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Clare E. Holley, Claire Farrow, Emma Haycraft

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Investigating the role of parent and child characteristics in healthy eating intervention outcomes

Clare E Holley[1]

Claire Farrow[2]

Emma Haycraft[1*]

[1] Loughborough University, Leicestershire, UK

[2] Aston University, Birmingham, UK

* Address correspondence or requests for reprints to: Dr Emma Haycraft, School of Sport, Exercise & Health Sciences, Loughborough University, Loughborough, Leicestershire, LE11 3TU, UK. Email: E.Haycraft@lboro.ac.uk, Tel. +44(0)1509 228160.

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Abstract

While numerous studies have investigated the efficacy of interventions at increasing children's vegetable consumption, little research has examined the effect of individual characteristics on intervention outcomes. In previous research, interventions consisting of modelling and rewards have been shown to increase children's vegetable intake, but differences were identified in terms of how much children respond to such interventions. With this in mind, the current study investigated the role of parental feeding practices, child temperament, and child eating behaviours as predictors of intervention success. Parents (N=90) of children aged 2-4 years were recruited from toddler groups across Leicestershire, UK. Parents completed measures of feeding practices, child eating behaviours and child temperament, before participating in one of four conditions of a home-based, parent led 14 day intervention aimed at increasing their child's consumption of a disliked vegetable. Correlations and logistic regressions were performed to investigate the role of these factors in predicting intervention success. Parental feeding practices were not significantly associated with intervention success. However, child sociability and food fussiness significantly predicted intervention success, producing a regression model which could predict intervention success in 61% of cases. These findings suggest that future interventions could benefit from being tailored according to child temperament. Furthermore, interventions for children high in food fussiness may be better targeted at reducing fussiness in addition to increasing vegetable consumption.

Key words: Vegetable, intervention, temperament, eating behaviours, parent, feeding practices, children

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It is well known that vegetables are commonly disliked by children (e.g., Cooke & Wardle, 2005; Skinner, Carruth, Bounds, & Ziegler, 2002), as well as being under consumed (Public Health England & Food Standards Agency, 2014). Given that food habits established in childhood are known to track through to adulthood (e.g., Lytle, Seifert, Greenstein, & McGovern, 2000; Mikkilä, Räsänen, Raitakari, Pietinen, & Viikari, 2007), interventions aimed at increasing vegetable consumption in early childhood are vital. Both parent and child factors (e.g., parents' feeding practices and child eating behaviours) have been linked to children's intake of fruit and vegetables (e.g., Cooke et al., 2004; Galloway, Fiorito, Lee, & Birch, 2005; Galloway, Lee, & Birch, 2003; Palfreyman, Haycraft, & Meyer, 2014). However, it is not known whether individual differences in the ways that caregivers parent, or in children's characteristics, influence the outcome of interventions aimed at increasing children's acceptance of previously disliked vegetables. Indeed, Mitchell, Farrow, Haycraft, and Meyer, (2013) suggest that although interventions aimed at increasing vegetable consumption have shown promising results, their outcomes may well be influenced by the ability of the parent, other actors, and/or the child to engage with the intervention.

A previous paper described the development of a home-based parent led intervention comprised of a programme of 14 daily offerings of a vegetable which the child disliked (Holley, Haycraft, & Farrow, 2014). It focused on comparing different elements of an intervention to explore which behaviours are necessary alongside repeated exposure to increase children's liking and consumption of a disliked vegetable. These elements were rewards and modelling, with four different variants of this programme explored. It was found that post-intervention consumption of the target vegetable was significantly higher for children who had experienced either rewards and repeated exposure or the combination of modelling, rewards and repeated exposure when compared to a no-offerings control group. Nevertheless, significant increases in consumption across the intervention period were seen in all intervention groups, with strong variability within each group. This suggests that rather than one type of intervention being the most successful, individual differences in both parent and child factors likely influence the success of such interventions. With this is mind, research needs to explore the individual parent and child factors which might be related to the success or failure of these interventions, in order to help modify and tailor the development of future interventions in this area.

One characteristic that might alter the success of such interventions is the feeding practices that children are exposed to from their parents. Feeding practices have previously been shown to influence children's eating behaviours in both positive (such as promoting healthy food choice and consumption) and negative (such as increasing unhealthy food choice and food avoidance) ways (e.g., Blissett, Haycraft, & Farrow, 2010; Fisher, Mitchell, Smiciklas-Wright, & Birch, 2002; Palfreyman et al., 2014; Pearson, Biddle, & Gorely, 2009). Several feeding practices may be used in an effort to promote 'healthier' eating in children, with parental modelling of fruit and vegetable intake suggested as a potentially successful method for increasing child intake (e.g., Cullen, 2001; Gregory, Paxton, & Brozovic, 2011; Palfreyman et al., 2014; Pearson et al., 2009; Tibbs et al., 2001). Research also supports the use of a healthy home environment and encouraging balance and variety for increasing vegetable consumption (Melbye, Øgaard, & Øverby, 2013), with school education programmes suggesting utility in teaching children about nutrition (Auld, Romaniello, Heimendinger, Hambidge, & Hambidge, 1999). With this in mind, it is possible that interventions may be more successful for children whose parents adopt feeding practices which promote healthy eating.

Parenting does not occur as a one-way process and characteristics of children, such as their temperament, can influence parenting (e.g., Stright, Gallagher, & Kelley, 2008; Vereecken, Legiest, De Bourdeaudhuij, & Maes, 2009) and quite probably the success of any parenting based interventions. Low sociability could possibly inhibit a child's potential to learn eating behaviours through others, particularly through methods such as modelling. In support of this notion, children with inhibited approach (shyness/low sociability) have indeed shown lower initial acceptance of novel foods (Moding, Birch, & Stifter, 2014). Another aspect of child temperament that is linked to eating behaviour is emotionality. Children who display higher levels of emotionality have been reported by parents to be more food avoidant (Haycraft, Farrow, Meyer, Powell, & Blissett, 2011) and parental reports of their child being emotional or shy (less sociable) have been related to children's unwillingness to try new foods (Pliner & Loewen, 1997). Moreover, children having a difficult temperament (characterised by high emotionality and low sociability) has been associated with difficult mealtimes and food refusal in children (Farrow & Blissett, 2007). Together, this research indicates that some aspects of child temperament may be linked to more difficult eating behaviours in children and also to the success of vegetable interventions.

Children's general eating behaviours are also likely to be important in determining their intake of healthy foods. Enjoyment of food has been positively related to vegetable liking (Fildes et al., 2015) as well as fruit and vegetable consumption in pre-schoolers (Cooke et

al., 2004) and food enjoyment has also been found to be a predictor of consumption change across previous vegetable interventions, with those who enjoy food more achieving greater increases in consumption in Caton et al.'s (2014) study. Food fussiness is also likely to influence children's eating behaviours. Children who are picky or fussy eaters like vegetables less (e.g., Fildes et al., 2015) and often consume fewer fruits and vegetables than other children (e.g., Galloway et al., 2005), while recent research suggests that the underpinnings of food fussiness lie in a child's genetic make-up (Fildes, van Jaarsveld, Cooke, Wardle & Llewellyn, 2016). Food fussiness has been reported to correlate negatively with enjoyment of food and food responsiveness and positively with satiety responsiveness (Svensson et al., 2011; Wardle, Guthrie, Sanderson, & Rapoport, 2001). Research has investigated whether children's food responsiveness is associated with how successful parents' methods of encouraging consumption of novel fruits are, finding that children who are less responsive to food may respond more to parental modelling of consumption (Blissett, Bennett, Fogel, Harris & Higgs, 2016). As a body of literature, this suggests that enjoyment of food, food responsiveness, satiety responsiveness and food fussiness may influence the choices children make about what and when they eat, including vegetables.

In summary, it is known that most children do not eat enough fruits and vegetables (Lennox, Olson, & Gay, 2011). Furthermore, it is likely that parent factors (such as feeding practices) and child factors (such as temperament and eating behaviour) contribute to children's low consumption of vegetables. The aim of this study was to examine whether parental feeding practices, child temperament, and child eating behaviours were associated with children's acceptance of a disliked vegetable after a home-based, parent led, repeated exposure intervention. Factors that were significantly associated were then examined for their ability to predict the success or failure of the repeated exposure interventions. It was hypothesised that a repeated exposure based intervention would result in greater consumption of a disliked vegetable for children whose parents report using health-promoting feeding practices, including encouraging balance and variety, involving their child in meal planning and preparation, modelling healthy eating, teaching about nutrition, keeping a healthy home food environment, and for children who display higher levels of food approach behaviours (i.e. enjoyment of food and food responsiveness). It was further hypothesised that a repeated exposure based intervention would result in lower consumption of a disliked vegetable for children who are described as higher in emotionality, lower in sociability, display higher levels of food avoidant behaviours (i.e. food fussiness and satiety responsiveness), and whose parents use greater pressure to eat.

Method

Participants

Ninety parent-child pairs took part in this study. Children were aged from 27 to 55 months (*M* = 39 months; SD = 7.77 months). Parents' age ranged from 22 to 46 years (*M* = 35.85 years, SD = 4.82 years). Child height and weight were measured by the researcher and converted into age and gender adjusted BMI z-scores (Cole, Freeman, & Preece, 1995). Children's BMI z-scores ranged from -3.07 to 1.73 (*M* = 0.21, SD = 0.90). Parents' BMI (kg / m^2) ranged from 25.60 to 38.44 (*M* = 25.60, SD = 4.66), and 42% of the children who took part were male (n = 38).

Procedure

Full ethical clearance for this study was obtained from Loughborough University's Institutional Review Board. Parents were recruited from toddler groups across the East Midlands of the UK. Individuals with children aged between two and four years old were approached and asked if they would like to take part in a study which aimed to encourage their child to eat disliked vegetables. Following recruitment, all parents provided informed consent and were fully advised of their right to withdraw themselves or their child at any point. Children also assented to take part in the study.

Baseline

During a baseline session, parents were asked to complete a series of validated questionnaire measures, described below, as well as to provide demographic information for themselves and their child, including age, gender, ethnicity, and level of education. Children were also assigned a target vegetable from a list of commonly consumed vegetables (ensuring they are disliked rather than novel; tomato, celery, cucumber, pepper, baby corn and sugar snap peas) which, in line with previous studies (e.g., Cooke et al., 2011), parents rated as being disliked by their child. This dislike was confirmed by the child during a taste test and five minute free-eating session. If dislike was not confirmed by the child, the process was repeated to find a suitable alternative vegetable.

Parent-child dyads all took part in a parent led, home-based 14 day intervention designed to increase children's consumption of a disliked vegetable. This length of intervention was chosen on the basis of previous research (e.g., Cooke et al., 2011) whilst allowing testing of consumption at weekly toddler groups. Each dyad was assigned to one of four experimental groups: one where parents simply offered the vegetable daily (condition 1 - repeated exposure); one where parents modelled eating the target vegetable and then offered it to their child (condition 2 - modelling and repeated exposure); one where parents gave small

incentives and praise in exchange for trying the vegetable (condition 3 - rewards and repeated exposure); and one combining modelling, rewards and daily offering (condition 4). For this intervention, all parents were asked to offer they child a small piece of a target vegetable outside of a mealtime, using the methods assigned to them (either simple offering, modelling tasting, rewarding tasting or all of these methods). Parents were also asked to complete a daily tasting diary, recording whether offerings were performed in line with the instructions and whether these offerings resulted in tastings. On average, caregivers made 12 offerings (*M* =11.95, *SD* =2.49), showing good compliance with the study protocol.

After the 14 day intervention period, parent-child dyads attended a follow-up session. This session was identical in format to the baseline session to allow comparison of liking and consumption of the targeted vegetables pre and post-intervention. Parent and child height and weight were also measured (using Salter scales/Stanley tylon pocket tape measure), and parents returned their completed tasting diaries.

Both pre (baseline) and post intervention, each child was provided with a weighed and chopped 30g portion of their disliked target vegetable. Each child was asked to try a piece of the vegetable, and told they could eat as much as they liked during a five minute free eating session. The portion was removed and re-weighed to measure consumption once five minutes had passed or the child had terminated the session

Measures

Comprehensive Feeding Practices Questionnaire (CFPQ; Musher-Eizenman & Holub, 2007)

Feeding practices were measured using five subscales of the CFPQ. These subclass were: Pressure to eat (e.g. '*If my child says, "I'm not hungry," I try to get him/her to eat anyway'*); Modelling (e.g. '*I show my child how much I enjoy eating healthy foods'*); Environment (e.g. '*Most of the food I keep in the house is healthy'*); Encourage balance and variety (e.g. '*I encourage my child to eat a variety of foods'*); and Teaching about nutrition (e.g. '*I discuss with my child the nutritional value of foods'*). Items are responded to on a five-point likert scale. Mean scores are generated for each subscale, with possible scores between one and five. Higher scores indicate greater use of the feeding practice. This measure has been validated and shown to have good test-retest reliability (Musher-Eizenman & Holub, 2007). Most subscales showed adequate internal validity in the current sample, with Cronbach's alpha values ranging from .60 to .81.

EAS Temperament survey for children (*EAS; Buss & Plomin, 1984*)

Two aspects of child temperament were assessed using the EAS: Sociability (e.g. '*Child likes to be with people'*); and Emotionality (e.g. '*Child cries easily'*). Parents are asked to state how characteristic of their child each statement is on a five-point likert scale. Mean scores are then calculated for each subscale, with possible scores ranging from one to five. Higher scores on each subscale represent higher levels of that trait (i.e. higher emotionality or sociability). The EAS is a valid measure of young children's temperament as reported by parents (Mathiesen & Tambs, 1999). Cronbach's alphas in the current sample were .65 for the Sociability subscale and .90 the Emotionality subscale.

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

The CEBQ was used to assess child eating behaviours. Four of the subscales were used for the purposes of this study; two measuring food approach eating behaviours (food responsiveness and enjoyment of food), and two measuring food avoidance (satiety responsiveness and food fussiness). Parents are asked to respond to each statement using a five-point likert scale ranging from never to always, and mean scores for each subscale are calculated. Scores range from one to five, with higher scores indicating higher frequency of that behaviour. The CEBQ has been demonstrated as having good internal validity and test-retest reliability (Wardle et al., 2001). For the current sample, Cronbach's alphas were good, ranging from .76 to .89.

Outcome variables

The main outcome measures for the study were post-intervention consumption of the disliked vegetable (measured after the 14 day intervention period) and consumption change across the study. Consumption change was calculated by subtracting pre-intervention consumption from post-intervention consumption, allowing for comparison regardless of baseline consumption. Positive change scores represented an increase in consumption across the study, while negative scores indicated a decrease in consumption.

Data analysis

In order to examine whether parental feeding practices, child temperament, and child eating behaviours were associated with children's acceptance of a disliked vegetable after a home-based, parent led, repeated exposure intervention, data from the four repeated exposure intervention conditions were pooled. Power recommendations from Cohen (1992) were used to inform the size of sample who participated in the intervention study. The total sample (n=90) of experimental dyads met Cohen's (1992) power recommendations for correlation and regression analysis with an alpha of .05 and to detect medium effect sizes. A series of Kolmogorov-Smirnov tests indicated that the majority of the study's variables were not

normally distributed therefore non-parametric tests were used, where possible, to test the study's hypotheses. Preliminary one-tailed Spearman's correlations were run between parent and child age and BMI/BMIz with the study variables. Child age was significantly correlated with teaching about nutrition (r=.27, p=.003) and child BMIz was significantly related to child enjoyment of food (r=.32, p=.002). Analyses involving the teaching about nutrition and enjoyment of food subscales controlled for child age and BMIz, respectively. Parent age and BMI were not significantly related to any of the feeding practices.

One-tailed Spearman's correlations (or partial correlations, where appropriate) were used to investigate associations between child temperament, eating behaviours and parental feeding practices with pre-intervention consumption, post-intervention consumption, and consumption change across the intervention period. Significant correlates of each of these outcome measures were then combined and entered into a forced entry, one-tailed logistic regression model to assess which factors could best predict success of the interventions. Success was a binary variable, with any increase in grams of vegetable consumed between pre and post-intervention categorised as success, and no change or a decrease in consumption categorised as not successful.

Due to the large number of correlations conducted and the associated risk of type 1 errors, a more stringent significance level of p<.01 was used for the correlations. Significance was set at p<.05 for the regression analyses as variables had already been selected based on alpha of .01.

Results

Descriptive statistics

Descriptive statistics for all measures are displayed in Table 1. The study sample's mean scores for the CEBQ, CFPQ and EAS subscales are similar to other means from similar samples (e.g., Ashcroft, Semmler, Carnell, van Jaarsveld, & Wardle, 2008; Haycraft et al., 2011; Musher-Eizenman & Holub, 2007). On average, consumption of the disliked vegetable increased markedly across the intervention period, with post-intervention consumption more than eight times greater than pre-intervention consumption.

Table 1: Mean and standard deviation (SD) scores for parent feeding practices, child temperament, child eating behaviours and measures of vegetable consumption

Measure	Mean (SD)	Min/Max
Parental feeding practices		
Pressure to eat	3.32 (0.82)	1.25/4.75
Modelling	4.11 (0.75)	1.75/5.00
Environment	3.67 (0.68)	2.25/5.00
Encourage balance and variety	4.33 (0.49)	3.00/5.00
Teaching about nutrition	3.63 (0.83)	1.67/5.00
Child temperament		
Sociability	3.55 (0.67)	1.00/5.00
Emotionality	2.76 (1.03)	1.00/5.00
Child eating behaviours		
Food responsiveness	2.53 (0.73)	1.20/4.60
Enjoyment of food	3.64 (0.72)	1.00/5.00
Satiety responsiveness	3.05 (0.60)	1.60/6.00
Food fussiness	3.00 (0.75)	1.17/5.00
Pre-intervention consumption[†]	0.43 (0.84)	0.00/3.60
Post-intervention consumption[†]	3.78 (6.57)	0.00/30.00
Consumption change[†]	3.36 (6.43)	-3.60/29.80

[†] Grams of vegetable eaten during the testing period

Relationships between parents' feeding practices, child temperament and eating behaviours with measures of consumption

One-tailed correlations were run to assess whether there were any significant associations between parents' feeding practices, child temperament or eating behaviours with pre-intervention consumption of a disliked vegetable, post-intervention consumption of a disliked vegetable, and consumption change. There was a trend towards a positive correlation of parents providing a healthy home environment with higher post-intervention consumption of the disliked vegetable. Greater child sociability was significantly correlated with greater post-intervention consumption of a disliked vegetable and greater consumption change scores. Greater child food fussiness was significantly correlated with lower pre and post-intervention consumption of a disliked vegetable, and there was a trend towards a negative correlation with change in consumption across the intervention. There were no other significant relationships (see Table 2).

Table 2: One-tailed Spearman's correlations between parent and child factors with consumption scores (N=90).

	Pre-consumption		Post-consumption		Consumption change	
Measure	**R_s**	**p**	**R_s**	**p**	**R_s**	**p**
Encourage balance and variety	.16	.07	.12	.12	.10	.17
Environment	.02	.42	.20	.03	.17	.06
Modelling	.05	.34	.15	.08	.11	.16
Pressure to eat	-.01	.47	-.04	.35	-.02	.44
Teaching about nutrition†	-.06	.30	-.10	.18	-.10	.19
Emotionality	-.05	.34	-.04	.36	-.08	.46
Sociability	.01	.45	**.23**	**.01**	**.28**	**.01**
Food responsiveness	.03	.39	.05	.32	.02	.44
Enjoyment of food‡	-.07	.29	-.07	.27	-.07	.29
Satiety responsiveness	-.05	.31	-.13	.12	-.07	.26
Food fussiness	**-.25**	**.01**	**-.31**	**.00**	-.20	.03
Child age (months)	.05	.31	-.07	.26	-.12	.13
Child BMIz	.12	.14	.12	.15	.12	.15

†partial correlation controlling for child age
‡partial correlation controlling for child BMI z-score

Predictors of the success of the interventions

In order to identify intervention 'success', the consumption change data were split to form two groups: those for whom the interventions were successful (as categorised by showing any increase in grams of vegetable consumed between pre and post-intervention), and those for whom the interventions were not successful (categorised by no change or a decrease in consumption). Descriptive statistics for these two groups are displayed in Table 3. Mann-Whitney U analysis revealed that consumption change was significantly different between these two groups (U=0.00, z=-8.42, p<.001).

Table 3: Descriptive statistics for change in vegetable consumption for children for whom the interventions were successful or not

	N	Median (g)	Mean (g)	SE mean	Range (g)
Successful	44	4.60	7.00	1.31	0.10 to 29.80
Not successful	46	0.00	-0.30	0.11	-3.60 to 00.00

g = grams, positive mean and median values indicate an increase in consumption

These two groups were then used to explore whether intervention success can be predicted by food fussiness and sociability (the only two significant correlates). A one-tailed logistic regression was performed, using the enter method. The model was a significant fit for the data (x^2 (2)=6.56, p=.02) and was able to correctly predict success of the intervention in 61% of cases. Sociability, but not food fussiness, was a significant individual predictor of intervention success (Table 4).

Table 4: Coefficients for the logistic regression model predicting success of the interventions from children's sociability and food fussiness (N=90)

				95% CI for Odds Ratio		
	b	SE B	p	*Lower*	*Odds*	*Upper*
Sociability	0.71	0.36	.03	1.00	2.03	4.11
Food fussiness	-0.35	0.30	.12	0.39	0.70	1.27

Discussion

This study aimed to examine whether individual differences in caregivers' feeding practices or children's characteristics are associated with children's acceptance of a disliked vegetable after a home-based, parent led, repeated exposure intervention. The ability of these variables to predict the success of this intervention was then tested. It was hypothesised that this repeated exposure based intervention would result in greatest acceptance for children who display higher levels of food approach behaviours and for children whose parents use more health-promoting feeding practices. It was further hypothesised that this repeated exposure based intervention would result in least acceptance among children whose parents use more pressure to eat, who are lower in sociability, higher in emotionality and more food avoidant. These hypotheses were partially supported. While there were no significant correlations between feeding practices and the outcome of the repeated exposure intervention, children's sociability and food fussiness were significantly correlated with the outcomes of this intervention and, in combination, were able to predict their success.

As hypothesised, parent led repeated exposure interventions appeared to be more successful for children who were more sociable. Here, sociability was significantly associated with post intervention vegetable consumption as well as with increased intake across the interventions. Sociability was also able to predict the success of the interventions. This is in line with Social Learning Theory (Bandura, 1977), where it is claimed that learning takes place within a social context. For children who are low in sociability, their capacity to learn through others may be diminished, whereas children who are more sociable may be more open to the influence of factors such as parental modelling or rewards (particularly praise). Previous research supports this notion, where children who are shy or less sociable have shown lower initial acceptance of novel foods (Moding et al., 2014), and a higher prevalence of feeding difficulties has been found in unsociable children (e.g., Hagekull, Bohlin, & Rydell, 1997; Pliner & Loewen, 1997). Moreover, sociability may influence the nature of tastings made during the intervention. Parents were told that a range of behaviours from licking and sucking to biting or eating qualified as tasting the vegetable. Therefore, it is possible that more sociable children were more motivated to suck or eat the piece of vegetable so as to please their parent, and that these types of tastings may be better for increasing acceptance of the target vegetable than a brief lick or bite of the piece.

Food fussiness was found to be significantly negatively correlated with consumption of the disliked vegetable, both pre and post intervention, which supported predictions. This is in line with previous research suggesting that picky/fussy eaters consume fewer vegetables (Galloway et al., 2005). With specific reference to the influence of fussiness on intervention outcomes, research by Caton et al. (2014) has suggested that children who are fussier are more likely to consume a very small amount or none of a target vegetable during interventions. In the current study, food fussiness was correlated with pre intervention consumption as well as post intervention consumption, but was not correlated with consumption change (although there was a trend towards this). This suggests that rather than food fussiness having a strong influence on the outcome of repeated exposure interventions, food fussiness may have a more pervasive effect on consumption of vegetables in general. This suggestion is supported by recent literature (Fildes et al., 2016) which suggests that children's food fussiness and liking for vegetables has a shared genetic underpinning, which would also infer a pervasive effect of fussiness. This notion is further corroborated by the regression analyses performed in this study, where although food fussiness and sociability formed a model which could significantly predict success of the intervention, only sociability was a significant predictor of success when used alone. Together, these findings suggest that while children's food fussiness is likely to influence

children's general consumption of vegetables (as indicated by being associated with lower pre and post intervention consumption), fussy children may still benefit from interventions aimed at improving healthy eating (as suggested by the lack of significant association between fussiness and consumption change across the intervention). Having said this, the trend towards an association between food fussiness and lower consumption change across the intervention suggests that fussy children may benefit from components additional to those in this intervention. Future work may need to tailor interventions to promote tasting – and encourage repeated exposure and trying – in children who are inherently more fussy.

Contrary to the hypotheses, no significant correlations were found between food approach behaviours or feeding practices and children's consumption of the target vegetable in the interventions. However, in line with previous research on availability (e.g., Hanson, Neumark-Sztainer, Eisenberg, Story, & Wall, 2005), there was a trend towards an association between parents keeping a healthy home environment and higher post-intervention consumption. This was an exploratory study, as there is currently very limited research investigating the impact of these factors on intervention outcomes. One previous study has found that children's enjoyment of food can predict consumption change across an intervention (Caton et al., 2014). However, it should be noted that Caton et al.'s study was with a large sample of children (N = 332), who were younger (*M* = 18.9 months) than those in this study, and that the intervention groups involved repeated exposure with either flavour-flavour or flavour-nutrient learning, rather than modelling and rewards. Furthermore, it is possible that child eating behaviours and maternal feeding practices were not relevant within the context of this study. For example, in the case of food (and indeed satiety) responsiveness, parents were asked to offer their child the target vegetable at their usual snack time, or before a meal. This should have ensured that children in the study were hungry when offerings occurred, minimising the effect of individual differences in food/satiety responsiveness.

Contrary to the hypotheses, children's emotionality and parental use of pressure to eat were not significantly correlated with post intervention consumption of the disliked vegetable or consumption change across the intervention period. Although previous research suggests that use of pressure to eat results in lower consumption of the pressured foods (Galloway et al., 2005), it is not clear whether parents who would ordinarily use pressure to eat did so during the course of the intervention. It is possible that parents in fact adhered to the study protocol, and as such would not have used controlling feeding practices to encourage consumption during the study.

This study has a number of strengths and limitations. First, as there are very few previous studies into the effect of individual differences on intervention outcomes, the current study is novel and adds to previous literature by helping to guide the potential tailoring of future interventions. However, the intervention groups were combined for the analyses so as to optimise statistical power but this precluded the ability to detect correlations between individual differences and intervention outcomes, where these might have varied between the intervention groups. To better assess this, future research with similar interventions should employ larger samples, to allow for the impact of parent and child differences to be assessed separately for each intervention condition. The measures of child eating behaviours, parent feeding practices and temperament were all self-report measures. As such, there may have been a degree of inaccuracy in parents' reports, which may also explain the lack of significant findings in this study (possibly explaining the low variance seen in scores). The sample employed was also not particularly diverse; despite attempts to recruit a less homogenous sample (by recruiting from Sure Start toddler groups as well as community groups), the majority of this sample were white and middle class. The applicability of these findings to other samples must therefore be considered.

The study's findings indicate that parent led, home-based, repeated exposure interventions are more successful with sociable children, and that other types of interventions might need to be tailored to children with different temperamental predispositions. For example, children who are more sociable may benefit from interventions with more social components such as modelling and rewards, while less sociable children may benefit from interventions which promote change in other ways. Furthermore, these results suggest that food fussiness may have a prevailing effect on eating behaviour and vegetable consumption, rather than specifically altering the outcome of interventions such as these. This suggests that in order for vegetable consumption to be increased in individuals with food fussiness, interventions may be better targeted at reducing food fussiness than specifically increasing consumption of vegetables.

References

Ashcroft, J., Semmler, C., Carnell, S., van Jaarsveld, C. H. M., & Wardle, J. (2008). Continuity and stability of eating behaviour traits in children. *European Journal of Clinical Nutrition*, *62*(8), 985–90.

Auld, G. W., Romaniello, C., Heimendinger, J., Hambidge, C., & Hambidge, M. (1999). Outcomes from a school-based nutrtion education program alternating special resource teachers and classroom teachers. *Journal of School Health*, *69*(10), 403–408.

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191–215.

Blissett, J., Bennett, C., Fogel, A., Harris, G. & Higgs, S. (2016). Parental modelling and prompting effects on acceptance of a novel fruit in 2-4 year-old children are dependent on food responsiveness. *British Journal of Nutrition, 115,* 554-564.

Blissett, J., Haycraft, E., & Farrow, C. (2010). Inducing preschool children's emotional eating: relations with parental feeding practices. *The American Journal of Clinical Nutrition*, *92*(2), 359–365.

Buss, A. H., & Plomin, R. (1984). Theory and measurement of EAS. In *Temperament: Early developing personality traits* (pp. 84–104). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Caton, S. J., Blundell, P., Ahern, S. M., Nekitsing, C., Olsen, A., Møller, P., … Hetherington, M. M. (2014). Learning to eat vegetables in early life: the role of timing, age and individual eating traits. *PloS One*, *9*(5), e97609.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*(1), 155-9.

Cooke, L.J., Chambers, L.C., Anez, E.V., Croker, H.A., Boniface, D., Yeomans, M.R., & Wardle, J. (2011). Eating for pleasure or profit: The effect of incentives on children's enjoyment of vegetables. *Psychological Science, 22*(2), 190-6.

Cole, T. J., Freeman, J. V, & Preece, M. A. (1995). Body mass index reference curves for the UK, 1990. *Archives of Disease in Childhood*, *73*(1), 25–9.

Cooke, L. J., & Wardle, J. (2005). Age and gender differences in children's food preferences. *British Journal of Nutrition*, *93*(5), 741–746.

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

Cullen, K. W. (2001). Child-reported family and peer influences on fruit, juice and vegetable consumption: reliability and validity of measures. *Health Education Research*, *16*(2), 187–200.

Farrow, C. & Blissett, J. (2006). Does maternal control during feeding moderate early infant weight gain? *Pediatrics,* 118(2), 293-298.

Fildes, A., Mallan, K.M., Cooke, L., van Jaarsveld, C., Llewellyn, C., Fisher, A. & Daniels, L. (2015). The relationship between appetite and food preferences in British and Australian children*. The International Journal of Behavioral Nutrition and Physical Activity, 12*(1), 116.

Fildes, A., van Jaarsveld, C.H.M., Cooke, L., Wardle, J. & Llewellyn, C.H. (2016). Common genetic architecture underlying children's food fussiness and liking for fruit and vegetables. *American Journal of Clinical Nutrition, 103*(4), 1099-1104.

Fisher, J. O., Mitchell, D. C., Smiciklas-Wright, H., & Birch, L. L. (2002). Parental influences on young girls' fruit and vegetable, micronutrient, and fat intakes. *Journal of the*

524 *American Dietetic Association*, *102*(1), 58–64. Retrieved from
525 http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2530939&tool=pmcentrez&re
526 ndertype=abstract

527 Galloway, A. T., Fiorito, L. M., Lee, Y., & Birch, L. L. (2005). Parental pressure, dietary
528 patterns, and weight status among girls who are “picky eaters”. *Journal of the American*
529 *Dietetic Association*, *105*(4), 541–548.

530 Galloway, A. T., Lee, Y., & Birch, L. L. (2003). Predictors and consequences of food
531 neophobia and pickiness in young girls. *Journal of the American Dietetic Association*,
532 *103*(6), 692–698.

533 Gregory, J. E., Paxton, S. J., & Brozovic, A. M. (2011). Maternal feeding practices predict
534 fruit and vegetable consumption in young children. Results of a 12-month longitudinal
535 study. *Appetite*, *57*(1), 167–172.

536 Hagekull, B., Bohlin, G., & Rydell, A. M. (1997). Maternal sensitivity, infant temperament,
537 and the development of early feeding problems. *Infant Mental Health Journal*, *18*(1),
538 92–106.

539 Hanson, N., Neumark-Sztainer, D., Eisenberg, M. ., Story, M., & Wall, M. (2005).
540 Associations between parental report of the home food environment and adolescent
541 intakes of fruits, vegetables and dairy foods. *Public Health Nutrition*, *8*(1), 77–85.
542 Retrieved from http://journals.cambridge.org/abstract_S1368980005000133

543 Haycraft, E., Farrow, C., Meyer, C., Powell, F. C., & Blissett, J. (2011). Relationships
544 between temperament and eating behaviours in young children. *Appetite*, *56*(3), 689–
545 692.

546 Holley, C. E., Haycraft, E., & Farrow, C. (2014). “Why don”t you try it again?’ a comparison
547 of parent led, home based interventions aimed at increasing children’s consumption of
548 a disliked vegetable. *Appetite*, *87*, 215–222. http://doi.org/10.1016/j.appet.2014.12.216

549 Lennox, A., Olson, A., & Gay, C. (2011). National diet and nutrition survey. *Headline Results*
550 *from Years 1 to 4*. Retrieved from
551 http://www.foodafactoflife.org.uk/attachments/8921d124-960e-4f68d4b026f4.pdf

552 Lytle, L. A., Seifert, S., Greenstein, J., & McGovern, P. (2000). How Do Children’s Eating
553 Patterns and Food Choices Change Over Time? Results from a Cohort Study.
554 *American Journal of Health Promotion*, *14*(4), 222–228.

555 Mathiesen, K. S., & Tambs, K. (1999). The EAS Temperament Questionnaire-Factor
556 Structure, Age Trends, Reliability, and Stability in a Norwegian Sample. *Journal of Child*
557 *Psychology and Psychiatry*, *40*(3), 431–439.

558 Melbye, E. L., Øgaard, T., & Øverby, N. C. (2013). Associations between parental feeding
559 practices and child vegetable consumption. Mediation by child cognitions? *Appetite*, *69*,
560 23–30.

561 Mikkilä, V., Räsänen, L., Raitakari, O. T., Pietinen, P., & Viikari, J. (2007). Consistent dietary
562 patterns identified from childhood to adulthood: The Cardiovascular Risk in Young
563 Finns Study. *British Journal of Nutrition*, *93*(06), 923–931.

564 Mitchell, G. L., Farrow, C., Haycraft, E., & Meyer, C. (2013). Parental influences on
565 children’s eating behaviour and characteristics of successful parent-focussed
566 interventions. *Appetite*, *60*(1), 85–94.

567 Moding, K. J., Birch, L. L., & Stifter, C. A. (2014). Infant temperament and feeding history
568 predict infants’ responses to novel foods. *Appetite*, *83*, 218–225.

569 Musher-Eizenman, D., & Holub, S. C. (2007). Comprehensive Feeding Practices
570 Questionnaire: validation of a new measure of parental feeding practices. *Journal of*
571 *Pediatric Psychology*, *32*(8), 960–72.

572 Palfreyman, Z., Haycraft, E., & Meyer, C. (2014). Development of the Parental Modelling of
573 Eating Behaviours Scale (PARM): links with food intake among children and their
574 mothers. *Maternal & Child Nutrition*, *10*(4), 617–29. http://doi.org/10.1111/j.1740-
575 8709.2012.00438.x

576 Pearson, N., Biddle, S. J. H., & Gorely, T. (2009). Family correlates of fruit and vegetable
577 consumption in children and adolescents: a systematic review. *Public Health Nutrition*,
578 *12*(2), 267–83.

579 Pliner, P., & Loewen, E. R. (1997). Temperament and food neophobia in children and their
580 mothers. *Appetite*, *28*(3), 239–254.

581 Public Health England & Food Standards Agency (2014). *National Diet and Nutrition*
582 *Survey: Results from years 1, 2, 3, and 4 (combined) of the Rolling Programme*
583 *(2008/2009 – 2011/2012).* Retrieved from
584 https:www.gov.uk/government/uploads/system/uploads/attachment_data/file/310995/N
585 DNS_Y1_to_4_report.pdf

586 Skinner, J. D., Carruth, B. R., Bounds, W., & Ziegler, P. J. (2002). Children's Food
587 Preferences: A longitudinal analysis. *Journal of the American Dietetic Association*,
588 *102*(11), 1638–1647. http://doi.org/10.1016/S0002-8223(02)90349-4

589 Stright, A., Gallagher, K., & Kelley, K. (2008). Infant temperament moderates relations
590 between maternal parenting in early childhood and children's adjustment in first grade.
591 *Child Development*, *79*(1), 186–200. Retrieved from
592 http://onlinelibrary.wiley.com/doi/10.1111/j.1467-8624.2007.01119.x/pdf

593 Svensson, V., Lundborg, L., Cao, Y., Nowicka, P., Marcus, C., & Sobko, T. (2011). Obesity
594 related eating behaviour patterns in Swedish preschool children and association with
595 age, gender, relative weight and parental weight--factorial validation of the Children's
596 Eating Behaviour Questionnaire. *The International Journal of Behavioral Nutrition and*
597 *Physical Activity*, *8*(1), 134–144.

598 Tibbs, T., Haire-Joshu, D., Schechtman, K. B., Brownson, R. C., Nanney, M. S., Houston,
599 C., & Auslander, W. (2001). The relationship between parental modeling, eating
600 patterns, and dietary intake among African-American parents. *Journal of the American*
601 *Dietetic Association*, *101*(5), 535–541.

602 Vereecken, C., Legiest, E., De Bourdeaudhuij, I., & Maes, L. (2009). Associations between
603 general parenting styles and specific food-related parenting practices and children's
604 food consumption. *American Journal of Health Promotion*, *23*(4), 233–40.

605 Viana, V., Sinde, S., & Saxton, J. C. (2008). Children's Eating Behaviour Questionnaire:
606 associations with BMI in Portuguese children. *British Journal of Nutrition*, *100*(2), 445–
607 450.

608 Wardle, J., Guthrie, C. A., Sanderson, S., & Rapoport, L. (2001). Development of the
609 children's eating behaviour questionnaire. *Journal of Child Psychology and Psychiatry*,
610 *42*(7), 963–970.

611 Webber, L., Hill, C., Saxton, J. C., Van Jaarsveld, C. H. M., & Wardle, J. (2009). Eating
612 behaviour and weight in children. *International Journal of Obesity (2005)*, *33*(1), 21–8.
613 http://doi.org/10.1038/ijo.2008.219