Children overcoming picky eating (COPE) – A cluster randomised controlled trial

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Abstract

Objectives: Food neophobia limits dietary variety in children and adults. Interventions to alleviate the impact of neophobia on children's dietary variety have had varying success. The potential effectiveness of mindfulness, a process of bringing awareness to the present moment, has received little attention. This trial aimed to explore the effectiveness of two mindfulness exercises on novel food acceptance for children.

Methods: A cluster-randomised controlled trial with three trial arms compared the impact of two mindfulness exercises (mindful breathing and mindful raisin-eating) and a non-mindful control task on anticipated liking and intake of a novel fruit. Seventy-one children aged 10 to 12 years engaged in one of the three tasks at school over five days and were offered a novel fruit at the end of the intervention. Children self-reported mindfulness, food neophobia and anxiety at baseline and follow-up.

Results: Two mixed-effects models showed that, controlling for school effects and covariates (including mindfulness, food neophobia and anxiety), children in the mindful raisin-eating arm reported greater anticipated liking of a novel fruit and children in both mindfulness arms consumed greater amounts of a novel fruit than children in the control arm. Mixed-design ANOVAs indicated that mindfulness, food neophobia and anxiety did not change over time in each trial arm.

Conclusions: The results provide promising evidence for the potential effectiveness of mindfulness interventions in encouraging children to try new foods. The mechanisms underlying effectiveness remain unclear and further research, exploring long-term effects and the possibility to generalise these findings to other food groups such as vegetables, is needed.

Keywords: Mindfulness, Food Neophobia, Food Intake, Eating Behaviour.

CHILDREN OVERCOMING PICKY EATING (COPE) – A CLUSTER RANDOMISED CONTROLLED TRIAL

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Declarations of interest
None

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A balanced and varied diet is crucial for the optimal health and development of children and positively impacts on health outcomes of humans across the lifespan (World Health Organisation, 2003). The foundations for a healthy and varied diet are laid down in childhood (Nicklaus, Boggio, Chabanet, & Issanchou, 2005; Skinner Carruth, Bounds, & Ziegler, 2002; Skinner, Carruth, Bounds, Ziegler, & Reidy, 2002). Reflecting this, research has indicated that the introduction of healthy foods into children's diets from an early age is crucial (Cashdan, 1994; Harris, 1993). Research has also indicated that parents often find it difficult to introduce healthy foods, such as fruit and vegetables, into their children's diets successfully. A report by Public Health England (2014) has indicated that only 7% of girls and 10% of boys consume the recommended five or more portions of fruit and vegetables a day.

Food neophobia has been defined as the rejection of novel, unfamiliar foods prior to tasting (Dovey, Staples, Gibson, & Halford, 2008). It involves the rejection of novel foods on the basis of primarily visual properties such as colour and is associated with the same physiological responses as fear (Adessi, Galloway, Visalberghi, & Birch, 2005; Maratos & Staples, 2015; Raudenbusch & Capiola, 2012). Food neophobia has also been linked with increased anxiety and disgust reactions towards novel foods (Galloway, Lee, & Birch, 2003; Nordin, Broman, Garvill, & Nyroos, 2004; Raudenbusch & Capiola, 2012; Tuorila, Lähteenmäki, Pohjalainen, & Lotti, 2001). It is thought that these physiological and emotional responses to novel foods influence the rejection of these foods (Brown & Harris, 2012a, 2012b). Food neophobia is thought to be an evolutionary adaptive mechanism, limiting a child's risk of accidental poisoning at a time of increasing independence from caregivers (Pliner & Hobden, 1992; Pliner, Pelchat, & Grabski, 1993).

Cross-sectional research has indicated that food neophobia varies with age, emerging gradually from weaning, reaching its peak when children are aged two to six years (Cashdan, 1994; Cooke, Wardle, & Gibson, 2003). Cross-sectional and longitudinal research indicates that from age six, food neophobia gradually reduces, reaching more stable levels in adolescence (McFarlane & Pliner, 1997; Nicklaus, Boggio, Chabanet, & Issanchou, 2005; Pliner & Hobden, 1992). The limited number of longitudinal studies makes it difficult to draw firm conclusions about approaches for intervention. Nevertheless, evidence suggests that effective interventions targeting food neophobia in children before they reach adolescence may be most beneficial for improving dietary variety in adolescence and adulthood.

Research has also suggested that individuals with high levels of food neophobia might compensate for their limited intake of healthy foods by eating larger amounts of less healthy foods (MacNicol, Murray, & Austin, 2003; Siegrist, Hartmann, & Keller, 2013). Food

neophobia is hence linked with children's and adults' willingness to try new foods, their food choices and limited dietary variety (Jaeger, Rasmussen, & Prescott, 2017; Lafraire, Rioux, Giboreau, & Picard, 2016). This makes it difficult for individuals with high levels of neophobia to achieve a balanced diet consisting of recommended amounts of fruit and vegetables, proteins, fibres, mono- and polyunsaturated fats, minerals and vitamins; these are particularly important for the healthy development of children (Capiola & Raudenbusch, 2012; Falciglia, Couch, Gribble, Pabst, & Frank, 2000).

A number of interventions have been used to target food neophobia. Sensory education involves teaching children about the use of all five sense when interacting with familiar and unfamiliar foods (Mustonen & Tuorila, 2010). Exposure involves repeatedly presenting a novel food to increase familiarity (Nederkoorn, Theißen, Tummers, & Roefs, 2018), while modelling involves trusted others interacting with and consuming a novel food, demonstrating safety (Hendy & Raudenbusch, 2000). Furthermore prompting involves encouraging novel food consumption by promoting physical interaction with it, e.g. moving it closer to the child on the plate during a mealtime or placing it into the child's hand (Blissett, Bennett, Fogel, Harris, & Higgs, 2016). These approaches have all shown some effectiveness in improving children's willingness to try new foods. Nevertheless, the effectiveness of these interventions is often limited by individual differences in food approach and avoidance behaviours and by difficulties in encouraging children to experience and tolerate sensory properties of new foods (Blissett et al., 2016; Nederkoorn et al., 2018). Exploring further approaches for intervention that can help to alleviate some of these difficulties is hence necessary.

Mindfulness-based approaches have received limited attention, despite being potentially useful in moderating the impact of food neophobia on food acceptance and dietary variety in children. Mindfulness has been defined as moment-by-moment, non-judgmental, open awareness (Kabat-Zinn, 2005; Williams & Penman, 2011). It is increasingly being used in Western therapeutic approaches and has been found to be effective in improving outcomes in relation to a number of physical and mental health difficulties, improving emotion regulation, well-being and resilience (Emery, 2013; Roemer, Williston, & Rollins, 2015). Research has shown that brief mindfulness interventions delivered in a school setting can have a positive impact on young people's anxiety levels, especially, those whose anxiety levels are considered to be elevated, as well as self-reported calmness (Etherington & Costello, 2019; Nadler, Cordy, Stengel, Segal, & Hayden, 2017). Research has also begun to explore the potential benefits of mindfulness on obesity and weight loss (Olson & Emery, 2015) and problematic eating behaviours such as emotional eating, Bulimia Nervosa and

Binge Eating Disorder (Godfrey, Gallo, & Afari, 2015; Katterman, Kleinman, Hood, Nackers, & Corsica, 2014). More recently, researchers have started to explore potential benefits of mindfulness interventions, such as mindful eating, breathing and movement, to increase the acceptance of novel and disliked foods in adults (Hong, Lishner, & Han, 2014; Hong, Lishner, Han, & Huss, 2011) and children (Hong, Hanson, Lishner, Kelso, & Steinert, 2018; Kennedy, Whiting, & Dixon, 2014). Results of these studies suggest that interventions with mindfulness components can have a positive impact on dietary variety, reducing the reluctance to try a new food. Nonetheless, mindfulness has not been shown to be more effective than exposure in affecting liking (Hong et al., 2018). Furthermore, a number of confounding variables are present in these studies, such as repeated exposure to the target foods, peer-effects and modelling by a teacher, which limit the conclusions that can be drawn regarding the specific role of mindfulness per se in these interventions.

Therefore, this trial aimed to explore the effectiveness of two mindfulness exercises (mindful breathing, non-food related mindfulness exercise and mindful raisin-eating, a food-related mindfulness exercise) on two key outcome variables, namely novel food intake and anticipated food liking, in school children aged 10 to 12 years. It was predicted that children who engaged in a food-related mindfulness exercise (over a five-day period) would express significantly higher levels of anticipated liking for a novel fruit and would consume a greater amount of it when compared to children who engaged in a non-food related mindfulness exercise (over a five-day period). In turn, children who engaged in a non-food related mindfulness exercise would show significantly higher levels of anticipated liking for a novel fruit and would consume a greater amount of it compared to children who engaged in a non-mindful control task.

The secondary aim of the study was to explore changes from baseline to follow-up in measured levels of mindfulness, food neophobia and anxiety, to explore the potential mechanism of action of the intervention. Two specific hypotheses were tested in these secondary analyses. Firstly, it was predicted that all children who engaged in mindfulness exercises (food and non-food related) would increase in levels of mindfulness and decrease in levels of anxiety from baseline to follow-up. Secondly, it was predicted that children who engaged in a food-related mindfulness exercise (over a five-day period) would show greater reductions in food neophobia when compared to children who engaged in a non-food related mindfulness exercise (over a five-day period). In turn, children who engaged in a non-food related mindfulness exercise would show greater reductions in food neophobia when compared to children who engaged in a non-mindful control task.

Method

Design

A cluster-randomised controlled trial with three arms was conducted to evaluate the effectiveness of mindfulness on the main outcomes anticipated liking and novel fruit intake. Classrooms (clusters) were randomly allocated to one of three trial arms. Participants in arm one engaged in a non-mindful active comparison task (control arm), those in arm two engaged in a mindful breathing exercise, and those in arm three engaged in a mindful raisin-eating exercise.

Setting

Participants were recruited from two mainstream primary schools in and around Birmingham (UK) between November 2016 and December 2017; schools received a £50 Amazon voucher for their participation.

Participants

Overall, 71 children in nine classrooms aged 10-12 years, who were able to complete a number of self-report questionnaires in English, participated in this trial (see Table 1 for sample characteristics). Children with food allergies and those with close family members known to have food allergies were excluded from food testing. Parents and children provided written consent for participation. Children received stickers for their participation. Due to illness-related absences, two children completed the baseline but not the post-intervention measures, while one child completed the post-intervention but not baseline measures; 68 (95.77%) children engaged in five days of the intervention, while three children engaged in four days of the intervention.

Randomisation and Interventions

Classrooms were randomly allocated to one of three trial arms using a random number generator (https://www.randomizer.org).

Control (Educational Colouring Book). Children in classrooms allocated to this trial arm completed a 10-page book containing food-facts, food-quiz questions and fruit/vegetable shapes to be coloured in. The book was handed out by teachers for five minutes on each of the five days; children completed two pages each day.

Mindful Breathing. Children in classrooms allocated to this trial arm listened to an mp3 recording of a guided mindful breathing exercise lasting 5 minutes. This exercise guides listeners to focus on the breath, sensations and movements associated with it and how to approach thoughts in an open and non-judgemental way, while re-focusing on the breath.

Mindful Raisin-Eating. Children in classrooms allocated to this trial arm listened to an mp3 recording of a guided mindful raisin-eating exercise lasting 5 minutes. This exercise

guides listeners to approach a raisin in a curious and open-minded way. It encourages the exploration of the raisin using all senses (sight, touch, smell, hearing, taste) sequentially, while guiding the listener to acknowledge and let go of thoughts and judgements, re-focusing attention on the raisin.

Mindfulness-exercises were played through the classroom's audio system ensuring the consistency of delivery and fidelity to the intervention.

Primary Outcome Measures

Anticipated Liking. The anticipated liking of a novel fruit, presented in a clear plastic container (5cm diameter), was explored using a 5-point hedonic liking scale ranging from 1 (*Disgusting*) to 5 (*Delicious*). This scale has been validated for children aged 10 to 12 years (Bennett, 2015).

Novel Fruit Intake. The novel fruit was weighed before and after children interacted with it. The amount consumed (g) was recorded and percentage consumed calculated to account for differences in density between novel fruits. Percentage consumed will be referred to as *novel fruit intake*.

Demographic and Screening Measures

Parents completed a food allergy screening questionnaire and a brief demographic questionnaire, as part of the consent procedure.

Novel Fruit Selection

Parents indicated whether their child had/had not eaten the suggested novel fruits (dried apricots, fresh fig, Sharon fruit, dragon fruit, physalis or fresh/canned lychee) used in this study; a novel fruit was selected for each individual child on the basis of this information. Twenty children were offered dried apricot, 22 were offered physalis and 20 were offered lychee. One child had previously tried all the suggested foods and was offered papaya based on parent recommendations. Six children were not offered a novel fruit due to conflicting information about the presence of food allergies in family members in the consent and screening forms.

Secondary Measures

Children completed a range of self-report measures at baseline and follow-up to explore group differences and changes in factors that might drive changes in primary outcome measures.

Mindfulness was measured using the Child and Adolescent Mindfulness Measure (CAMM; Greco, Baer, & Smith, 2011). This 10-item measure explores mindfulness skills and has been validated for the measurement of the mindfulness trait in children aged 10 to 17 years. Items are scored on a 5-point Likert scale ranging from 0 (*Never True*) to 4 (*Always*

True) and summed, with higher scores indicating better mindfulness skills. The scale is reliable and has good internal consistency (Kuby, McLean, & Allen, 2015), with current Cronbach's alphas at baseline and follow-up reaching .69 and .84, respectively.

Food neophobia was measured using the Food Situations Questionnaire (FSQ; Loewen & Pliner, 2000). This 10-item measure allowed children to express how they would feel about eating a new food in 10 hypothetical scenarios. Items are scored on a 5-point Likert scale ranging from 1 (*Very Sad*) to 5 (*Very Happy*). Items are summed, ranging from 10 to 50 with higher scores indicating lower neophobia/greater willingness to try. The measure has been validated for use with 7-12-year-olds and has good internal consistency (Damsbo-Svendsen et al., 2017), with current Cronbach's alphas at baseline and follow-up reaching .86 and .89, respectively.

Anxiety was measured using the Spence Children's Anxiety Scale (SCAS; Spence, 1998). The scale consists of 44 items (six filler items), measuring six aspects of anxiety (Separation Anxiety, Social Phobia, Obsessive Compulsive Disorder, Panic/Agoraphobia, Physical Injury and Generalised Anxiety Disorder). Items (e.g. I would feel afraid of being on my own at home.) are measured on a 4-point Likert scale ranging from 0 (*Never*) to 3 (*Always*). A total score ranging from 0 to 114, with higher scores indicating greater anxiety symptoms, was calculated by adding the 38 anxiety items and the total score was used in analyses throughout. The scale has been validated for use with children as young as 8 years. It has good internal consistency and acceptable test-retest reliability (Spence, 1998), with current Cronbach's alphas at baseline and follow-up reaching .9.

Hunger. Hunger was measured using the Teddy Picture Rating Scale (PRS; Bennett & Blissett, 2014). This scale consists of five bear silhouettes with varying amounts of food in their stomachs and accompanying vignettes describing hunger and satiety states ranging from 1 (*Very Hungry*) to 5 (*Very Full*). The Teddy PRS has been validated for use with children as young as 5 years and has been found to reflect hunger and satiety states reliably (Bennett & Blissett, 2014).

Procedure

The trial was conducted at school over the course of five days. Schools participated consecutively (School 1, 2, 1). On day one of the study, the researcher visited the school during the morning. Children in classrooms in each trial arm carried out a number of activities consecutively. The intervention and control task were led by classroom teachers independently over the next four days. The researcher returned on day five to repeat

questionnaire measures and offer children a novel fruit (see Figure 1 for details). The Ethical Review Committee of the University of Birmingham approved this study (**ERN_16-1234A**).

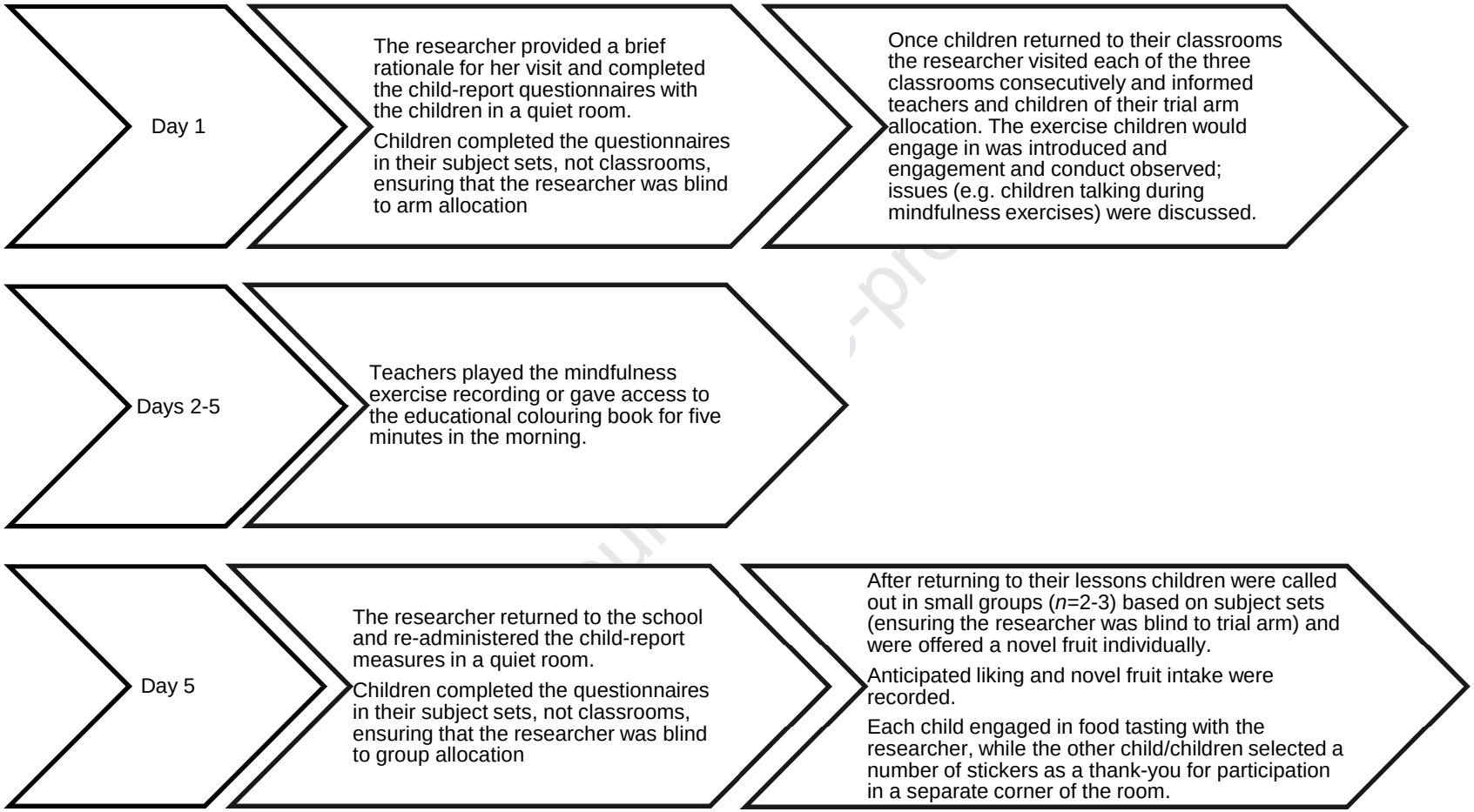

Figure 1. Overview and detailed description of the trial procedures

Data Analysis Plan

Visual data inspection indicated that the majority of variables were normally distributed; parametric tests (*p*-value of 0.05 for statistical significance) were used throughout. SPSS version 20 statistical software was used to analyse the data.

Preliminary analyses. Demographic characteristics and baseline differences in mindfulness, food neophobia and anxiety between trial arms were explored using one-way ANOVAs and χ^2 analyses. The impact of covariates, on the primary and secondary outcome measures was explored using Pearson's correlations and one-way ANOVAs. Furthermore, the impact of the type of novel fruit offered on the primary outcome measures was explored using one-way ANOVAs.

Analysis of primary outcome measures. Two linear mixed effects models (random intercepts models) were calculated to examine differences in anticipated liking and novel fruit intake by trial arm, while controlling for the effects of school context, baseline mindfulness, food neophobia and anxiety. All models were calculated step-by-step and fitted using robust estimation parameters (restricted maximum likelihood) as these produce unbiased estimates of variance and covariance parameters while fitting linear mixed effects models (Bates, Mächler, Bolker, & Walker, 2015).

Initially, school was entered as a Random Effects Term (modelled by intercept). This acknowledged the hierarchical structure of the data and allowed modelling the random effect of school on anticipated liking and novel fruit intake (Model 1). Secondly, fixed effects terms for baseline levels of mindfulness, food neophobia and anxiety were added to the model containing random effects for school to control for the effect of these covariates on anticipated liking and novel fruit intake. It was also explored whether controlling for them improved the model's goodness of fit (Model 2). Finally, trial arm was added as an explanatory variable to evaluate whether trial arm significantly impacted on anticipated liking and novel fruit intake. It was also explored whether this improved the model's goodness of fit (Model 3). Post-hoc analyses (Bonferroni correction) explored differences in liking and novel fruit intake between the three trial arms.

The goodness of fit of the three models was explored by comparing Schwarz's Bayesian Criterion (*BIC*), a criterion that is lower when the likelihood is higher (-2 log likelihood) and includes a correction for the number of parameters, as the models were calculated (Field, 2013). To compare models, the *BIC* of the new model was subtracted from the *BIC* of the old model. A change in 10 points or more suggests a significantly improved fit (Raftery, 1995). Smaller values indicate improved goodness of fit.

Exploratory analyses of secondary measures. To explore whether changes in mindfulness, food neophobia and anxiety from baseline to follow-up in the three trial arms could explain differences in anticipated liking and intake between arms, three mixed-design ANOVAs were carried out.

Results

Preliminary Analyses

Demographic Characteristics. Table 1 shows the sample's demographic characteristics. Three classrooms each were randomised to the Control arm (23 children), the Mindful breathing arm (23 children) and the Mindful raisin-eating arm (25 children). Preliminary analyses indicated that the trial arms did not differ in child age, (F[2, 70]=.04, p=.96), annual household income, (F[2, 56]=.93, p=.4), parent education (F[2, 58]=1.8, p=.17), gender composition (χ^2[2, N=71]=.43, p=.81) or ethnicity. (χ^2[5, N=66]=16.43, p=.09).

Baseline differences in secondary measures. One-way ANOVAs indicated that there were significant baseline differences in mindfulness and food neophobia between trial arms; children in the control arm were less mindful and more neophobic than children in the mindfulness arms; children in the mindfulness arms did not differ in mindfulness or neophobia. There were no baseline differences in anxiety between trial arms (Table 2).

Table 1

Demographic characteristics of the sample overall (N=71)*

Variables	**Caregiver Characteristics**	**Child Characteristics**
Gender	50 females, 15 males	49 females, 22 males
Age, mean (*SD*)	39.57 (7.46)	10.36 (.51)
Age range (years)	25 – 61	10 – 12
Educational level	6.6% Qualified professional (*n*=4)	
	19.7% University graduate (*n*=12)	
	18% AS/A-Levels (*n*=11)	
	31.1% O-Levels, CSEs or GCSEs (*n*=19)	
	9.8% Some secondary education (*n*=6)	
	8.2% Other (*n*=5)	
	6.6% No formal qualifications (*n*=4)	
Annual household income	6.8% > £75000 (*n*=4)	
	1.7% £60-75000 (*n*=1)	
	3.4% £45-60000 (*n*=2)	
	23.7% £30-45000 (*n*=14)	
	27.1% £15-30000 (*n*=16)	
	37.3% < £15000 (*n*=22)	
Ethnicity	50% Asian/Asian British (*n*=33)	
	33.3% White British (*n*=22)	
	9.1% Other (*n*=6)	
	4.5% Mixed (*n*=3)	
	3% Black British (*n*=2)	

* *Note.* five parent respondents failed to provide information on their ethnicity, six on gender, eight on age, and ten on education

Table 2

Overview of baseline scores and differences in secondary measures between trial arms

Secondary Measures	**Control arm**	**Mindful breathing arm**	**Mindful raisin-eating arm**	**One-way ANOVA**
Mindfulness (CAMM)	*N*=19	*N*=17	*N*=21	*F*(2, 61)=11.34, *p*<.001
	M=18.74	*M*=26.24	*M*=25.57	
	SD=4.74	*SD*=4.76	*SD*=6.98	
Food Neophobia (FSQ)	*N*=19	*N*=20	*N*=22	*F*(2, 63)=13.45, *p*<.001
	M=25.95	*M*=31	*M*=34.77	
	SD=6.54	*SD*=5.28	*SD*=6.8	
Anxiety (SCAS)	*N*=14	*N*=14	*N*=17	*F*(2, 49)=2.38, *p*=.1
	M=39.79	*M*=37.07	*M*=35.38	
	SD=15.34	*SD*=14.74	*SD*=17.15	

Note. Differences in *N*-values are due to absences and missed responses on individual questionnaire measures.

Covariates

Analyses indicated that none of the potential confounds (child age, gender, ethnicity, parent education or annual household income) were associated with anticipated liking or novel fruit intake. One-way ANOVAs indicated that the type of novel fruit offered (Apricot, Lychee, Physalis, Papaya) did not impact on anticipated liking (F[2, 43]=2.15, p=.13) or novel fruit intake (F[3, 62]=1.81, p=.16).

Pearson's correlations indicated mindfulness was not associated with any of the potential confounds and no gender differences were observed. Baseline and follow-up food neophobia were positively associated with child age, indicating that older children were less neophobic. No gender differences were observed. Baseline and follow-up anxiety were negatively associated with annual household income, indicating that children whose caregivers reported having a larger income were less anxious. Girls self-reported higher anxiety levels than boys at baseline and follow-up.

Table 3

Pearson's correlations between primary outcome measures and secondary measures and potential confounding variables, as well as differences in these variables by gender and ethnicity

	Anticipated Liking	**Novel Fruit Intake**	**CAMM baseline**	**CAMM follow-up**	**FSQ baseline**	**FSQ follow-up**	**SCAS baseline**	**SCAS follow-up**
Age	-.02	-.04	-.03	.02	.28*	.28*	-.02	-.02
Income	.23	.16	.15	.08	.04	-.05	-.32*	-.34*
Education	-.03	-.13	.04	.08	.06	.1	-.22	-.15
Gender	$F(1, 43)=2.59$, $p=.12$	$F(1, 62)=.37$, $p=.55$	$F(1, 63)=.31$, $p=.58$	$F(1, 63)=2.85$, $p=.1$	$F(1, 66)=.23$, $p=.63$	$F(1, 64)=.41$, $p=.52$	$F(1, 62)=9.78$, $p=.003$	$F(1, 60)=9.77$, $p=.003$
Ethnicity	$F(3, 38)=.42$, $p=.74$	$F(4, 57)=1.68$, $p=.17$	$F(4, 59)=1.36$, $p=.26$	$F(4, 58)=1.38$, $p=.25$	$F(4, 62)=2.26$, $p=.07$	$F(4, 60)=1.45$, $p=.23$	$F(4, 59)=1.85$, $p=.13$	$F(4, 56)=.39$, $p=.82$

Note. Child and Adolescent Mindfulness Measure (CAMM), Spence Children's Anxiety Scale (SCAS), Food Situations Questionnaire (FSQ).

* $p<.05$

Analysis of Primary Outcome Measures

Descriptive statistics for anticipated liking and intake can be seen in Table 4. Larger values indicate greater anticipated liking and novel fruit intake.

Table 4

Descriptive statistics for the primary outcome measures Anticipated Liking and Novel Fruit Intake for each of the three trial arms at follow-up

Outcome	**Control arm**	**Mindful breathing arm**	**Mindful raisin-eating arm**
Anticipated Liking	*N*=17 *M*=2.59 *SD*=.8	*N*=20 *M*=2.48 *SD*=.94	*N*=23 *M*=3.09 *SD*=.93
Novel Fruit Intake	*N*=20 *M*=18.48 *SD*=29.58	*N*=20 *M*=51.32 *SD*=45.76	*N*=23 *M*=51.47 *SD*=48

Anticipated Liking. To examine differences in anticipated liking of a novel fruit, a mixed effects model was calculated. School was entered as a contextual variable acknowledging the hierarchical nature of the data and potential random effects of school on the data (Model 1, intercept model). A significant random effect for school was observed $F(1, 59)=519.25$, $p<.001$, $BIC=171.37$, indicating that the school children attended had an impact on this outcome measure and needed to be controlled for.

Secondly, fixed effects for baseline mindfulness, food neophobia and anxiety were added to the model (Model 2). This significantly improved the model's goodness of fit; $BIC=149.68$ (BIC_{old}-$BIC_{New}=21.69$).

Finally, the fixed effects term for trial arm was added to the model; this significantly improved the model's goodness of fit; $BIC=137.63$ (BIC_{old} - $BIC_{New}=12.05$). Fixed effects terms for trial arm $F(2, 40.55)=7.59$, $p=.002$, mindfulness $F(1, 40.66)=9.9$, $p=.003$ and anxiety $F(1, 40.05)=4.78$, $p=.04$ were significant, while the term for food neophobia was not $F(1, 40.4)=.51$ $p=.48$.

The results indicate that controlling for school effects, baseline levels of mindfulness and anxiety, anticipated liking significantly differed between trial arms at follow-up. Post-hoc analyses indicated that children in the Control arm gave lower anticipated liking ratings than children in the Mindful raisin-eating arm (-.96, $p=.03$) but not the Mindful breathing arm (.11, $p=.1$). Children in the mindfulness arms significantly differed in anticipated liking; children in the Mindful raisin-eating arm gave higher anticipated liking ratings than children in the Mindful breathing arm (1.07, $p=.002$; Figure 2).

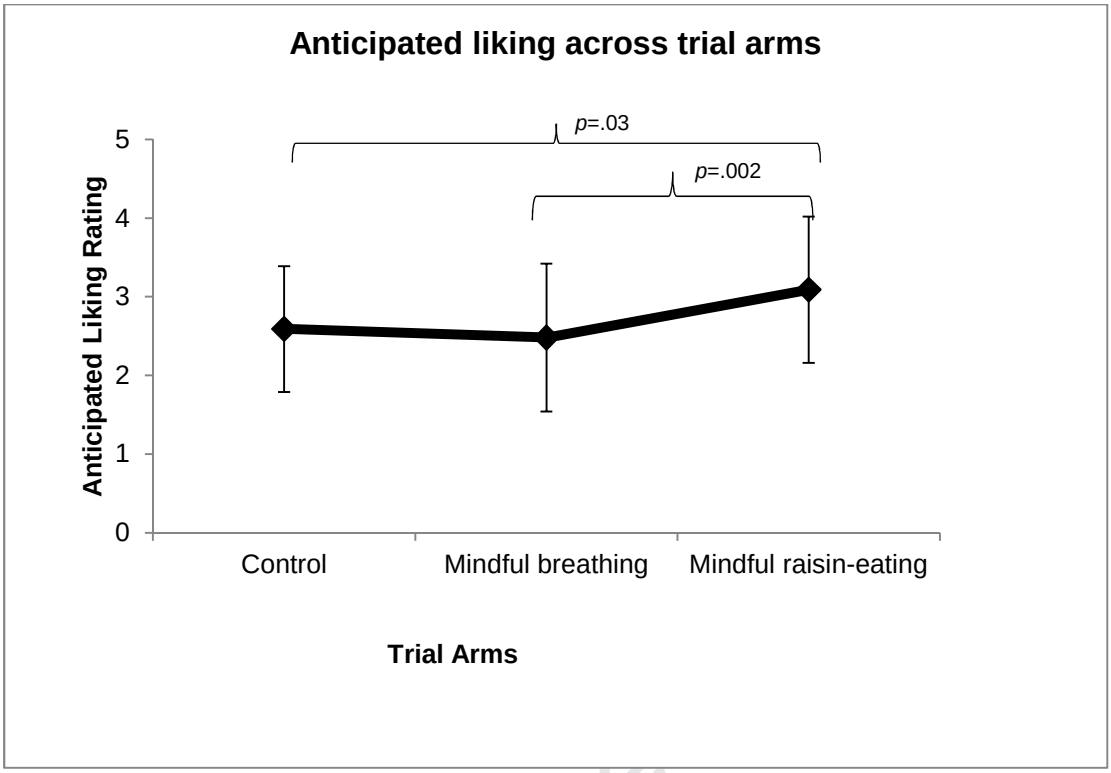

Figure 2. Adjusted means and standard deviations of anticipated liking ratings by trial arm and rating differences between arms at follow-up, adjusted for school effects, baseline levels of mindfulness and anxiety.

Intake. To examine differences in novel fruit intake, a mixed effects model was calculated. School was entered as a contextual variable, acknowledging the hierarchical nature of the data and potential random effects of school (Model 1, intercept model). A significant random effect for school was observed $F(1, 62)=53.72$, $p<.001$, $BIC=658.55$, indicating that as for anticipated liking, the school children attended had an impact on this outcome measure and needed to be controlled for.

Secondly, fixed effects for baseline mindfulness, food neophobia and anxiety were added to the model (Model 2). This significantly improved the model's goodness of fit; $BIC=513.07$ (BIC_{old}-$BIC_{New}=145.48$).

Finally, the fixed effects term for trial arm (explanatory variable) was added to the model. This significantly improved the model's goodness of fit; $BIC=490.74$ (BIC_{old} - $BIC_{New}=22.33$). Fixed effects terms for trial arm $F(2, 43.69)=4.08$, $p=.02$ and mindfulness $F(1, 43.45)=7.16$, $p=.01$ were significant, while terms for food neophobia $F(1, 43.06)=.11$ $p=.74$ and anxiety $F(1, 43.2)=1.58$, $p=.22$ were not.

The results indicate that controlling for school effects and baseline levels of mindfulness, children in the three trial arms significantly differ in novel fruit intake at follow-up. Post-hoc analyses indicated that children in the Control arm consumed significantly less of a novel fruit than children in the Mindful breathing arm (-42.91, $p=.04$) and the Mindful raisin-eating arm (-46.22, $p=.04$). Children in the two mindfulness arms did not significantly differ in novel fruit intake (3.31, $p=1$; Figure 3).

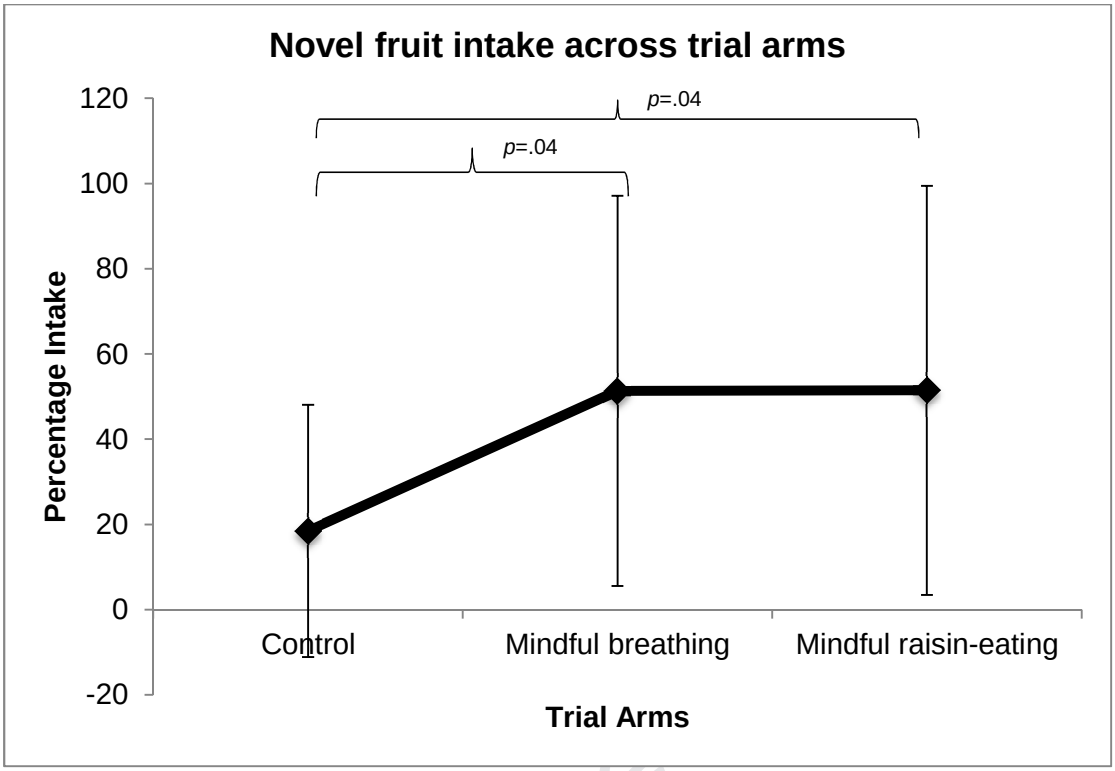

Figure 3. Adjusted means and standard deviations of the percentage of novel fruit intake by trial arm and intake differences between arms follow-up, adjusted for school effects and baseline levels of mindfulness.

Exploratory analyses of secondary measures.

Changes in mindfulness, food neophobia and anxiety, from baseline to follow-up points in the three trial arms, were explored in line with predicted hypotheses, using mixed-design ANOVAs. Descriptive statistics for each measure can be seen in Table 5.

Table 5

Descriptive statistics for mindfulness measured by the CAMM, food neophobia measured by the FSQ and anxiety measured by the SCAS in each trial arm at baseline and follow-up time points

	Control arm	**Mindful breathing arm**	**Mindful raisin-eating arm**
		Mindfulness	
CAMM baseline	*N*=19	*N*=17	*N*=21
	M=18.74	*M*=26.24	*M*=25.57
	SD=4.74	*SD*=4.76	*SD*=6.98
CAMM follow-up	*N*=19	*N*=17	*N*=21
	M=22.32	*M*=27.82	*M*=27.14
	SD=7.62	*SD*=5.5	*SD*=8.56
		Neophobia	
Baseline FSQ	*N*=19	*N*=20	*N*=22
	M=25.95	*M*=31	*M*=34.77
	SD=6.54	*SD*=5.28	*SD*=6.8
Follow-up FSQ	*N*=19	*N*=20	*N*=22
	M=26.89	*M*=30.9	*M*=34.23
	SD=6.34	*SD*=5.19	*SD*=9.31
		Anxiety	
Baseline SCAS	*N*=14	*N*=14	*N*=17
	M=39.79	*M*=37.07	*M*=35.38
	SD=15.34	*SD*=14.74	*SD*=17.15
Follow-up SCAS	*N*=14	*N*=14	*N*=17
	M=32.57	*M*=34.21	*M*=32.59
	SD=14.38	*SD*=14.96	*SD*=20.03

Mindfulness. Mindfulness scores were in line with scores reported in previous studies looking at mindfulness in non-clinical populations of children aged 10 to 17 years (Greco et al., 2011). The analyses indicated that there was a significant main effect for time point $F(1, 54)=7.58$, $p=.01$, indicating that mindfulness scores increased from baseline to follow-up (mean increase=2.25). Post-hoc analyses indicated that there was no significant change in mindfulness scores from baseline to follow-up in the Control arm $t(18)=-1.96$, $p=.07$, the Mindful breathing arm $t(16)=-1.15$, $p=.27$ or the Mindful raisin-eating arm $t(20)=-1.67$, $p=.11$. This may be due to the small sample sizes in each trial arm and a lack of power to detect changes. There was a significant main effect for trial arm $F(1, 54)=6.98$, $p=.002$. Children in the Control arm had significantly lower mindfulness scores than children in the Mindful breathing (-6.5, $p=.005$) or Mindful raisin-eating (-5.83, $p=.008$) arms. Children in the two mindfulness arms did not differ in mindfulness scores (.67, $p=1$). ANOVAs exploring differences in follow-up mindfulness, controlling for baseline differences, indicated that trial arms did not differ $F(2, 53)=.02$, $p=.98$. Finally, time point and trial arm did not interact $F(2, 54)=.67$, $p=.52$ (Figure 4).

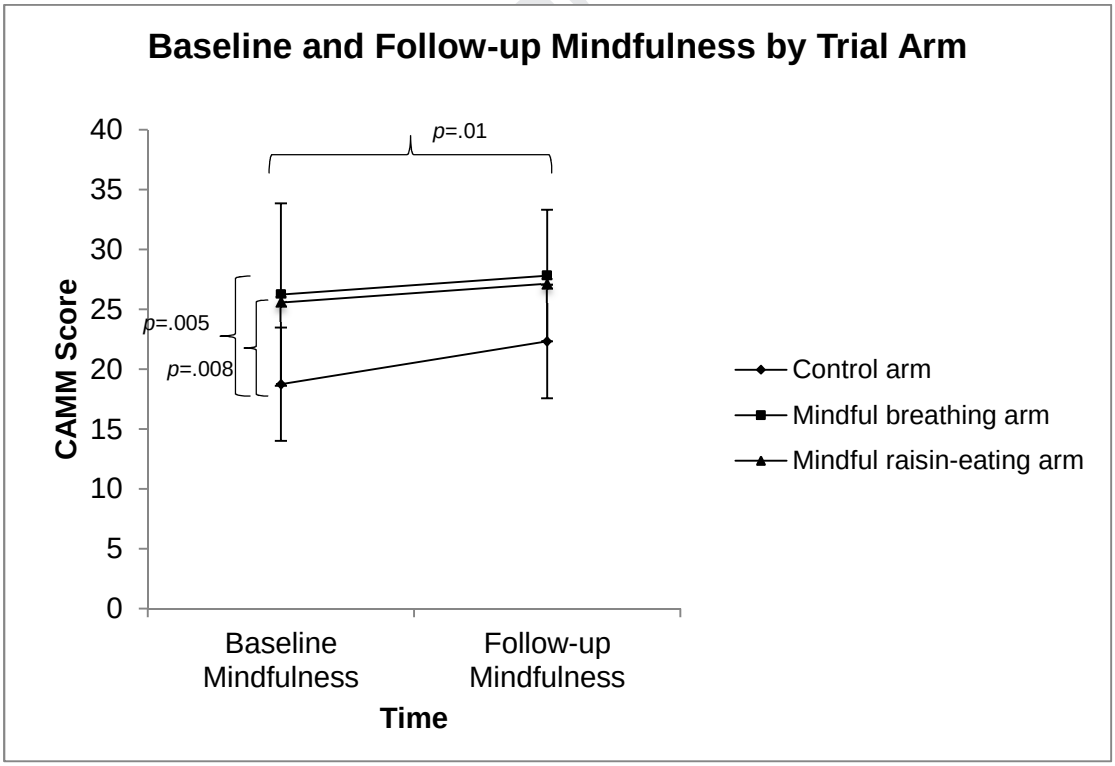

Figure 4. Adjusted means and standard deviations of the Mindfulness scores measured by the CAMM in each trial arm at baseline and follow-up.

Food Neophobia. Food neophobia scores were representative of scores reported in previous studies looking at food neophobia in non-clinical populations of children aged 10 to 12 years (Loewen & Pliner, 2000).

The analyses indicated that there was no significant main effect for time $F(1, 57)=.45$, $p=.5$; neophobia; scores did not significantly change from baseline to follow-up. There was a significant main effect for trial arm $F(2, 57)=10$, $p<.001$. Children in the Control arm had significantly lower neophobia scores than children in the Mindful breathing arm (-4.9, $p=.03$) and the Mindful raisin-eating arm (-8.11, $p<.001$). Children in the two mindfulness arms did not significantly differ in neophobia scores (3.21, $p=.24$). ANCOVAs (controlling for child age) exploring differences in follow-up neophobia, while controlling for baseline differences, indicated that trial arms did not differ $F(2, 56)=.03$, $p=.97$. Finally, time point and trial arm did not interact $F(2, 57)=.5$, $p=.61$ (Figure 5).

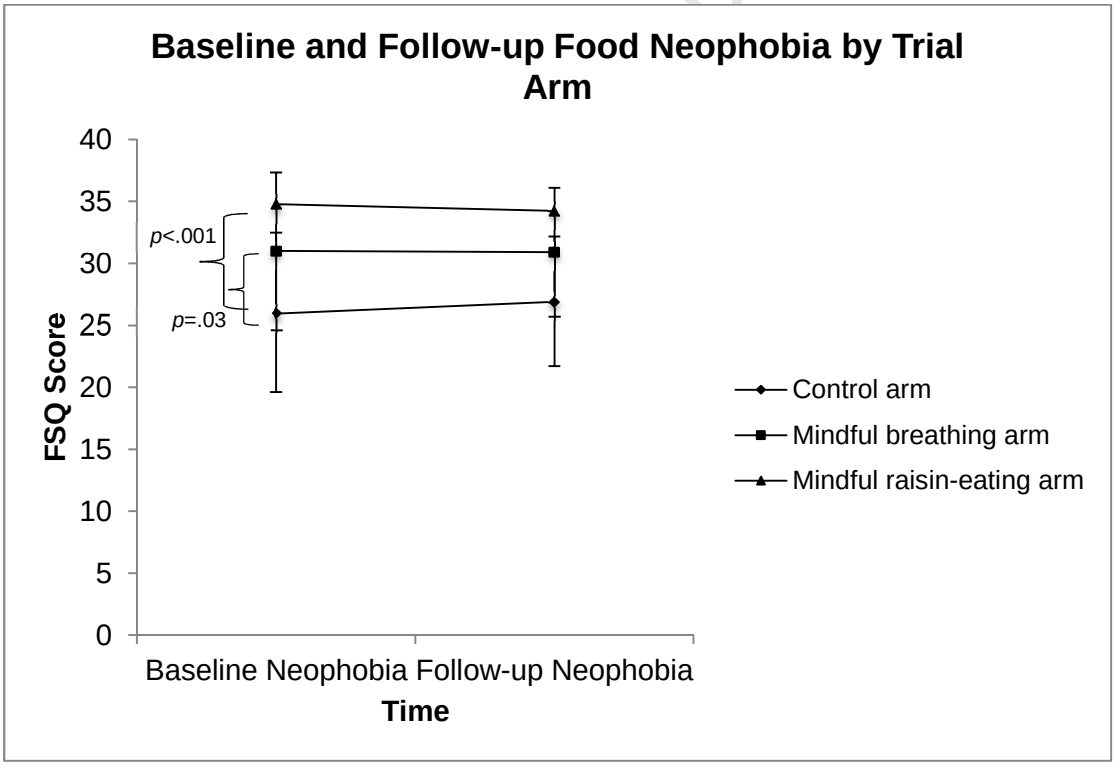

Figure 5. Adjusted means and standard deviations of the Food Neophobia scores measured by the FSQ in each trial arm at baseline and follow-up (adjusted for child age)

Anxiety. Anxiety scores in the current sample were in line with scores reported in previous studies looking at anxiety levels in non-clinical populations of children aged 8 to 12 years (Spence, 1998).

The analyses indicated that there was no significant main effect for time *F(1, 41)=1.98, p*=.17, or trial arm *F*(2, 41)=.12, *p*=.89 and no significant interaction between time point and trial arm *F*(2, 41)=1.77, *p*=.18 (Figure 6).

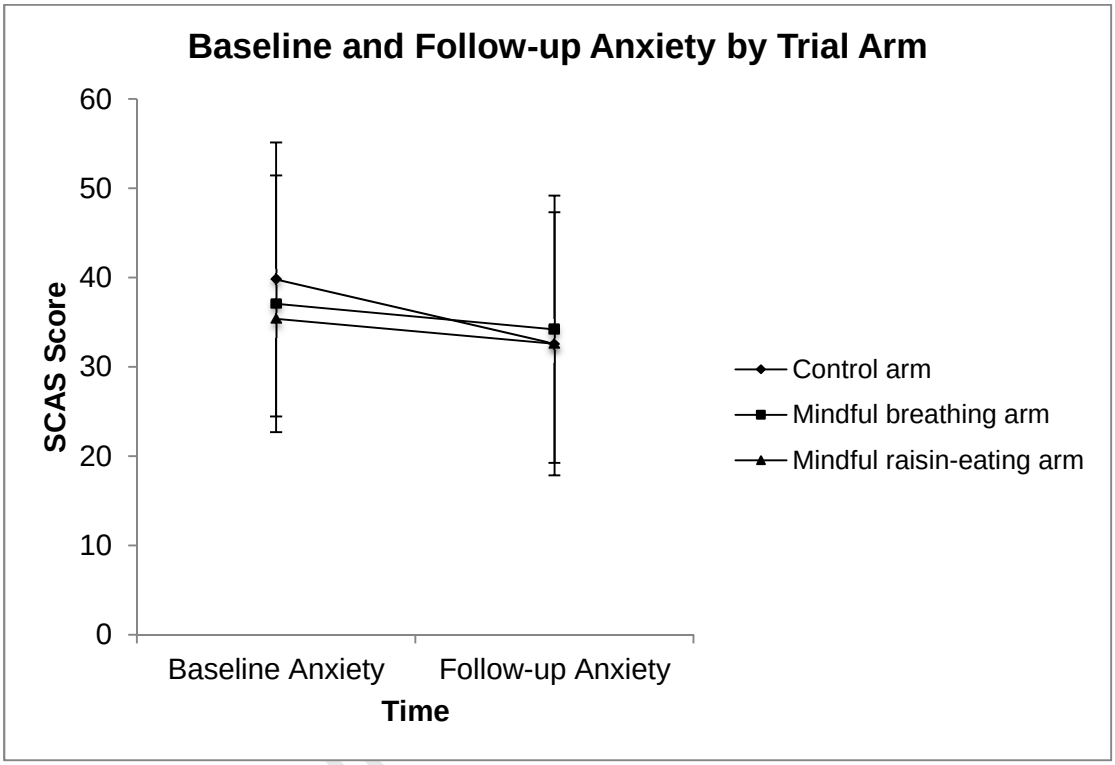

Figure 6. Adjusted means and standard deviations of the Anxiety scores measured by the SCAS in each trial arm at baseline and follow-up (adjusted for family annual income)

Discussion

This trial explored the impact of mindfulness-based exercises on anticipated liking and novel fruit intake in 10-12-year-olds. In line with the a priori hypothesis, children in the Mindful raisin-eating arm expressed greater anticipated liking for a novel fruit than children in the Mindful breathing arm of the trial. Contrary to the predicted hypothesis, however, children in the Mindful breathing arm and the Control arm did not differ in anticipated liking. Furthermore, although children in the Mindful raisin-eating and Mindful breathing arms did not differ in novel fruit intake, they did consume a greater amount of the novel fruit than children in the Control arm.

The results suggest that small changes in anticipated liking can be seen after children engaged in a food-related mindfulness exercise only. This finding could be explained by the exposure effect, which has been shown to positively impact on food neophobia (Mustonen, Oerlemans, & Tuorila, 2012; Nederkoorn et al., 2018). Exposing children to a raisin and encouraging them to focus on its sensory properties curiously and non-judgementally may have fostered skills that generalised to the novel fruit, leading to a more favourable appraisal of its (anticipated) sensory properties. The lack of such an effect in the Mindful breathing arm supports this conclusion, suggesting that the exposure to a fruit in the mindfulness exercise and learning mindfulness skills in this context were key aspects for increasing anticipated liking of a novel fruit (Mustonen et al., 2012; Nederkoorn et al., 2018). Nevertheless, as the observed changes in anticipated liking were small, any conclusions need to be regarded with caution.

The results also suggest that brief mindfulness exercises, whether food-related or not, can improve actual novel fruit intake. The change in observable behaviour in the absence of consistent changes in anticipated liking is in line with research, showing that behavioural change and changes in subjective evaluation are independent processes and that changes in subjective attitudes may follow overt behaviour change (Festinger, 1957; Priester, Cacioppo, & Petty, 1996; Smith & Mackie, 2007; Wells & Petty, 1980). The present findings are also in keeping with results by Hong et al. (2018) who observed improved intake but not liking of novel or disliked foods in 3-10-year-olds following a mindfulness intervention. Children in both mindfulness arms engaged in exercises fostering openness, curiosity and non-judgemental awareness of the present moment and experiences (Kabat-Zinn, 2005; Williams & Penman, 2011). Application of these skills in the context of tasting a novel fruit could have meant that children were more aware of their thoughts and judgements and physiological reactions associated with disgust and anxiety, while

being able to tolerate these and engage in behaviour that was not driven by these reactions (Brown & Harris, 2012a, 2012b; Galloway et al., 2003; Nordin et al., 2004; Tuorila et al., 2001). This in turn may have facilitated approach behaviour towards the novel fruit, increasing novel fruit intake in the Mindfulness arms compared to the Control arm. Changes in anticipated liking may follow this approach behaviour in both trial arms (Dazeley & Houston-Price, 2015; Priester et al., 1996).

The secondary aim of this study was to explore changes in mindfulness, food neophobia and anxiety from baseline to follow-up in each of the trial arms to allow an exploration of potential mechanisms that may contribute to the observed differences in primary outcomes. Although children became more mindful overall, there were no increases in mindfulness in individual trial arms suggesting that the mindfulness intervention did not lead to changes detectable by the Child and Adolescent Mindfulness Measure (CAMM). These results are similar to those reported by other researchers and a review into changes in mindfulness following mindfulness interventions (Huppert & Johnson, 2010; Visted, Vøllestad, Birkeland Nielsen, & Nielsen, 2015) and they raise the question of what underlies the observed differences in novel fruit intake and anticipated liking. Although the CAMM did not indicate an increase in mindfulness for children in the Mindfulness arms it is possible that the measure was not sensitive or specific enough to detect such changes. The CAMM conceptualises mindfulness as a trait, suggesting that individuals can act more or less mindfully independent of situations. Greco et al. (2011) note that the CAMM may be more likely to measure internal mindfulness skills rather than observable skills, as child self-reports and teacher ratings are only moderately related. It is likely that a longer and/or more intensive intervention would have been necessary for children to internalise the learnt mindfulness skills, become aware of associated changes in their behaviour and report these using the CAMM (Kuby et al., 2015). In line with this, Vickery and Dorjee (2016) also failed to observe changes in mindfulness measured by the CAMM following a 6-module mindfulness intervention with 7-9-year-olds. Nevertheless, mindfulness increased from post intervention to three-month follow-up as children continued to engage in brief informal mindfulness practice with their teachers. Huppert and Johnson (2010) observed that practice of mindfulness exercises was a key factor moderating changes in mindfulness and well-being from baseline to follow-up in adolescent boys enrolled in a mindfulness programme, consisting of four weekly 40-minute mindfulness sessions, delivered by teachers.

There was no detectable reduction in food neophobia or anxiety over the course of the intervention period. Neophobia is a complex and multifaceted concept

and different measures of neophobia may capture different aspects of neophobia (Damsbo-Svendsen, 2017). The Food Situations Questionnaire (FSQ) explored children's willingness to try foods in different situations (Loewen & Pliner, 2000). It is possible, however, that the mindfulness exercises impacted on non-situational aspects of the novel fruit, such as sensory properties, fostering skills that allowed children to accept negative evaluations of and disgust reactions towards the novel fruit without needing to act on these (e.g. noticing the thought "that fruit smells weird" and an urge to reject it but approaching it regardless of these thoughts and urges). Finally, the lack of evident changes in anxiety may also be associated with the brief duration of the mindfulness intervention or the sensitivity and specificity of the Spence Children's Anxiety Scale.

Limitations and Further Research

The number of children in each of the three arms was small, and the need to randomise clusters rather than individual children may have limited the power to detect changes in outcomes. A replication of the current results with larger sample is hence required.

Unfortunately, anticipated liking and novel fruit intake were measured at follow-up but not at baseline, limiting our certainty to some degree that the mindfulness exercises per se led to a change in novel fruit intake by trial arm. Analyses of differences in primary outcomes allowed controlling for baseline levels of mindfulness, neophobia and anxiety to address this. As baseline exposure to a novel fruit might have primed children to the main outcome measure, this was not included. Future research could consider alternative outcome measures such as changes in heart rate and cortisol levels to clarify whether changes in physiological reactivity to novel foods help to explain the observed effects (Feldman, Lavallee, Gildawie, & Greeson, 2016).

Children in the Control arm read food-facts, answered food-quiz questions and coloured in fruit/vegetable shapes for five minutes each day. Although this task was meant to represent a non-mindful control task, colouring activities like these may well represent mindful activities, while also exposing children to fruits and vegetables. This may also explain the small increase in mindfulness from baseline to follow-up reported by children in this trial arm. The effects of the selected mindfulness exercises on outcomes may hence have been weakened as a consequence.

Despite the cluster-randomisation process, children in the Control arm were less mindful and more anxious than children in the Mindfulness arms. The researcher was blind to the trial arm children were allocated to and children completed the

questionnaires and engaged in the food testing session individually and independently of the trial arm, suggesting that neither biases in the collection of outcome data, nor the influence of peer factors can explain these differences. Further exploration of the data suggested that gender, age and cohort effects did not explain these differences, suggesting that they reflect random differences.

Conclusions

This cluster-randomised controlled trial adds to the existing literature examining the effect of mindfulness interventions on improving intake of novel or disliked foods by including an active comparison control group and controlling for peer and school effects on outcomes. Additionally, this study has begun to explore factors that may explain changes in novel fruit intake and liking. Overall, the results suggest that despite the fact that engagement in mindfulness exercises does not lead to detectable changes in self-reported mindfulness, neophobia or anxiety, the mindfulness exercises are linked with greater anticipated liking (mindful raisin-eating only) and greater novel fruit intake (mindful breathing and raisin-eating), making this a promising, cost- and time-effective intervention to improve the variety and amount of fruit children consume. Further research exploring long-term effects and the possibility to generalise these findings to other food groups such as vegetables is needed.

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