoli
- Your child will watch a short video and be given raw broccoli to eat if they would like to
- After completing the session, you will receive a £5 Amazon voucher

Your child and close family/ household members must not have any:
- Food allergies
- Food intolerances
- Medical conditions affecting eating behaviour

Appendix A-4: Chapter 6 - Example study poster

ARE YOU A PARENT OF A 5-6-YEAR-OLD, LIVING IN THE UK?

PEACh

Aston University

£15 Amazon gift card after taking part!

Short questionnaire for parents (10-15 mins)

2 parent and child Zoom sessions (10 mins each)

- You will be asked to prepare and weigh 2 snacks for each session
- Your child will watch a short video and be given the snacks to eat if they would like to
- You might be invited to complete an additional 5 minute daily task with your child

Please email Katie at edwardk2@aston.ac.uk for more details or to get involved

To take part, your child **must not have**:

- Tried uncooked broccoli or uncooked mangetout before
- Any food allergies or medical conditions (or medication) that affect their eating behaviour

Your household members **must not** have any food allergies to fruit or vegetables

Appendix B: Ethical approval

Appendix B-1: Chapter 2 ethical approval

Aston University
BIRMINGHAM UK

Aston University
Birmingham B4 7ET
United Kingdom

+44 (0)121 204 3000
www.aston.ac.uk

Date: 19 November 2019

Dr Jason Thomas
School of Life and Health Sciences

Study title:	Do emotional reactions to food stimuli predict subsequent consumption?
REC REF:	#332

Confirmation of Ethical Opinion

On behalf of the Committee, I am pleased to confirm a favourable opinion for the amendment to this research as described in the Amendment Request Form dated 16 October 2019 (appendix a)

Documents approved

Document	*Version*	*Date*
Participant Information Sheet	3	15/11/2019
Consent Form	3	15/11/2019
Revised ethics application	2	16/10/2019
Study Testpack	2	16/10/2019

With the Committee's best wishes for the success of this project.

Yours sincerely

[redacted]

Professor James Wolffsohn,
Acting Chair, University Research Ethics Committee

Appendix B-2: Chapter 3 ethical approval

Aston University
BIRMINGHAM UK

Aston University
Birmingham B4 7ET
United Kingdom

+44 (0)121 204 3000
www.aston.ac.uk

Date: 19 May 2020

Dr Jason Thomas
School of Life and Health Sciences

Study title:	Do emotional reactions to food stimuli predict food liking and desire to eat?
REC REF:	#1332

Confirmation of Ethical Opinion

On behalf of the Committee, I am pleased to confirm a favourable opinion for the amendment to this research as described in the Amendment Request Form dated 18 May 2020 (appendix a)

Documents approved

Document	*Version*	*Date*
Online Ethics Application	3	14/05/2020
Protocol	3	14/05/2020
Test Pack	3	14/05/2020
PIS and Consent	3	14/05/2020
Risk Assessment	2	14/05/2020

With the Committee's best wishes for the success of this project.

Yours sincerely

Professor James Wolffsohn,
Acting Chair, University Research Ethics Committee

Appendix B-3: Chapter 4 ethical approval

Aston University
BIRMINGHAM UK

Aston University
Birmingham B4 7ET
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+44 (0)121 204 3000
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23 September 2020

Professor Jacqueline Blissett
Student: Katie Edwards
College of Health and Life Sciences

Dear Katie,

Study title:	Using models' facial expressions to enhance healthy eating behaviour in children (laboratory and online versions)
REC REF:	#1688

Confirmation of Conditional Favourable Ethical Opinion

On behalf of the Committee, I am pleased to confirm a favourable opinion (with conditions) for the above research on the basis of the application described in the application form, protocol and supporting documentation listed below.

- Prior to commencement of any face to face participant research, copies of Standard Operating Procedures must be submitted to the Committee in relation to the lab based work including the storage and preparation of food. Until this has been submitted, only research undertaken online can be conducted.

Approved documents

The final list of documents reviewed and approved by the Committee is as follows.

Document	*Version*	*Date*
Participant Information Sheet: face to face	2	14/09/2020
Consent Form: face to face	2	14/09/2020
Test pack: lab	1	21/07/2020
Risk assessment:	1	21/07/2020
Participant Information Sheet: Online	2	14/09/2020
Consent Form: online	2	14/09/2020
Test pack: online	1	21/07/2020
Risk assessment:	1	21/07/2020

After starting your research please notify the University Research Ethics Committee of any of the following:

- Amendments. Any amendment should be sent as a Word document, with the amendment highlighted or showing tracked changes. The amendment request must be accompanied by a covering letter along with all amended documents, e.g. protocols, participant information sheets, consent forms etc. Please include a version number and amended date to the file name of any amended documentation (e.g. "Ethics Application #100 Protocol v2 amended 17/02/19.doc").

  Amendment requests should be outlined in a "Notice of Amendment Form" available by emailing research_governance@aston.ac.uk.

- Unforeseen or adverse events e.g. disclosure of personal data, harm to participants.

- New Investigators

- End of the study

Please email all notifications or queries to research_governance@aston.ac.uk and quote your UREC reference number with all correspondence.

Wishing you every success with your research.

Yours sincerely

[redacted]

Professor James Wolffsohn
Acting Chair, University Research Ethics Committee

Appendix B-4: Chapter 6 ethical approval

Aston University
BIRMINGHAM UK

Aston University
Birmingham B4 7ET
United Kingdom

+44 (0)121 204 3000
www.aston.ac.uk

9 July 2021

Professor Jacqueline Blissett
Student: Katie Edwards
College of Health and Life Sciences

Dear Katie,

Study title:	Using models' positive facial expressions to enhance children's vegetable acceptance and intake (Helping children eat vegetables: do facial expressions matter?)
REC REF:	# 1790

Confirmation of Favourable Ethical Opinion

On behalf of the Committee, I am pleased to confirm a favourable opinion for the above research on the basis of the application described in the application form, protocol and supporting documentation listed below.

Approved documents

The final list of documents reviewed and approved by the Committee is as follows.

Document	*Version*	*Date*
Participant Information Sheet	1	21/05/2021
Consent Form	1	21/05/2021
Process flowchart	1	21/05/2021
Recruitment materials	1	21/06/2021
Test pack	2	05/07/2021
Risk assessment	2	05/07/2021

After starting your research please notify the University Research Ethics Committee of any of the following:

- Amendments. Any amendment should be sent as a Word document, with the amendment highlighted or showing tracked changes. The amendment request must be accompanied by a covering letter along with all amended documents, e.g. protocols, participant information sheets, consent forms etc. Please include a version number and amended date to the file name of any amended documentation (e.g. “Ethics Application #100 Protocol v2 amended 17/02/19.doc”).

Amendment requests should be outlined in a “Notice of Amendment Form” available by emailing research_governance@aston.ac.uk.

- Unforeseen or adverse events e.g. disclosure of personal data, harm to participants.
- New Investigators
- End of the study

Please email all notifications or queries to research_governance@aston.ac.uk and quote your UREC reference number with all correspondence.

Wishing you every success with your research.

Yours sincerely

[redacted]

Professor James Wolffsohn
Acting Chair, University Research Ethics Committee

Appendix C: Participant information sheets and consent forms
Appendix C-1: Chapter 2 participant information sheet

Aston University
Life & Health Sciences

Research Participant Information Sheet

Emotions and food

Invitation
We would like to invite you to take part in a research study.
Before you decide if you would like to participate take time to read the following information carefully and, if you wish, discuss it with others such as your family, friends or colleagues. Please ask a member of the research team, whose contact details can be found at the end of this information sheet, if there is anything that is not clear or if you would like more information before you make your decision.

What is the purpose of the project?
We are interested in understanding the relationship between objective measures of emotions and food. We are inviting participants from Aston University to take part in this study.

Why have I been chosen?
You are being invited to take part in this study because: you are an adult, with no current or previous eating disorders, no food allergies and no diabetes.

What will happen to me if I take part?
If you decide to take part you will be asked to complete a consent form and complete a questionnaire regarding some basic characteristics (e.g. your gender, age) and how you are feeling at the moment. You will then be asked to look at videos on a computer screen whilst being recorded by a video camera. Following this, you will be asked to taste various food items and rate your liking of them. Finally, you will complete a series of questionnaires. You will also have your weight and height recorded.

Do I have to take part?
No. It is up to you to decide whether or not you wish to take part. If you do decide to participate, you will be asked to sign and date a consent form. You will still be free to withdraw from the study at any time without giving a reason.

Will my taking part in this study be kept confidential?
Yes. A code will be attached to all the data you provide to maintain confidentiality. Your personal data (name and contact details) will only be used if the researchers need to contact you to arrange study visits or collect data by phone. Analysis of your data will be undertaking using coded data.
The data we collect will be stored in a secure document store (paper records) or electronically on a secure encrypted mobile device, password protected computer server or secure cloud storage device.

What are the possible benefits of taking part?
By participating you will be helping to advance scientific research in this field. You will be given a free lunch buffet of food. You will also be credited by the Aston University Research Participation Scheme (RPS) or entered into a prize draw for a £50 Amazon gift voucher for your participation, provided that you complete the study in full.

What are the possible risks and burdens of taking part?
There are no significant disadvantages or risks from taking part.

What will happen to the results of the study?
The results of this study may be published in scientific journals and/or presented at conferences. If the results of the study are published, your identity will remain confidential. A lay summary of the results of the study will be available for participants when the study has been completed and the researchers will ask if you would like to receive a copy.
The results of the study will also be used in Katie Edwards PhD thesis.

How will the video recordings made during the study be managed?
The video recordings will be destroyed as soon as the research team have analysed the information in them to answer the research question. We will ensure that anything from the analysis of the videos that is included in the reporting of the study will be anonymous.

Who is funding the research?
The study is being funded by Aston University.

Who is organising this study and acting as data controller for the study?
Aston University is organising this study and acting as data controller for the study.

Who has reviewed the study?
This study was given favourable ethical opinion by the Aston University Research Ethics Committee.

What if I have a concern about my participation in the study?
If you have any concerns about your participation in this study, please speak to the research team and they will do their best to answer your questions. Contact details can be found at the end of this information sheet. If the research team are unable to address your concerns or you wish to make a complaint about how the study is being conducted Participant Information Sheet Guidance Notes V3 20180730 you should contact the Aston University Director of Governance, Mr. John Walter, j.g.walter@aston.ac.uk or telephone 0121 204 4869.

Research Team
Katie Edwards (edwardk2@aston.ac.uk)
Dr Jason Thomas (0121 204 4899, j.thomas8@aston.ac.uk;)
Professor Jacqueline Blissett (0121 204 3784, j.blissett1@aston.ac.uk)

Thank you for taking time to read this information sheet. If you have any questions regarding the study please don't hesitate to ask one of the research team.

Appendix C-2: Chapter 2 consent form

Aston University

Emotions and Food

Consent Form

Name of Chief Investigator: Katie Edwards

Please initial boxes

1.	I confirm that I have read and understand the Participant Information Sheet (V2-16-10-2019) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
2.	I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and without my legal rights being affected.	
3.	I agree to my personal data and data relating to me collected during the study being processed as described in the Participant Information Sheet.	
4.	I agree to study visits being video recorded.	
5.	I agree to my anonymised data being used by research teams for future research.	
6.	I agree to my personal data being processed for the purposes of inviting me to participate in future research projects. I understand that I may opt out of receiving these invitations at any time.	
7.	I agree to take part in this study.	

Appendix C-3: Chapter 3 participant information sheet

Aston University
Life & Health Sciences

Research Participant Information Sheet

Emotions and food

Invitation
We would like to invite you to take part in a research study.

Before you decide if you would like to participate take time to read the following information carefully and, if you wish, discuss it with others such as your family, friends or colleagues.

Please ask a member of the research team, whose contact details can be found at the end of this information sheet, if there is anything that is not clear or if you would like more information before you make your decision.

What is the purpose of the project?
We are interested in understanding the relationship between emotions and food. We are inviting adult participants to take part in this study.

Why have I been chosen?
You are being invited to take part in this study because: you are an adult aged **18-30**, living in the UK, with no current or previous eating disorders, no food allergies and no diabetes.

What will happen to me if I take part?
If you decide to take part you will be asked to complete a consent form and complete a questionnaire regarding some basic characteristics (e.g. your gender, age), how you are feeling at the moment and your liking of various foods. You will then be asked to watch videos and answer questions about them after. Finally, you will complete a series of questionnaires and report your weight and height.

Do I have to take part?
No. It is up to you to decide whether or not you wish to take part. If you do decide to participate, you will be asked to sign a consent form. You will still be free to withdraw from the study at any time without giving a reason.

Will my taking part in this study be kept confidential?
Yes. A code will be attached to all the data you provide to maintain confidentiality. Your personal data (name and contact details) will only be used if the researchers need to contact you to arrange study visits or collect data by phone. Analysis of your data will be undertaking using coded data.

The data we collect will be stored in a secure document store (paper records) or electronically on a secure encrypted mobile device, password protected computer server or secure cloud storage device.

What are the possible benefits of taking part?
By participating you will be helping to advance scientific research in this field. You will be entered into a prize draw for a £50 Love2Shop gift voucher for your participation, provided that you complete the study in full.

What are the possible risks and burdens of taking part?
There are no significant disadvantages or risks from taking part.

What will happen to the results of the study?
The results of this study may be published in scientific journals and/or presented at conferences. If the results of the study are published, your identity will remain confidential. A lay summary of the results of the study will be available for participants when the study has been completed and the researchers will ask if you would like to receive a copy.

The results of the study will also be used in Katie Edwards PhD thesis.

Who is funding the research?
The study is being funded by Aston University.

Who is organising this study and acting as data controller for the study?
Aston University is organising this study and acting as data controller for the study.

Who has reviewed the study?
This study was given favourable ethical opinion by the Aston University Research Ethics Committee.

What if I have a concern about my participation in the study?
If you have any concerns about your participation in this study, please speak to the research team and they will do their best to answer your questions. Contact details can be found at the end of this information sheet. If the research team are unable to address your concerns or you wish to make a complaint about how the study is being conducted you should contact the Aston University Research integrity office at research_governance@aston.ac.uk or telephone 0121 204 3000.

Research Team
Katie Edwards (edwardk2@aston.ac.uk)
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Professor Jacqueline Blissett (0121 204 3784, j.blissett1@aston.ac.uk)

Thank you for taking time to read this information sheet. If you have any questions regarding the study, please don't hesitate to ask one of the research team.

Appendix C-4: Chapter 4 consent form

Aston University

Emotions and Food

Consent Form

Name of Chief Investigator: Katie Edwards

Please initial boxes

1.	I confirm that I have read and understand the Participant Information Sheet (V3-14-05-2020) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
2.	I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and without my legal rights being affected.	
3.	I agree to my personal data and data relating to me collected during the study being processed as described in the Participant Information Sheet.	
4.	I agree to my anonymised data being used by research teams for future research.	
5.	I agree to my personal data being processed for the purposes of inviting me to participate in future research projects. I understand that I may opt out of receiving these invitations at any time.	
6.	I agree to take part in this study.	

Appendix C-5: Chapter 4 participant information sheet

Aston University

Using models' facial expressions to enhance healthy eating behaviour in children

Participant Information Sheet

Invitation

We would like to invite you and your child to take part in a research study.

Before you decide if you would like to participate, take time to read the following information carefully and, if you wish, discuss it with others such as your family, friends or colleagues.

Please ask a member of the research team, whose contact details can be found at the end of this information sheet, if there is anything that is not clear or if you would like more information before you make your decision.

What is the purpose of the study?

The purpose of the study is to examine the effect of other people's facial expressions towards vegetables on children's willingness to try and eating of raw broccoli. The study will also examine your child's characteristics: their sensory processing, anxiety, empathy and autistic traits and how willing they are to try new foods. People differ in these traits and they are being measured to examine whether they influence your child's willingness to try and eating of raw broccoli. They are not being measured for diagnostic purposes.

Why have I been chosen?

You and your child are being invited to take part in this study because your child is aged 4-6 years old with no food allergies, intolerances or medical conditions that influence eating behaviour. To be eligible to participate, there should also be no food allergies, intolerances or medical conditions that influence eating behaviour in your child's immediate family or household members.

What will happen to my child and I if we take part?

If you decide to take part, you will be provided with an online study link to complete various questionnaires online (suitable for mobile phone use). You will be asked demographic questions and the usual fruit and vegetable intake of you and your child. You will also be asked questions about your child's characteristics. These questionnaires will measure your child's sensory processing, anxiety, empathy and autistic traits and how willing they are to try new foods. People differ in these traits and this is known to influence our eating behaviour and how we process faces. Therefore, this information is being collected to examine whether these traits influence your child's willingness to try and eating of raw broccoli. These measures are not diagnostic (e.g., they cannot establish whether your child has autism) and individual feedback will not be given. These questionnaires should take around 15 minutes to complete.

Once you have completed the online questionnaires, a session using an online video chat platform (e.g. Zoom) will be arranged at a time convenient to you. You and your child will need to be present for this session. Prior to the session you will be asked to prepare and weigh a portion of raw broccoli. Details of how to do this will be provided via email.

Firstly, we will explain to your child what the session will involve and ask them if they would like to take part. There will be no pressure for your child to take part in any of the tasks and participation will only take place if your child is happy to take part. If they agree to take part, we will ask your child how hungry they feel at that moment using a picture scale of a teddy bear. Following this, your child will watch one of 3 short video clips of adults either: eating a raw broccoli whilst smiling; eating a raw broccoli with a neutral facial expression; or playing with toys. Next, you will be asked to give your child a portion of raw broccoli to eat. Your child will be told they can try the food if they would like to, but they do not have to. They will be recorded through the online platform whilst interacting with the food. You will then be asked to re-weigh the food and report the 'before and after' weights to the researcher. Finally, you and your child will have the opportunity to ask questions about the study. This session should take around 10 minutes.

Do I have to take part?

No. It is up to you to decide whether or not you wish you and your child to take part.

If you do decide to participate, you will be asked to complete a consent form. You would still be free to withdraw from the study at any time without giving a reason. Once you have completed the study, you will have 1 month to withdraw your data if you change your mind about participating.

Will my taking part in this study be kept confidential?

Yes. Your child's name will be used to match your consent to your child. Your email address will used to arrange the online session. This will be stored in a separate and secure database and will be completely deleted once data collection is complete. A code will be attached to all the data you provide. Analysis will be undertaken using anonymised data and your identifying information is not stored with the data you provide. We never share your identifying information.

The data we collect will be stored in a secure document store (paper records) or electronically on a secure encrypted mobile device, password protected computer server or secure cloud storage device. Once we have finished our data analysis, an anonymous version of the data may be shared with other researchers. You will not be identifiable in any such dataset.

What are the possible benefits of taking part?
By participating you will be helping to advance scientific research in understanding children's eating.

What are the possible risks and burdens of taking part?
There are no significant disadvantages or risks from taking part. To reduce risk of an allergic reaction to food, children with food allergies of any kind are not eligible to take part in the study.
There will be a time burden for you and your child completing the study. Your questionnaires should take no more than 15 minutes for you to complete. The online video chat session for you and your child will last approximately 10 minutes and will take place at a time convenient to you.

What will happen to the results of the study?

The results of this study may be published in scientific journals and presented at conferences. If the results of the study are published, your identity will remain confidential.

A summary of the results of the study will be available when the study has been completed and the researchers will ask if you would like to receive a copy.

The results of the study will also be used in Katie Edwards' PhD thesis.

Expenses and payments
You will receive a £5 shopping voucher to compensate you for purchasing raw broccoli.

Who is funding the research?

The study is being funded by Aston University.

Who is organising this study and acting as data controller for the study?

Aston University is organising this study and acting as data controller for the study. You can find out more about how we use your information in Appendix A.
Who has reviewed the study?

This study was given a favorable ethical opinion by Aston University Research Ethics Committee.

What if I have a concern about my participation in the study?

If you have any concerns about your participation in this study, please speak to the research team and they will do their best to answer your questions. Contact details can be found at the end of this information sheet.

If the research team are unable to address your concerns or you wish to make a complaint about how the study is being conducted you should contact the Aston University Research Integrity Office at research_governance@aston.ac.uk or telephone 0121 204 3000.

Research Team
Katie Edwards (edwardk2@aston.ac.uk)
Professor Jacqueline Blissett (0121 204 3784, j.blissett1@aston.ac.uk)
Dr Jason Thomas (0121 204 4899, j.thomas8@aston.ac.uk)

Thank you for taking time to read this information sheet. If you have any questions regarding the study please don't hesitate to ask one of the research team.

Appendix C-6: Chapter 4 consent form

Aston University

Using models' facial expressions to enhance modelling of healthy eating behaviour in children

Online Consent Form

Name of Chief Investigator: Katie Edwards

Please initial boxes

1.	I confirm that I have read and understand the Participant Information Sheet (V2-14-09-2020) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
2.	I understand that my participation and my child's participation is voluntary and that we are free to withdraw at any time, without giving any reason and without my legal rights being affected.	
3.	I agree to my personal data and my child's personal data, and data relating to us collected during the study being processed as described in the Participant Information Sheet.	
4.	I agree to my anonymised data and my child's anonymised data being used by research teams for future research.	
5.	I agree to take part in this study.	

If you would like to be sent a summary of the results when the study has been finished and data analysed, please include your email address below:
……………

Appendix C-7: Chapter 6 participant information sheet

Aston University
BIRMINGHAM UK

Using models' positive facial expressions to enhance children's vegetable acceptance and intake

(Helping children eat vegetables: do facial expressions matter?)

Participant Information Sheet (Parents)

Invitation

We would like to invite you and your child to take part in a research study.

Before you decide if you would like to participate, take time to read the following information carefully and, if you wish, discuss it with others such as your family, friends or colleagues.

Please ask a member of the research team, whose contact details can be found at the end of this information sheet, if there is anything that is not clear or if you would like more information before you make your decision.

What is the purpose of the study?

This study will test whether seeing a video of a person smiling when they eat a vegetable makes children more likely to eat the same vegetable themselves. We will also look at whether this effect lasts for a week. This study will measure some of your child's characteristics: how they respond to sensory information (such as taste and texture), how willing they are to try new foods and their typical eating behaviour. People differ in these responses, and they are being measured to test whether they are related to your child's acceptance and eating of vegetables. They are not being measured for diagnostic purposes (e.g., they cannot establish whether your child has a problem with their senses) and individual feedback will not be given.

Why have I been chosen?

You and your child are being invited to take part in this study because your child is aged 5-6 years old, and you are both living in the UK. To take part, your child should have no food allergies, and no medical condition (or medication) that affects their eating. You should have no household members with a food allergy to fruit or vegetables. Your child should not have tried raw (uncooked) broccoli or raw (uncooked) mangetout before. To take part in the study, both you and your child should be willing to do so, though of course you can change your minds at any time.

What will happen to my child and I if we take part?

If you decide to take part, you will be provided with a link to complete an online questionnaire (suitable for computer/laptop/tablet/mobile phone use). You will be asked questions about you and your child's characteristics (e.g., gender, age) so that we know a little more about the people who take part in our study, and we can make sure that we include a wide range of people. You will then be asked to complete some questionnaires to measure how your child responds to sensory information, how willing they are to try new foods and their typical eating behaviour. These questionnaires should take around 15 minutes to complete.

Once you have completed the online questionnaires, two online sessions will be arranged at a time convenient to you. The sessions will be 7 days apart (e.g., if your first session was on a Monday, the second session will take place the following Monday) and they will take place using an online video chat platform (e.g., Zoom). You and your child will both need to be present for this session. Before the session, you will be asked to purchase, prepare, and weigh a portion of raw broccoli and raw mangetout. Details of how to do this will be provided via email and you will be compensated for your purchase with a shopping voucher after completing the study.

At both online sessions, we will explain to your child what the session involves and ask them if they would like to take part. There will be no pressure for your child to take part in any of the tasks, and participation will only take place if your child is happy to take part. If they agree to take part, we will ask your child how hungry they feel at that moment using a picture scale of a teddy bear. At the first session, your child will watch one of 2 short video clips of adults either: eating a vegetable whilst smiling or putting pens away into a pencil case (this video will not be shown in the second session). Next, you will be asked to give your child a portion of raw broccoli and raw mangetout to eat. Your child will be told that they can try the food if they would like to, but they do not have to. They will be recorded through the online platform whilst interacting with the food. You will then be asked to re-weigh the vegetables and report the 'before and after' weights to the researcher. Finally, you and your child will have the opportunity to ask questions about the study. This session should take around 10 minutes.

After the first online session, you may be randomly invited to complete a brief online task with your child each day for 5 days. This will take approximately 5 minutes each day. A third of our participants will be asked to do this. If randomly invited, you will receive an email after booking your online sessions. You may let the researcher know if you would not like to do this task and it will not affect your taking part in the other sessions. If you are invited and decide to participate, you will be sent an email including the links to the daily task. You will be asked to report the time and day of the week, and how long ago your child last ate anything. You will then be asked to show your child a short video clip of adults eating a vegetable whilst smiling. To check your child has watched the video, they will be asked a simple question about the video. To make the daily task fun for your child, they will receive a letter of the alphabet after answering the question. Save the letter each day to find out the secret word, which you and your child can tell the researcher at the second online session. The researcher will let you know if you have been randomly invited to complete these tasks and will email you details of what you will need to do if you are happy to take part. This part of the study is to examine whether children need repeated exposures of other people enjoying vegetables to influence their vegetable acceptance and eating. If you are not randomly selected, you will just have the first and second online sessions only (no tasks in between).

How will the video recordings made during the study be managed?

The video recordings will be destroyed as soon as the research team have analysed the information in them to answer the research question.

We will ensure that anything from the analysis of the videos that is included in the reporting of the study will be anonymous.

Do I have to take part?

No. It is up to you to decide whether or not you wish you and your child to take part.

If you do decide to participate, you will be asked to complete a consent form for your and your child's participation. Your child will also be asked to give their assent to take part in the online sessions. You would still be free to withdraw from the study at any time without giving a reason. Once you have completed the study, you will have one month to withdraw your data if you change your mind about participating. Data will be anonymised, so after this time you will be unable to withdraw, because we will not be able to tell which data is yours.

Will my taking part in this study be kept confidential?

Yes.
A code will be attached to all the data you provide to maintain confidentiality. Your personal data (name and contact details) will only be used when the researchers need to contact you to organise study sessions. Analysis of your data will be undertaken using coded data. The data we collect will be stored in a secure document store (paper records) or electronically on a secure encrypted mobile device, password protected computer server or secure cloud storage device. Once we have finished our data analysis, an anonymous version of the data may be shared with other researchers. You will not be identifiable in any such dataset.

What are the possible benefits of taking part?

While there are no direct benefits to you of taking part in this study, the data gained will be helping to advance scientific research in understanding children's eating behaviour.

What are the possible risks and burdens of taking part?

To reduce risk of an allergic reaction to the vegetables, children with food allergies are not eligible to take part in the study. If a member of your household has an allergy to fruit or vegetables, you are also not eligible to take part in the study due to the risk of allergic reaction.

There will be a time burden for you and your child completing the study. Your questionnaires should take no more than 15 minutes for you to complete. The online video chat sessions for you and your child will both last approximately 10 minutes and will take place at a time convenient to you. If you are randomly invited to show your child the video on 5 different days at home, this will take no more than 5 minutes each day.

What will happen to the results of the study?

The results of this study may be published in scientific journals and/or presented at conferences. If the results of the study are published, your identity will remain confidential. A lay summary of the results of the study will be available for participants when the study has been completed and the researchers will ask if you would like to receive a copy. The results of the study will also be used in Katie Edwards' PhD thesis.

Expenses and payments
You will receive a £15 shopping voucher to compensate you for taking part in the study and purchasing the vegetables. If you are randomly invited to complete a 5-minute task for 5 days with your child, you will receive an additional £5 shopping voucher after taking part to compensate you for your additional time.

Who is funding the research?
The study is being funded by Aston University.

Who is organising this study and acting as data controller for the study?
Aston University is organising this study and acting as data controller for the study. You can find out more about how we use your information in Appendix A.

Who has reviewed the study?

This study was given a favorable ethical opinion by Aston University Research Ethics Committee.

What if I have a concern about my participation in the study?

If you have any concerns about your participation in this study, please speak to the research team and they will do their best to answer your questions. Contact details can be found at the end of this information sheet.

If the research team are unable to address your concerns or you wish to make a complaint about how the study is being conducted you should contact the Aston University Research Integrity Office at research_governance@aston.ac.uk or telephone 0121 204 3000.

Research Team
Katie Edwards (edwardk2@aston.ac.uk)
Professor Jacqueline Blissett (0121 204 3784, j.blissett1@aston.ac.uk)
Dr Jason Thomas (0121 204 4899, j.thomas8@aston.ac.uk)

Thank you for taking time to read this information sheet. If you have any questions regarding the study, please don't hesitate to ask one of the research team.

Appendix C-8: Chapter 6 consent form

Aston University
BIRMINGHAM UK

Using models' positive facial expressions to enhance children's vegetable acceptance and intake

(Helping children eat vegetables: do facial expressions matter?)

Consent Form (online)

Name of Chief Investigator: Katie Edwards

Please enter your initials into each box to indicate you have read and agree to the statement:

1.	I confirm that I have read and understand the Participant Information Sheet (V1-21-05-2021) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
2.	I understand that my participation and my child's participation is voluntary and that we are free to withdraw at any time, without giving any reason and without my legal rights being affected.	
3.	I agree to my personal data and my child's personal data, and data relating to us collected during the study, being processed as described in the Participant Information Sheet.	
4.	I agree to online sessions being video recorded.	
5.	I agree to my anonymised data and my child's anonymised data being used by research teams for future research.	
6.	I agree to take part in this study.	

If you would like to be sent a summary of the results when the study has been finished and data analysed, please include your email address below:
……………

Appendix D: Questionnaires and measures

Appendix D-1: Chapter 2 - Demographic and Lifestyle Questionnaire

Please answer all of the following questions. All answers will be treated as strictly confidential.

1. What is your age? …………

2. Please state your gender:
   Man *Woman* *Other*

3. Please choose which option best describes your ethnic background:
   White British
   White Irish
   White and Black Caribbean
   White and Black African
   White and Asian
   Indian
   Pakistani
   Bangladeshi
   Chinese
   Black Caribbean
   Black African
   Other Black
   Other
   Prefer not to say

   If other, please specify….....

4. Do you regularly eat breakfast in the morning? *Yes* *No*

5. Do you regularly eat lunch? *Yes* *No*

6. Do you suffer from any medical illnesses, food allergies or intolerances: e.g., diabetes, nut allergies or lactose intolerance? *Yes* *No*

   If yes, please state ………………………

7. Do you presently have, or have you ever had, an eating disorder? *Yes* *No*

8. Do you smoke? *Yes* *No*

If yes, please indicate how many cigarettes you smoke per day, on average.

1-5 5-10 10-15 15-20 20-25 25+

9. Approximately how many hours ago did you last eat anything?
   ___________________ hours

Appendix D-2: Chapter 3 - Demographic and Lifestyle Questionnaire

Please answer all of the following questions. All answers will be treated as strictly confidential.

1. What is your age? …………

2. Please state your gender:
   Man *Woman* *Other* *Prefer not to say*

3. Please choose which option best describes your ethnic background:
   White British
   White Irish
   White and Black Caribbean
   White and Black African
   White and Asian
   Indian
   Pakistani
   Bangladeshi
   Chinese
   Black Caribbean
   Black African
   Other Black
   Other
   Prefer not to say
   If other, please specify…......

4. Are you a student? *Part-time student* *Full-time student* *No*

5. Are you employed? *Part-time employment* *Full-time employment* *Unemployed*

6. Do you regularly eat breakfast in the morning? *Yes* *No*

7. Do you regularly eat lunch? *Yes* *No*

8. Do you suffer from any medical illnesses, food allergies or intolerances: e.g., nut allergies or lactose intolerance? *Yes* *No*

   If yes, please state ……………………………

9. Do you smoke? *Yes* *No*

   If yes, please indicate how many cigarettes you smoke per day, on average.

   1-5 5-10 10-15 15-20 20-25 25+

10. Approximately how many hours ago did you last eat anything?
    ___________________ hours

Appendix D-3: Chapters 2 & 3 - Hunger and mood state

Please answer the following questions.

Using the sliders below, please indicate your current levels of the following factors. **Don't** spend a long time thinking about each one. Each scale runs from 0-100 with 100 being the most you **could ever imagine** and 0 being **completely absent**.

You must move the sliders for a response to be logged.

Alertness	0	____	100
Drowsiness	0	____	100
Light-headed	0	____	100
Anxiety	0	____	100
Happiness	0	____	100
Nausea	0	____	100
Sadness	0	____	100
Withdrawn	0	____	100
Faint	0	____	100
Hungry	0	____	100
Full	0	____	100
Desire to Eat	0	____	100
Thirst	0	____	100

Appendix D-4: Chapters 2 & 3 Habitual Intake and Liking

Please answer the following questions:

1. How many servings of vegetables do you normally eat a day?
(1 serving = 80g or 1 large serving spoon of vegetables)

2. How much do you like eating vegetables?

Liking 0____100

3. How many servings of fruit do you normally eat a day?
(1 serving = 80g, 1 item of fruit, or a large handful of berries)

4. How much do you like eating fruit?

Liking 0____100

5. How many junk food snack items do you normally eat a day?
(E.g. a small bar of chocolate, a packet of crisps, etc.)

6. How much do you like eating junk food snack items?

Liking 0____100

7. How many sugar-sweetened beverages (e.g. fruit juice, fizzy drinks, etc.) do you normally consume a day?
(E.g. soft drinks, fruit juice, sweetened-tea/coffee, energy drinks, etc.)

8. How much do you like drinking sugar-sweetened beverages?

Liking 0____100

Appendix D-5: Adolescent / Adult Sensory Profile (AASP; Brown & Dunn, 2002)

This questionnaire could not be reproduced due to copyright.

More information about the AASP can be found here:
https://www.pearsonassessments.com/store/usassessments/en/Store/Professional-Assessments/Motor-Sensory/Adolescent-Adult-Sensory-Profile/p/100000434.html

Appendix D-6: Adult Eating Behaviour Questionnaire (AEBQ; Hunot et al., 2016)

Please read each statement and tick the box most appropriate to you

		Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
EF	I love food					
FF	I often decide that I don't like a food, before tasting it					
EF	I enjoy eating					
EF	I look forward to mealtimes					
EOE	I eat more when I'm annoyed					
H	I often notice my stomach rumbling					
FF	I refuse new foods at first					
EOE	I eat more when I'm worried					
H	If I miss a meal I get irritable					
EOE	I eat more when I'm upset					
SR	I often leave food on my plate at the end of a meal					
FF*	I enjoy tasting new foods					
FR	I often feel hungry when I am with someone who is eating					
SE*	I often finish my meals quickly					
EUE	I eat less when I'm worried					
EOE	I eat more when I'm anxious					
FR	Given the choice, I would eat most of the time					
EUE	I eat less when I'm angry					
FF*	I am interested in tasting new food I haven't tasted before					
EUE	I eat less when I'm upset					
EOE	I eat more when I'm angry					
FR	I am always thinking about food					
SR	I often get full before my meal is finished					
FF*	I enjoy a wide variety of foods					
SE	I am often last at finishing a meal					
SE	I eat more and more slowly during the course of a meal					
EUE	I eat less when I'm annoyed					
H	I often feel so hungry that I have to eat something right away					
SE	I eat slowly					
SR	I cannot eat a meal if I have had a snack just before					
SR	I get full up easily					
H	I often feel hungry					
FR	When I see or smell food that I like, it makes me want to eat					

H	If my meals are delayed I get light-headed					
EUE	I eat less when I’m anxious					

***Reversed items**

EF = Enjoyment of food

EOE = Emotional over-eating

EUE = Emotional under-eating

FF = Food fussiness

FR = Food responsiveness

SE = Slowness in eating

H = Hunger

SR = Satiety responsiveness

Appendix D-7: Autism-Spectrum Quotient (AQ-10; Allisson et al., 2012)

Please tick one option per question only.

	Definitely Agree	Slightly Agree	Slightly Disagree	Definitely Disagree
I often notice small sounds when others do not				
I usually concentrate more on the whole picture rather than the small details				
I find it easy to do more than one thing at once				
If there is an interruption, I can switch back to what I was doing very quickly				
I find it easy to 'read between the lines' when someone is talking to me				
I know how to tell if someone listening to me is getting bored				
When I'm reading a story I find it difficult to work out the characters' intentions				
I like to collect information about categories of things (e.g. types of car, types of bird, types of train, types of plant etc.)				
I find it easy to work out what someone is thinking or feeling just by looking at their face				
I find it difficult to work out people's intentions				

Only 1 point can be scored for each question. Score 1 point for Definitely or Slightly Agree on each of items 1, 7, 8, and 10. Score 1 point for Definitely or Slightly Disagree on each of items 2, 3, 4, 5, 6, and 9.

Individuals with scores more than 6 out of 10 should be considered for referral to specialist diagnostic assessment.

Appendix D-8: Beck's Anxiety Inventory (BAI; Beck & Steer, 1993)

Below is a list of common symptoms of anxiety. Please carefully read each item in the list. Indicate how much you have been bothered by that symptom during the past month, including today, by circling the number in the corresponding space in the column next to each symptom.

	Not at all	Middle, but it didn't bother me much	Moderately – it wasn't pleasant at times	Severely – it bothered me a lot
Numbness or tingling				
Feeling hot				
Wobbliness in legs				
Unable to relax				
Fear of worst happening				
Dizzy or lightheaded				
Heart pounding / racing				
Unsteady				
Terrified or afraid				
Nervous				
Feeling of choking				
Hands trembling				
Shaky / unsteady				
Fear of losing control				
Difficulty in breathing				
Fear of dying				
Scared				
Indigestion				
Faint / lightheaded				
Face flushed				
Hot / cold sweats				

Appendix D-9: Food Neophobia Scale (FNS; Pliner & Hobden, 1992)

Please select one option per question:

	1	2	3	4	5	6	7
I am constantly sampling new and different foods*							
I don't trust new foods							
If I don't know what a food is, I won't try it							
I like foods from different cultures*							
Ethnic food looks too weird to eat							
At dinner parties, I will try new foods*							
I am afraid to eat things I have never had before							
I am very particular about the foods I eat							
I will eat almost anything*							
I like to try new ethnic restaurants*							

***Reversed items**

1 = Disagree strongly
2 = Disagree moderately
3 = Disagree slightly
4 = Neither disagree nor agree
5 = Agree slightly
6 = Agree moderately
7 = Agree strongly

Appendix D-10: Three Factor Eating Questionnaire (TFEQ-R21; Cappelleri et al., 2009)

We would like to ask you some questions about your eating style.
Please tick the response that best applies to you:

1. I deliberately take small helpings as a means of controlling my weight

2. I start to eat when I feel anxious.

3. Sometimes when I start eating, I just can't seem to stop.

4. When I feel sad, I often eat too much.

5. I don't eat some foods because they make me fat.

6. Being with someone who is eating, often makes me want to also eat.

7. When I feel tense or "wound up", I often feel I need to eat.

8. I often get so hungry that my stomach feels like a bottomless pit.

9. I'm always so hungry that it's hard for me to stop eating before finishing all of the food on my plate.

10. When I feel lonely, I console myself by eating.

11. I consciously hold back on how much I eat at meals to keep from gaining weight.

12. When I smell a sizzling steak or see a juicy piece of meat, I find it very difficult to keep from eating - even if I've just finished a meal.

13. I'm always hungry enough to eat at any time.

14. If I feel nervous, I try to calm down by eating.

15. When I see something that looks very delicious, I often get so hungry that I have to eat right away.

16. When I feel depressed, I want to eat.

Questions 1-16 answered on a scale from:

(1) Definitely true, (2) Mostly true, (3) Mostly false, (4) Definitely false

17. How often do you avoid "stocking up" on tempting foods?

(1) Almost never, (2) Seldom, (3) Usually, (4) Almost always

18. How likely are you to make an effort to eat less than you want?

(1) Unlikely, (2) A little likely, (3) Somewhat likely, (4) Very likely

19. Do you go on eating binges even though you're not hungry?

(1) Never, (2) Rarely, (3) Sometimes, (4) At least once a week

20. How often do you feel hungry?

(1) Only at mealtimes, (2) Sometimes between meals, (3) Often between meals, (4) Almost always

21. On a scale from 1 to 8, where 1 means no restraint in eating and 8 means total restraint, what number would you give yourself?

1 2 3 4 5 6 7 8

Items 1-16 should be reverse coded, and item 21 should be recoded as follows: 1–2 scores as 1; 3–4 as 2; 5–6 as 3; 7–8 as 4.

Uncontrolled eating subscale items: 3, 6, 8, 9, 12, 13, 15, 19, 20

Cognitive restraint subscale items: 1, 5, 11, 17, 18, 21

The emotional eating subscale items: 2, 4, 7, 10, 14, 16

Appendix D-11: Toronto Empathy Scale (TEQ; Spreng et al., 2009)

Below is a list of statements. Please read each statement carefully and rate how frequently you feel or act in the manner described. Select your answer on the response form. There are no right or wrong answers or trick questions. Please answer each question as honestly as you can.

	Never	**Rarely**	**Sometimes**	**Often**	**Always**
When someone else is feeling excited, I tend to get excited too					
Other people's misfortunes do not disturb me a great deal*					
It upsets me to see someone being treated disrespectfully					
I remain unaffected when someone close to me is happy*					
I enjoy making other people feel better					
I have tender, concerned feelings for people less fortunate than me					
When a friend starts to talk about his\her problems, I try to steer the conversation towards something else*					
I can tell when others are sad even when they do not say anything					
I find that I am "in tune" with other people's moods					
I do not feel sympathy for people who cause their own serious illnesses*					
I become irritated when someone cries*					
I am not really interested in how other people feel					
I get a strong urge to help when I see someone who is upset					
When I see someone being treated unfairly, I do not feel very much pity for them*					
I find it silly for people to cry out of happiness*					
When I see someone being taken advantage of, I feel kind of protective towards him\her					

***Reversed items**

Appendix D-12: Chapters 4 - 6 - Demographic and Lifestyle Questionnaire

Please answer the following questions. All answers will be treated as strictly confidential.

1. Please state your gender
   Man *Woman* *Other* *Prefer not to say*

2. How old are you? ………..

3. Please choose which option best describes your ethnic background
   White British
   White Irish
   White and Black Caribbean
   White and Black African
   White and Asian
   Indian
   Pakistani
   Bangladeshi
   Chinese
   Black Caribbean
   Black African
   Other Black
   Other
   Prefer not to say
   If other, please specify…

4. What is the highest educational qualification you have achieved?
   No schooling completed
   GCSE/ O-Level/ other level 2 qualification
   A Level/ Level 3 qualification
   Degree
   Postgraduate qualification
   Other
   If other, please specify…

5. Do you have any special dietary requirements or dietary needs? (E.g., Vegetarianism, veganism, religious dietary requirements, etc.)
   Yes *No* If Yes, please specify….

6. How many children do you have in total? ….....

7. Please state your child's gender
   Boy *Girl* *Other* *Prefer not to say*

8. Please state the age of your child in years and months *Years....* *Months....*

9. Please report your child's height *CM or Feet/inches ….*

10. Please report your child's weight *KG or Stone/pounds ….*

Exclusion checks:

1. Please state any allergies or conditions your child has that may affect their eating behaviour (e.g., nut allergy, diabetes) …

   Intolerances: *Yes* *No*

   Food allergies: *Yes* *No*

   Medical conditions that may affect eating behaviour: *Yes* *No*

   If you answered Yes to any of these questions, please specify….

2. Please state any allergies or conditions that yourself, close family members or household members have that affect eating behaviour (e.g. nut allergy, diabetes) …

   Intolerances: *Yes* *No*

   Food allergies: *Yes* *No*

   Medical conditions that may affect eating behaviour: *Yes* *No*

   If you answered Yes to any of these questions, please specify….

Appendix D-13: Habitual Fruit and Vegetable Consumption

Please answer the following questions about **your own** eating habits:

1. How many servings of **vegetables** do you normally eat a day?
(1 serving = 80g or 1 large serving spoon of vegetables)

2. Think back carefully, how many servings of **vegetables** did you eat yesterday?
(1 serving = 80g or 1 large serving spoon of vegetables)

3. How many servings of **fruit** do you normally eat a day?
(1 serving = 80g, 1 item of fruit, or a large handful of berries)

4. Think back carefully, how many servings of **fruit** did you eat yesterday?
(1 serving = 80g, 1 item of fruit, or a large handful of berries)

Please answer the following questions about **your child's** eating habits

1. How many servings of **vegetables** do they normally eat a day?
(1 serving = 80g or 1 large serving spoon of vegetables)

2. Think back carefully, how many servings of **vegetables** did they eat yesterday?
(1 serving = 80g or 1 large serving spoon of vegetables)

3. How many servings of **fruit** do they normally eat a day?
(1 serving = 80g, 1 item of fruit, or a large handful of berries)

4. Think back carefully, how many servings of **fruit** did they eat yesterday?
(1 serving = 80g, 1 item of fruit, or a large handful of berries)

Appendix D-14: Child Autism-Spectrum Quotient (AQ-10; Allison et al., 2012)

Please tick one option per question only:

	Definitely Agree	Slightly Agree	Slightly Disagree	Definitely Disagree
S/he often notices small sounds when others do not				
S/he usually concentrates more on the whole picture, rather than the small details				
In a social group, s/he can easily keep track of several different people's conversations				
S/he finds it easy to go back and forth between different activities				
S/he doesn't know how to keep a conversation going with his/her peers				
S/he is good at social chit-chat				
When s/he is read a story, s/he finds it difficult to work out the character's intentions or feelings				
When s/he was in preschool, s/he used to enjoy playing games involving pretending with other children				
S/he finds it easy to work out what someone is thinking or feeling just by looking at their face				
S/he finds it hard to make new friends				

Only 1 point can be scored for each question. Score 1 point for Definitely or Slightly Agree on each of items 1, 7, 8, and 10. Score 1 point for Definitely or Slightly Disagree on each of items 2, 3, 4, 5, 6, and 9.

Individuals with scores more than 6 out of 10 should be considered for referral to specialist diagnostic assessment.

Appendix D-15: Children's Eating Behaviour Questionnaire (CEBQ; Wardle et al., 2001)

Please read the following statements and tick the boxes most appropriate to your child's eating behaviour.

		Never	**Rarely**	**Sometimes**	**Often**	**Always**
EF	My child loves food					
SR*	My child has a big appetite					
EF	My child is interested in food					
FF	My child refuses new foods at first					
FF*	My child enjoys tasting new foods					
FR	My child is always asking for food					
FR	If allowed to, my child would eat too much					
FF*	My child enjoys a wide variety of foods					
SR	My child leaves food on his/her plate at the end of a meal					
FR	Given the choice, my child would eat most of the time					
EF	My child looks forward to mealtimes					
SR	My child gets full before his/her meal is finished					
EF	My child enjoys eating					
FF	My child is difficult to please with meals					
SR	My child gets full up easily					
FR	Even if my child is full up s/he finds room to eat his/her favourite food					
SR	My child cannot eat a meal if s/he has had a snack just before					
FF*	My child is interested in tasting food s/he hasn't tasted before					
FF	My child decides that s/he doesn't like a good, even without tasting it					
FR	If given the chance, my child would always have food in his/her mouth					

***Reversed items**

FR = Food responsiveness
EF = Enjoyment of food
SR = Satiety responsiveness
SE = Slowness in eating
FF = Food fussiness

Appendix D-16: Child Food Neophobia Scale (CFNS; Pliner, 1994)

Please select one option per question:

	1	2	3	4	5	6	7
My child does not trust new foods							
If my child doesn't know what's in a food, s/he won't try it							
My child is afraid to eat thing s/he has never tried before							
My child will eat almost anything*							
My child is very particular about the food s/he will eat							
My child is constantly sampling new and different foods*							

***Reversed items**

1 = Disagree strongly
2 = Disagree moderately
3 = Disagree slightly
4 = Neither disagree nor agree
5 = Agree slightly
6 = Agree moderately
7 = Agree strongly

Appendix D-17: Empathy Questionnaire (EmQue; Rieffe et al., 2010)

The following statements are about your child's behaviour over the last 2 months. Please answer them to the best of your ability, even if the behaviour mentioned in the statement does not seem to apply to your child.

	Not at all applicable	A little or sometimes applicable	Clearly or often applicable
When another child cries, my child gets upset too.			
When I make clear that I want some peace and quiet, my child tries not to bother me.			
When my child sees other children laughing, he/she starts laughing too.			
My child also needs to be comforted when another child is in pain.			
When another child starts to cry, my child tries to comfort him/her.			
When an adult gets angry with another child, my child watches attentively.			
When another child makes a bad fall, shortly after my child pretends to fall too.			
When another child gets upset, my child tries to cheer him/her up.			
My child looks up when another child laughs.			
When another child is upset, my child needs to be comforted too.			
When I make clear that I want to do something by myself (e.g. read), my child leaves me alone for a while.			
When adults laugh, my child tries to get near them.			
When another child gets frightened, my child freezes or starts to cry.			
When two children are quarrelling, my child tries to stop them.			
My child looks up when another child cries.			
When other children argue, my child gets upset.			
When another child gets frightened, my child tries to help him/her.			
When another child is angry, my child stops his own play to watch.			
When another child cries, my child looks away.			
When other children quarrel, my child wants to see what is going on.			

Appendix D-18: Preschool Anxiety Scale (PAS; Spence et al., 2001)

Below is a list of items that describe children. For each item please select the response that best describes your child. Please answer all the items as well as you can, even if some do not seem to apply to your child.

	Not True at All	Seldom True	Sometimes True	Quite Often True	Very Often True
Has difficulty stopping him/herself from worrying					
Worries that he/she will do something to look stupid in front of other people					
Keeps checking that he/she has done things right (e.g., that he/she closed a door, turned off a tap)					
Is tense, restless or irritable due to worrying					
Is scared to ask an adult for help (e.g., a preschool or schoolteacher)					
Is reluctant to go to sleep without you or to sleep away from home					
Is scared of heights (high places)					
Has trouble sleeping due to worrying					
Washes his/her hands over and over many times each day					
Is afraid of crowded or closed-in places					
Is afraid of meeting or talking to unfamiliar people					
Worries that something bad will happen to his/her parents					
Is scared of thunderstorms					
Spends a large part of each day worrying about various things					
Is afraid of talking in front of the class (preschool group) e.g., show and tell					
Worries that something bad might happen to him/her (e.g., getting lost or kidnapped), so he/she won't be able to see you again					
Is nervous of going swimming					
Has to have things in exactly the right order or position to stop bad things from happening					

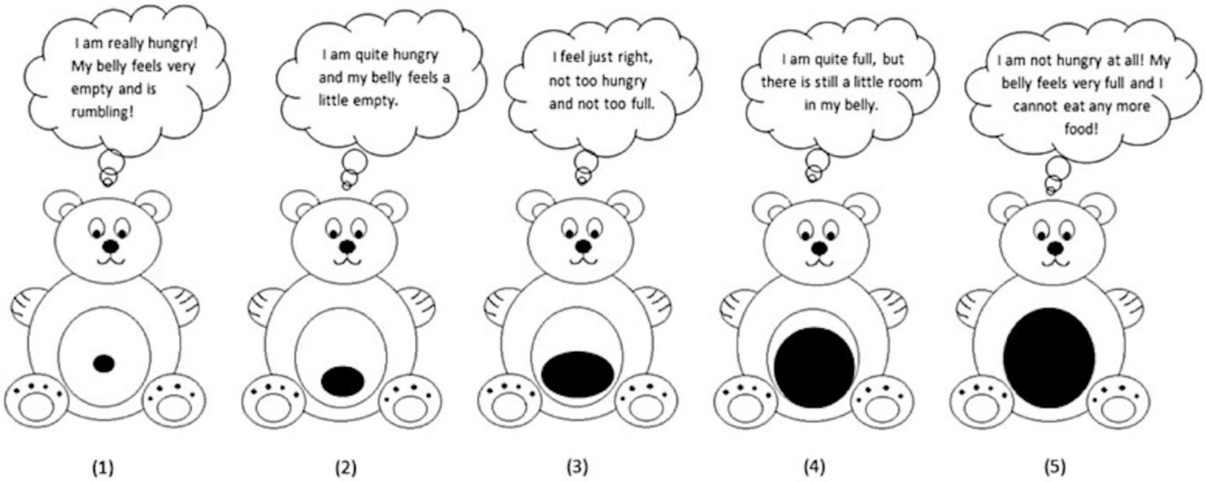
Worries that he/she will do something embarrassing in front of other people					
Is afraid of insects and/or spiders					
Has bad or silly thoughts or images that keep coming back over and over					
Becomes distressed about your leaving him/her at preschool/school or with a babysitter					
Is afraid to go up to group of children and join their activities					
Is frightened of dogs					
Has nightmares about being apart from you					
Is afraid of the dark					
Has to keep thinking special thoughts (e.g., numbers or words) to stop bad things from happening					
Asks for reassurance when it doesn't seem necessary					

Appendix D-19: Sensory Experiences Questionnaire (SEQ; Baranek et al., 2006)

Please read each statement and select the box most appropriate to your child's behaviour:

	Almost never	**Once in a while**	**Sometimes**	**Frequently**	**Almost always**
Does not respond to name					
Ignores new person					
Seeks rough-housing play					
Stares at lights/objects					
Flaps arms					
Lacks attention to novel objects					
Mouths objects					
Ignores loud noises					
Smells objects					
Does not respond to pain					
Craves movement					
Dislikes being held					
Distressed during grooming					
Averse to social touch					
Avoids eye contact					
Dislikes tickling					
Sensitive to loud noises					
Avoids textures					
Sensitive to lights					
Averse to water					
Averse food taste/ texture					

Appendix D-20: Teddy Picture Rating Scale (Bennett & Blissett, 2014)



● - Food in Teddy's belly

Appendix E: Additional tables

Appendix E-1: Chapter 2 mood, appetite, and individual difference scores

Table A: Mean (SD) baseline mood and appetite scores in positive, negative, and neutral conditions

	Positive	Negative	Neutral	*F*	*p*
Alertness	61.00 (19.56)	67.48 (21.50)	61.92 (15.66)	0.94	.39
Drowsiness	30.78 (26.56)	26.66 (27.26)	25.88 (21.54)	0.29	.75
Light-headed	12.89 (21.48)	13.62 (22.50)	13.69 (20.33)	0.01	.99
Anxious	18.41 (21.04)	19.24 (23.56)	18.85 (19.04)	0.01	.99
Happiness	60.30 (19.68)	63.93 (17.05)	59.12 (16.20)	0.56	.57
Nausea	7.60 (17.37)	11.31 (18.08)	9.54 (18.26)	0.30	.74
Sadness	14.93 (17.63)	16.10 (23.71)	14.00 (18.69)	0.07	.93
Withdrawn	20.60 (19.96)	19.72 (25.53)	22.73 (24.19)	0.12	.89
Faint	8.60 (15.70)	11.97 (18.59)	13.19 (20.61)	0.45	.64
Energised	39.70 (20.45)	50.93 (23.89)	45.62 (25.16)	1.63	.20
Stressed	36.04 (31.43)	30.07 (27.00)	34.31 (25.05)	0.34	.71
Thirst	57.67 (23.80)	52.10 (27.86)	57.42 (22.61)	0.45	.64
Appetite*	62.11 (23.77)	44.59 (21.75)	51.62 (22.70)	4.19	02

Table B: Mean (SD) individual difference measures in positive, negative, and neutral conditions

	Positive	Negative	Neutral	*F*	*p*
AASP					
Low Registration	14.33 (3.33)	15.03 (4.00)	14.85 (4.62)	0.23	.80
Sensation Seeking	25.15 (4.44)	24.93 (4.42)	25.27 (5.38)	0.04	.97
Sensory Sensitivity	19.56 (3.95)	19.17 (5.09)	18.58 (4.13)	0.33	.72
Sensory Avoiding	22.70 (4.78)	21.14 (4.43)	21.46 (4.74)	0.87	.42
AEBQ					
Enjoyment of food	4.54 (.56)	4.47 (.59)	4.51 (.51)	0.12	.89
Emotional overeating	2.54 (1.17)	2.39 (.92)	2.43 (.98)	0.17	.85
Emotional undereating	3.44 (1.01)	2.90 (.89)	3.29 (1.15)	2.06	0.13
Food fussiness	2.35 (.97)	2.52 (.77)	2.39 (.85)	0.57	.57
Food responsiveness	3.69 (.66)	3.43 (.75)	3.53 (.74)	0.96	.39
Hunger	3.19 (.73)	3.04 (.63)	3.22 (.82)	0.50	.61
Slowness in eating	2.57 (1.12)	2.66 (1.02)	2.62 (.87)	0.05	.96
Satiety responsiveness	2.72 (.80)	2.78 (.79)	2.54 (.86)	0.66	.52
AQ-10	2.96 (1.19)	2.52 (1.66)	3.04 (1.68)	0.95	.39
BAI*	16.15 (8.93)	10.07 (7.46)	14.88 (11.95)	3.18	.047
FNS	30.85 (12.99)	30.17 (10.14)	31.73 (10.79)	0.13	.88
TEQ	50.93 (5.88)	48.76 (5.21)	49.38 (6.63)	0.99	.38
TFEQR-21					
Uncontrolled eating	23.22 (5.15)	22.62 (3.69)	23.65 (4.52)	0.37	.69
Cognitive restraint	13.52 (4.22)	14.55 (3.65)	13.42 (3.91)	0.71	.49
Emotional eating	13.11 (4.69)	12.59 (4.34)	13.33 (4.51)	0.80	.46

Note. Adolescent/Adult Sensory Profile (AASP); Adult Eating Behaviour Questionnaire (AEBQ); Autism-Spectrum Quotient (AQ-10); Beck's Anxiety Inventory (BAI); Food Neophobia Scale (FNS); Toronto Empathy Questionnaire (TEQ); Three Factor Eating Questionnaire (TFEQ-R21).

Appendix E-2: Mediation analysis - facial mimicry

Table A: Coefficients for facial mimicry as a mediator of the relationship between FE type and broccoli and cucumber intake

		Consequent								
		M (FM)					Y (Broccoli intake)			
Antecedent		**Coeff.**	***SE***	***t***	***p***		**Coeff.**	***SE***	***t***	***p***
X (FE 1)	***a***	-.03	.05	-.54	.59	***c'***	1.21	5.08	.24	.81
M (FM)		-	-	-	-	***b***	-8.35	11.58	-.72	.47
constant	i_M	.02	.05	.45	.66	i_Y	7.87	5.30	1.48	.14
		R^2 = .16 F(4, 70) = 3.45, *p* = .01					R^2 = .01 F(5,69) = .82, *p* = .54			
X (FE 2)	***a***	.02	.05	.46	.65	***c'***	-5.27	5.19	-1.02	.31
M (FM)		-	-	-	-	***b***	-11.36	12.92	-.88	.38
constant	i_M	-.04	.05	-.68	.50	i_Y	14.50	5.83	2.49	.02
		R^2 = .32 F(4, 70) = 8.39, *p* < .0001					R^2 = .05 F(5, 69) = .71 *p* = .62			
X (FE 3)	***a***	.05	.04	1.43	.16	***c'***	-6.08	4.95	-1.23	.26
M (FM)		-	-	-	-	***b***	-17.74	15.63	-1.14	.26
constant	i_M	-.05	.04	-1.05	.30	i_Y	14.14	5.85	2.42	.02
		R^2 = .54 F(4, 70) = 20.54, *p* < .0001					R^2 = .05 F(5, 69) = .77, *p* = .57			
		M (FM)					**Y (Cucumber intake)**			
X (FE 1)	***a***	.05	.08	.60	.55	***c'***	21.17	10.30	2.06	.04
M (FM)		-	-	-	-	***b***	-20.24	15.20	-1.33	.19
constant	i_M	.02	.08	.20	.84	i_Y	56.53	10.73	5.27	.00
		R^2 = .09 F(4, 70) = 1.71, *p* = .16					R^2 = .16 F(5, 69) = 2.70, *p* = .03			
X (FE 2)	***a***	.00	.09	.04	.97	***c'***	-3.49	10.40	-.34	.74
M (FM)		-	-	-	-	***b***	-19.24	14.48	-1.33	.19
constant	i_M	.05	.10	.54	.59	i_Y	80.94	11.70	6.92	.00
		R^2 = .01 F(4, 70) = .10, *p* = .98					R^2 = .17 F(5, 69) = 2.86, *p* = .02			
X (FE 3)	***a***	-.04	.04	-.93	.36	***c'***	-24.56	9.94	-2.47	.02
M (FM)		-	-	-	-	***b***	-18.87	26.87	-.70	.49
Constant	i_M	.03	.05	.62	.54	i_Y	81.00	11.77	6.88	.00
		R^2 = .71 F(4, 70) = 42.53, *p* < .0001					R^2 = .16 F(5, 69) = 2.69, *p* = .03			

Note. FM = Facial mimicry; FE 1 = positive FE vs negative FE; FE 2 = positive FE vs neutral FE; FE 3 = negative FE vs neutral FE

Table B: Coefficients for facial mimicry as a mediator of the relationship between FE type and broccoli and cucumber liking

	Consequent									
		M (FM)					**Y (Broccoli change in liking)**			
Antecedent		**Coeff.**	***SE***	***t***	***p***		**Coeff.**	***SE***	***t***	***p***
X (FE 1)	***a***	-.03	.05	-.54	.59	***c'***	6.06	8.24	.74	.46
M (FM)		-	-	-	-	***b***	21.61	18.79	1.15	.25
constant	i_M	.02	.05	.45	.66	i_Y	.97	8.60	.11	.91
		$R^2 = .16$					$R^2 = .11$			
		$F(4, 70) = 3.45$, $p = .01$					$F(5, 69) = 1.64$, $p = .16$			
X (FE 2)	***a***	.02	.05	.46	.65	***c'***	-13.29	8.50	-1.56	.12
M (FM)		-	-	-	-	***b***	16.42	21.17	.78	.44
constant	i_M	-.04	.05	-.68	.50	i_Y	20.92	9.56	2.19	.03
		$R^2 = .32$					$R^2 = .08$			
		$F(4, 70) = 8.39$, $p < .0001$					$F(5, 69) = 1.23$, $p = .30$			
X (FE 3)	***a***	.05	.04	1.43	.16	***c'***	-16.60	25.30	-.66	.51
M (FM)		-	-	-	-	***b***	-16.60	25.30	-.66	.51
Constant	i_M	-.05	.04	-1.05	.30	i_Y	19.14	9.47	2.02	.05
		$R^2 = .54$					$R^2 = .11$			
		$F(4, 70) = 20.54$, $p < .0001$					$F(5, 69) = 1.66$, $p = .16$			
		M (FM)					**Y (Cucumber change in liking)**			
X (FE 1)	***a***	.05	.08	.60	.55	***c'***	11.80	5.35	2.20	.03
M (FM)		-	-	-	-	***b***	4.19	7.90	.53	.60
constant	i_M	.02	.08	.20	.84	i_Y	6.71	5.58	1.20	.23
		$R^2 = .09$					$R^2 = .10$			
		$F(4, 70) = 1.71$, $p = .16$					$F(5, 69) = 1.61$, $p = .17$			
X (FE 2)	***a***	.00	.09	.04	.97	***c'***	7.53	5.44	1.39	.17
M (FM)		-	-	-	-	***b***	3.69	7.56	.49	.63
constant	i_M	.05	.10	.54	.59	i_Y	3.69	7.56	.49	.63
		$R^2 = .01$					$R^2 = .10$			
		$F(4, 70) = .10$, $p = .98$					$F(5, 69) = 1.60$, $p = .17$			
X (FE 3)	***a***	-.04	.04	-.93	.36	***c'***	-4.01	5.15	-.78	.44
M (FM)		-	-	-	-	***b***	11.15	13.93	.80	.43
Constant	i_M	.03	.05	.62	.54	i_Y	10.88	6.10	1.78	.08
		$R^2 = .71$					$R^2 = .11$			
		$F(4, 70) = 42.53$, $p < .0001$					$F(5, 69) = 1.69$, $p = .15$			

Note. FM = Facial mimicry; FE 1 = positive FE vs negative FE; FE 2 = positive FE vs neutral FE; FE 3 = negative FE vs neutral FE

Appendix E-3: Chapter 3 mood, appetite, and individual difference scores

Table A: Mean (SD) baseline mood and appetite scores for participants in each condition (one-way ANOVA)

	Positive	Negative	Neutral	*F*	*p*
Alertness	59.22 (21.37)	64.15 (21.99)	65.01 (20.60)	1.42	.24
Drowsiness	47.71 (28.90)	40.48 (24.80)	37.46 (28.63)	2.43	.09
Light-headed	25.20 (25.65)	22.10 (20.00)	24.04 (26.87)	0.29	.75
Anxious	38.38 (30.93)	37.12 (29.31)	40.06 (31.33)	0.16	.85
Happiness	63.23 (20.16)	64.58 (20.70)	67.19 (17.39)	0.71	.49
Nausea	17.23 (21.39)	15.49 (22.90)	15.48 (23.49)	0.13	.88
Sadness	34.00 (28.33)	33.32 (26.72)	31.93 (27.48)	0.10	.91
Withdrawn	32.00 (29.14)	32.32 (28.28)	27.18 (26.34)	0.72	.49
Faint	12.63 (15.89)	14.01 (19.02)	13.76 (21.61)	0.10	.90
Energised	44.15 (24.69)	47.36 (22.44)	51.30 (24.89)	1.47	.23
Stressed	49.69 (26.21)	42.18 (31.38)	49.16 (28.94)	1.47	.23
Hunger	37.45 (32.04)	36.81 (29.87)	28.91 (27.69)	1.70	.19
Fullness	59.02 (28.42)	53.07 (27.74)	59.78 (29.70)	1.16	.31
Desire to Eat	46.11 (31.95)	27.08 (29.92)	42.91 (30.16)	0.35	.71
Thirst	61.41 (24.66)	56.37 (24.88)	61.36 (24.73)	0.95	.39

Table B: Mean (SD) change in liking and change in desire to eat scores for additional food items

		Mean (SD)
Change in liking	Grapes	-1.19 (11.91)
	Apple	.50 (12.41)
	Crisps	-.98 (12.02)
	Tortilla chips	-3.33 (14.06)
	Chocolate	-.21 (10.51)
	Cookies	-1.34 (13.49)
Desire to eat	Grapes	-.01 (1.34)
	Apple	.05 (1.45)
	Crisps	-.08 (1.37)
	Tortilla chips	.01 (1.51)
	Chocolate	-.08 (1.63)
	Cookies	-.12 (1.53)

Table C: Mean (SD) scores on questionnaires measuring individual characteristics for participants in each condition (one-way ANOVA)

	Positive	Negative	Neutral	*F*	*p*
AASP					
Low Registration	14.25 (3.93)	14.51 (3.56)	14.64 (3.56)	0.20	.82
Sensation Seeking	26.05 (4.11)	25.21 (4.68)	25.82 (3.64)	0.76	.47
Sensory Sensitivity	20.75 (4.77)	20.49 (4.24)	20.48 (4.89)	0.08	.93
Sensory Avoiding	21.31 (4.50)	21.55 (4.13)	21.97 (4.93)	0.37	.70
AEBQ					
Enjoyment of food	4.37 (0.67)	4.20 (0.73)	4.41 (0.71)	1.82	.16
Emotional overeating	2.88 (1.02)	2.53 (1.04)	2.50 (0.95)	2.88	.06
Emotional undereating	3.08 (1.02)	3.32 (0.95)	3.36 (0.93)	1.55	.22
Food fussiness	2.30 (0.93)	2.30 (0.93)	2.41 (0.95)	0.32	.73
Food responsiveness	3.41 (0.79)	3.30 (0.76)	3.38 (0.71)	0.39	.68
Hunger	3.03 (0.76)	3.08 (0.76)	3.09 (0.71)	0.12	.89
Slowness in eating	2.89 (0.89)	2.76 (1.06)	2.69 (1.03)	0.72	.49
Satiety responsiveness	2.57 (0.75)	2.73 (0.84)	2.82 (0.80)	1.73	.18
AQ-10	3.12 (1.71)	3.16 (1.92)	3.03 (1.69)	0.10	.90
BAI	18.08 (10.43)	18.36 (11.72)	18.51 (12.65)	0.02	.98
FNS	33.29 (10.24)	35.00 (9.81)	35.03 (9.83)	0.66	.52
TEQ	49.22 (6.30)	49.68 (6.82)	50.22 (5.78)	0.42	.66
TFEQR-21					
Uncontrolled eating	21.32 (5.46)	20.33 (5.34)	20.39 (4.71)	0.77	.46
Cognitive restraint	13.85 (3.62)	14.42 (4.35)	14.62 (4.46)	0.61	.55
Emotional eating	14.77 (4.93)	12.81 (5.34)	13.19 (4.73)	2.88	.06

Note. Adolescent/Adult Sensory Profile (AASP); Adult Eating Behaviour Questionnaire (AEBQ); Autism-Spectrum Quotient (AQ-10); Beck's Anxiety Inventory (BAI); Food Neophobia Scale (FNS); Toronto Empathy Questionnaire (TEQ); Three Factor Eating Questionnaire (TFEQ-R21).

Table D: Pearson Correlation coefficients for change in liking of broccoli and cucumber, and AEBQ and TFEQ-R21 subscales

	Change in liking				**Change in desire to eat**			
	Broccoli		Cucumber		Broccoli		Cucumber	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*
AEBQ								
Enjoyment of food	-.06	.41	-.04	.62	-.09	.21	-.03	.65
Emotional overeating	.69	.69	-.11	.12	-.02	.77	-.00	.96
Emotional undereating	-.00	.96	.14*	.04	.09	.21	.03	.67
Food fussiness	.02	.80	.04	.58	.01	.83	.11	.23
Food responsiveness	-.07	.30	.07	.31	-.08	.26	.03	.67
Hunger	.04	.58	.07	.30	-.09	.19	.06	.40
Slowness in eating	-.04	.58	.15*	.03	.08	.25	-.08	.27
Satiety responsiveness	.01	.86	-.03	.73	-.02	.76	-.01	.88
TFEQ-R21								
Uncontrolled eating	-.05	.48	.03	.68	-.08	.27	.08	.24
Cognitive restraint	-.02	.77	.01	.94	-.04	.61	.08	.28
Emotional eating	-.03	.65	-.14*	.04	-.03	.66	.04	.59

*$p < .05$.