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The root of the problem: Increasing root vegetable intake in preschool children by repeated exposure and flavour flavour learning.

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Abstract

Children's vegetable consumption falls below current recommendations, highlighting the need to identify strategies that can successfully promote intake. The current study aimed to investigate the effectiveness of flavour-flavour learning as one such strategy for increasing vegetable intake in preschool children. Children (N=29) aged 15 to 56 months were recruited through participating nurseries. Each received a minimum of 6 and maximium 8 exposures to a root vegetable puree with added apple puree (flavour-flavour learning) alternating with 6-8 exposures to another with nothing added (repeated exposure). A third puree acted as a control. Pre and post-intervention intake measures of the three purees with nothing added were taken to assess change in intake. Follow up measures took place 1 month (n=28) and 6 months (n=10) post-intervention. Intake increased significantly from pre to post intervention for all purees (~36g), with no effect of condition. Magnitude of change was smaller in the control condition. Analysis of follow up data showed that intake remained significantly higher than baseline 1 month ($p<0.001$) and 6 months ($p<0.001$) post-intervention for all conditions. Children under 24 months ate consistently more across the intervention than the older children (≥25 m) with no differences found in response to condition. This study confirms previous observations that repeated exposure increases intake of a novel vegetable in young children. Results also suggest that mere exposure (to the food, the experimenters, the procedure) can generalise to other, similar vegetables but the addition of a familiar flavour confers no added advantage above mere exposure.

Keywords: Vegetable intake; Pre-school children; Repeated exposure; Learning

Introduction

Habitual vegetable consumption provides many known health benefits (Bazzano, 2006; He, Nowson, & MacGregor, 2006; Hung et al., 2004; Joshipura et al., 2001; Serdula et al., 1996; World Cancer Research Fund / American Institute for Cancer Research, 2007) and yet intake remains much lower than recommendations (The NHS Information Centre, 2012), particularly in children (Magarey, Daniels, & Smith, 2001; National Obesity Observatory, 2012; Yngve et al., 2005). The eating habits we develop during childhood often persist into later life (S. Nicklaus, Boggio, Chabanet, & Issanchou, 2005) suggesting the development of interventions targeting children, that aim to increase vegetable intake, may serve to maximise the potential health benefits of improving diet.

Studies that have explored approaches to promoting vegetable consumption in young children have so far identified several potential strategies. These range from providing larger portion sizes (Rolls, Roe, & Meengs, 2010) to serving vegetables by stealth, incorporated within meals in order to hide their presence (Caton, Ahern, & Hetherington, 2011; Spill, Birch, Roe, & Rolls, 2011). In addition offering children tangible rewards and social praise has also been successful in increasing both liking for and consumption of novel vegetables (L. J. Cooke, Chambers, Añez, Croker, et al., 2011; L. J. Cooke, Chambers, Añez, & Wardle, 2011).

A method that has proven particularly effective in increasing children's preference for vegetables is simple repeated exposure. Grounded in the mere exposure effect (Zajonc, 1968), repeated exposure works by building familiarity with a novel stimulus. Zajonc (1968) suggested that animals initially respond to all novel stimuli with fear or avoidance. He goes on to explain that preference for a stimulus object can be developed simply by repeatedly presenting that stimulus to an individual and consequently increasing familiarity with it. Therefore, foods that we are frequently exposed to become liked. The success of mere exposure via familiarisation is that experience with the stimulus produces no negative affect which could result in damaging associations to be formed and actually acts to decrease preference (Zajonc, Markus, & Wilson, 1974). This idea is consistent with the 'learned safety' hypothesis in food preference development, proposed by Rozin and Kalat (1971). They demonstrated that repeated experiences with a food with no negative post-ingestive outcomes can increase preferences for previously novel or disliked foods. There is growing evidence that repeated exposure can successfully increase children's liking and acceptance of a novel food or flavour. There is also evidence to suggest that this effect can generalise, promoting acceptance of other new foods (Birch, McPhee, Shoba, Pirok, & Steinberg, 1987; Loewen & Pliner, 1999) particularly when children are repeatedly and frequently exposed to a variety of new foods and flavours (Maier, Chabanet, Schaal, Leathwood, & Issanchou, 2008). Recent research has produced favourable results with increases in liking and consumption of vegetables across ages (Lakkakula, Geaghan, Zanovec, Pierce, & Tuuri, 2010; Wardle et al., 2003).

A review of dietary learning by Brunstrom (2005) has suggested that associative conditioning can also play an important role in the development of food preferences, allowing us to learn about the properties of different foods and shaping the choices we make about what foods to consume. Much of this has focussed on flavour-nutrient learning (FNL) where associations are formed between the flavour of a food and its post-ingestive consequences. Ingestion of foods that lead to positive outcomes, such as feeling satiated, result in an increase in the hedonic value of those foods and acceptance of those flavours. Another proposed mechanism for establishing flavour preferences is flavour-flavour learning (FFL). Instead of being regulated by post-ingestive feedback FFL occurs when associations are established between a flavour cue and another, already liked flavour. Repeated pairings of these two flavours result in a positive shift in liking for the target flavour even when it is presented on its own. Similarly, pairings with a disliked or aversive flavour reduce liking for the conditioned flavour. A number of recent studies have attempted to apply the principles of FFL to promote vegetable liking and consumption in children. Havermans and Jansen (2007) presented primary school children (average age of 5 years) with unsweetened and sweetened vegetable juices across six pairs of conditioning trials. Using this method they were able to demonstrate an increase in preference for those juices that had been paired with a sweet taste when compared with those that had not. However, this increase in preference did not translate to an increase in liking. Additionally the number of children who completed the study was low, with only thirteen of the twenty-one children recruited taking part in all of the conditioning trials. More recent studies involving pre-school aged children have been successful in increasing children's intake of a novel vegetable by pairing it with a sweet taste (Caton et al., 2013; Hausner, Olsen, & Moller, 2012; Remy, Issanchou, Chabanet, & Nicklaus, 2013). These experiments performed in three different European countries, used near identical designs and the same products to compare FFL with FNL and repeated exposure. Children were assigned to one of the three conditions and received up to 10 exposures to a novel artichoke puree of a corresponding recipe. In the FFL condition this consisted of an artichoke puree paired with a 3.6g of sugar per 100g. The results of all three studies showed a significant increase in intake of a plain artichoke puree offered post-intervention in the FFL condition suggesting that FFL had taken place. It is important to note, however, that all three studies also found no advantage in using FFL to increase vegetable consumption over a simple repeated exposure method (Caton et al., 2013; Hausner et al., 2012; Remy et al., 2013).

The technique of pairing vegetables with flavours that are liked by children is one that UK mothers already use to encourage consumption, often in the form of dips and sauces (Caton et al., 2011). The extent to which this is helpful in developing a preference for vegetables is yet to be established experimentally, although a recent study was unable to demonstrate increased liking or intake when compared with repeated exposure (Anzman-Frasca, Savage, Marini, Fisher, & Birch, 2012). Instead Anzman-Frasca et al. (2012) suggested that these kinds of pairings may serve to encourage initial tastes of new or disliked vegetables. To date, the success of FFL interventions has relied upon pairings of vegetables with a sweet taste. Although not always explicitly stated, a sweet taste is likely to be chosen as the unconditioned stimulus because of the pleasure response associated with it (Booth, Higgs, Schneider, & Klinkenberg, 2010). Children have an innate preference for sweet tastes and it therefore follows that adding sweetness will likely enhance preference, perhaps especially for vegetables which are bitter. However, this conflicts with health messages to reduce added sugars in the diet (Department of Health, 2013). If effective, employing naturally sweet ingredients such as fruit or pureed fruits may be more attractive to parents as a technique for increasing children's vegetable consumption.

There is growing evidence that repeated exposure offers an effective strategy for promoting vegetable intake in children, however, research in support of FFL is limited suggesting further investigation is needed. Given that the mere exposure effect is predicated upon a lack of negative consequence over time, adding an already liked flavour to a novel vegetable might facilitate preference and acceptance. The addition of a sweet taste may assist in reducing the intensity or bitterness of vegetable flavours which may in turn encourage initial intake and increase the opportunity for taste exposure.

The aim of the present experiment was to test the hypothesis that adding sweetness via fruit puree to a novel, target vegetable would be more effective than simple repeated exposure in increasing liking and intake of the target.

Method

Participants

Parents of pre-school children aged 12-60 months were recruited through local day care nurseries in the West Yorkshire area, UK. Initial contact was made with nurseries via email or telephone and managers were given details of the study. If managers expressed interest in taking part further meetings were held with staff teams at the nurseries to ensure they understood and were comfortable with the purpose of the study and consent forms were distributed to parents.

Of the fifteen nurseries that were approached, four agreed to take part and three successfully completed the intervention. Through these three nurseries, 42 children aged 15–56 months were recruited. Participants were screened for food allergies (as reported by parents) and inclusion in the study required children to attend nursery for at least 2 days per week. The study was approved by the Institute of Psychological Sciences (University of Leeds) ethics committee (12-0018).

Procedure

A within subjects design was employed. Three target vegetables were identified as being relatively novel to pre-school children and neutrally liked based on the results of a previous study (Ahern et al., 2013); celeriac, swede and turnip, and these were counterbalanced across conditions and then counterbalanced across participants. A summary of the procedure is shown in Figure 1. Children's baseline intakes of the RE versions of all three vegetable purees were measured before the intervention (see Table 1 for puree recipes). They received up to 200g of each vegetable puree on three separate days at their usual snack time. Children were initially offered a single pot containing 100g of puree and were asked to consume and much or as little as they would like. If children ate all of the first pot, then a second pot of 100g was offered. Purees were offered to the children by nursery staff or experimenters. Nursery staff had been instructed to approach feeding the children in the same way as they normally would and children were given as much time as they needed to consume the puree snacks.

The conditioning phase began 2 to 5 days after baseline. Participants received between 6 and 8 exposures to a FFL variant of one of the vegetable purees, alternated with 6 to 8 exposures to a RE variant of another of the vegetable purees (a total of two or three exposures per week). No exposures were given to the third vegetable. Test days were separated by at least one day and no more than three and intake was measured after each exposure. Post-intervention measures of intake of the RE variants of all three purees on three spate days took place 2 to 5 days later. Two follow-up measures of intake were also taken 1 and 6 months post-intervention.

Study Foods

Purees were produced using organic frozen celeriac, swede and turnip (JE Hartley, York, UK), boiled and blended using a hand blender and with no other ingredients added.

Purees were prepared in 5 to 10 kg batches and refrozen as individual 100g portions. Sufficient portions for each test visit were defrosted while being refrigerated overnight. Recipes for the purees can be seen in Table 1. For the FFL recipe 21.5g of Ella's Kitchen© First Taste apple puree (Table 1) was added to 100g of vegetable puree and stirred until fully mixed. For a portion, 100g of this mixed puree was then extracted (18% apple). The concentration of apple puree for the FFL recipes was selected using sensory profiling by adult participants. Results showed a significant increase in sweetness, decrease in bitterness and increase in liking for the vegetable purees with 18% apple puree versus the plain versions.

Sensory profiling revealed that the vegetable purees did not differ significantly for liking, flavour intensity or for sweet, bitter, salty and sour taste.

Anthropometrics

Where consent had been given the heights and weights of participating children were measured at the end of the intervention. Children were weighed using Seca digital scales and measured using a Leicester SMSSE portable stadiometer. For infants under the age of two years Seca infant scales and a Seca mobile measuring board were used. BMI z-scores were calculated using the WHO anthropometric calculator (http://www.who.int/childgrowth/software/en/).

Statistical Analysis

Multilevel models (MLM) were constructed to examine the effects of condition, time and age group on consumption. Analysis was carried out using lme4 package in R (Bates, Maechler, Bolker & Walker, 2014, R Core Team, 2013). All children who completed the intervention were included in the analyses.

Fixed factors in the model were time (pre-intervention, post-intervention, 1 month follow up, 6 month follow up), condition (FFL, RE, Control), age group (<24 m , >24 m), and the interaction of those factors. Random factors were participant, and the interaction of participant with each of the within subjects factors. Finally, the identity of the vegetable in each condition was added as a fixed factor. Co-efficients were estimated using REML, and the statistical significance of each factor was calculated using Wald Chi-squared test for the package car (Fox and Weisberg, 2011).

To examine changes in intake across the conditioning period further models were constructed. Fixed factors in the model were time (exposure 1 - 8), condition (FFL, RE), age group (<24m months and ≥24m), and the interaction of those factors. Random factors were participant, and the interaction of participant with each of the within subjects factors. The identity of the vegetable in each condition was then added as a fixed factor.

Finally Pearson's correlation was used to investigate relationships between intake pre and post-intervention in the three conditions and the three vegetables. This was conducted using SPSS version 19 (SPSS Inc., Chicago, IL, USA).

Results

Of the 42 children recruited, 29 completed the intervention. This involved children being present for at least six of the eight exposures to both the FFL and RE purees and all pre-test and post-test measures. Due to illness and holidays 13 of the children were unable to complete the intervention as a result of non-attendance on testing days. Of the 29 children who completed the intervention, 28 completed the 1 month follow-up and 10 completed the 6 month follow-up.

Intake pre and post intervention

Baseline intakes did not differ by condition ($p=0.7$): RE 6.6±2.9g; FFL 6.2±2.2g; Control 9.5±3.4g. MLM revealed a significant effect of time (Chi-sq(3) = 106.22, $p<0.001$) with increases in intake from pre-intervention to each of the post-intervention time points in all three conditions (Figure 2). Although baseline intake did not differ by vegetable ($p=0.1$; Celeriac 3.8±0.9g; Swede 11.7±4.2g; Turnip 6.9±2.3g) an overall main effect of vegetable was found (Chi-sq(2) = 25.97, $p< 0.001$) with children consuming more swede and turnip than celeriac over the course of the study. A significant effect of age group (Chi-sq(1) = 8.81, $p<0.01$), and a significant interaction of time by age group (Chi-sq(3) = 36.85,

$p<0.001$) were found. Children in the older age group (>24m) ate less vegetable puree immediately post-intervention and at follow up than the younger group and showed less of an increase in intake (Figure 3). Mean change in intake from pre to post-intervention by condition (RE, FFL and control) and age group (<24 months, >24 months) is shown in Figure 4. Simple contrasts comparing each time point with baseline showed that the estimated intercepts were more than 2 standard errors away from zero.

Intake across exposures

MLM analysis revealed a significant main effect of exposures (Chi-sq(7) = 63.16, $p< 0.001$), with more vegetable puree being consumed in later trials than earlier trials. A significant increase in intake was identified by exposure 3 and no further significant increase was found after the third exposure. There was no main effect of condition, however, there was a statistically significant interaction between exposures and condition (chi-sq(7) = 16.54, $p<0.05$, with intake increasing more across exposures in the FFL condition. While this might suggest that FFL is more effective at increasing consumption than RE, examination of the estimates of the intercepts and their standard errors, showed that the contrasts were within 2 standard errors of zero, and so this cannot be considered a reliable difference.

Again a main effect of age group was identified (Chi-sq(1) = 5.83, $p<0.05$) as well as a significant interaction of exposures by age group (chi-sq(7) = 32.32, $p<0.001$) showing that younger children consistently ate more vegetable puree across the intervention (Figure 5).

Examination of the simple contrasts between the younger 238 and older children with exposures demonstrated that the older children again ate less in the later trials.

Correlations

Post-intake of vegetable puree in all three conditions was significantly correlated (RE and FFL: $r(29)=0.63$, $p<0.001$, RE and Control: $r(29)=0.65$, $p<0.001$, FFL and Control: $r(29)=0.64$, $p<0.001$) as was change in intake (RE and FFL: $r(29)=0.51$, $p<0.01$, RE and Control: $r(29)=0.47$, $p<0.01$, FFL and Control: $r(29)=0.76$, $p<0.001$) suggesting that a child whose intake increased in one condition was likely to eat more in all conditions. No relationships were identified between pre and post-intervention intake in the RE and FFL conditions, however, a significant positive correlation was observed between pre and post intake in the control condition, $r(29)=0.49$, $p<0.01$. No relationship was found between pre and post-intervention intake for any of the three vegetables, however, post-intervention intake for all three were positively related; celeriac and swede: $r(29)=0.49$, $p<0.01$, celeriac and turnip: $r(29)=0.65$, $p<0.001$; swede and turnip: $r(29)=0.88$, $p<0.001$.

Discussion

The results of the present study support much of the current literature demonstrating that repeated exposure to a novel or disliked target vegetable can increase children's acceptance and intake of that vegetable (Caton et al., 2013; de Wild, de Graaf, & Jager, 2013; Hausner et al., 2012; Lakkakula et al., 2010; Wardle et al., 2003). Intake of the FFL puree also increased from pre to post-intervention, when no longer paired with the sweet tasting fruit puree, indicating that associative learning had taken place. Again these findings support those of previous investigations into the effectiveness of FFL in increasing children’s liking for vegetables (Caton et al., 2013; Hausner et al., 2012; Havermans & Jansen, 2007; Remy et al., 2013). However, when compared with repeated exposure FFL does not appear to offer any additional advantage as both techniques seem equally effective at increasing vegetable intake post-intervention, even with vegetables which tend to be disliked such as celeriac. Six exposure sessions were sufficient to increase intake in both conditions and intake shifted from around 7g (less than ¼ of the recommended 40g child portion) to approximately 46g. In addition, results suggest that as few as three exposures may be sufficient to significantly increase intake. These results confirm that for young children a relatively small number of exposures are required to increase intake of vegetables (Caton et al. 2013).

Although no significant difference was found between the conditions of this study, children in both the experimental conditions did consume more of the target vegetables post-intervention when compared with the control. It is unlikely that the increase in intake of all three vegetables was a result of developmental changes in the children during the intervention period since this was a relatively short time span. Instead results suggest that repeated experiences with two novel vegetable purees across the exposure period worked to promote acceptance and intake of a third similar puree. Whether this is a result of repeated taste exposure, however, is unclear. Gordon and Holyoak (1983) were able to demonstrate that the increase in positive affect for a stimulus produced via mere exposure can generalize to other previously novel stimuli where these stimuli are sufficiently similar. As a result of experience with the exposed stimulus these novel but similar stimuli are not perceived to be entirely unfamiliar and when presented in a way with which participants have previous experience, structural mere exposure can occur (Zizak & Reber, 2004). In addition to offering an explanation for an increase in the consumption of the control puree structural mere exposure may also account for the increase in intake observed in the FFL condition. It has previously been assumed that increases produced via repeated exposure to a vegetable paired with a sweet taste is evidence of associative conditioning (Caton et al., 2013; Hausner et al., 2012; Remy et al., 2013). However, the similarities between the vegetable purees used might suggest that the effects of repeated exposure to a sweetened version simply generalized to the plain or unadulterated puree.   To date the structural dimension of mere exposure has not been investigated in relation to food preference development and so conclusions about its effect in this context cannot be made. Positive shifts in intake could just as easily be a result of the children becoming familiar with the experimental procedure and environment and so learning to expect to consume a vegetable puree at snack time. Irrespective of the cause, children do consume significantly more of all three vegetable purees post-intervention and increase in intake of the control is positively associated with the increase in both experimental conditions. It seems reasonable to suggest, therefore, that children’s previous experiences with the vegetable purees have worked to increase their willingness to consume the control. This assumption is further supported by Kalat and Rozin's (1973) 'learned safety' hypothesis. They suggested that animals approach all new foods as potentially toxic and through repeated experiences with that food, which do not result in negative consequences, gradually learn that it is safe. As all of the children received a minimum of twelve exposures to relatively similar vegetable purees, all presented in an identical way during the intervention period, it follows that they came to trust that the food that they were being offered was safe to eat. As previously discussed, this idea of repeated exposure in the absence of negative affect underpins Zajonc's mere exposure effect making mere exposure a legitimate explanation for the increases in intake observed within this study.

The observed increase in intake of all three purees persisted one month after the end of the intervention despite no further exposures being given. This suggests that the effects of repeated exposure to both a plain and sweetened vegetable puree remained stable over this period. However, while the target vegetables were not found to be commonly offered to pre-school age children, it is important to consider that some children may have been offered one or all of these vegetables at home between the intervention and follow-up measure of intake. Although the vegetables may not have been offered as puree these children would have received further taste exposure. The timing of the intervention and the age of the children taking part meant most were unable to participate in the six month follow up as they had left nursery to attend school. Those that did were almost entirely made up of children who were in the younger age group at the time of the intervention which may have resulted in a biased sample. However, it is worth noting that at the time of the six month follow up around half of these children were over two years of age. Intake in this subsample continued to increase over time with children eating on average 114g of puree, more than double the 40g recommended amount for a child's single portion of vegetables. This 35g increase in intake from one month to six months post intervention is not statistically significant, however, only a third of the original sample took part in this follow-up which no doubt reduced statistical power. The results are therefore encouraging. Overall results suggest that repeated exposure may be an effective strategy for producing long term enhancement of children's liking for and intake of vegetables.

Participants over two years of age consumed substantially less vegetable puree throughout the intervention period and at post-intervention than those aged below two years. This pattern of intake has been found in previous research (Caton et al. 2013) and supports existing literature that suggests the neophobic response to new foods peaks between two and six years of age (Addessi, Galloway, Visalberghi, & Birch, 2005; L. Cooke, Wardle, & Gibson, 2003; Dovey, Staples, Gibson, & Halford, 2008; Sophie Nicklaus, 2009). Consequently, a more neophobic response to a novel food is a likely explanation for the age effect. Equally, it is worth noting that the use of puree as target foods may also have reduced intake in the older children who are more accustomed to receiving solid foods at lunch and snack times and, given its resemblance to 'baby food', maybe reluctant to consume pureed vegetables. While intake within this age group did not increase to the same extent as the younger children, it did increase. A study by Coulthard and colleagues (2010) found that frequency of exposure became more important for promoting intake when introducing vegetables later in childhood and so older children may require more exposures to the vegetable purees to produce a similar increase in intake over time. Alternatively, given the period of neophobia multiple exposures might nonetheless produce modest effects until after this has peaked.

Evidence supporting the effectiveness of repeated exposure in increasing children's vegetable intake is growing and much of the recent research, including this study, suggests that very few exposures are necessary (Caton et al., 2013; Wardle et al., 2003). The present study demonstrates a significant positive shift in consumption after only three exposures. It is worth noting, however, that due to the design of the study by the third exposure to either condition, each child would have received five or six exposures to vegetable puree overall. A limitation of the study was therefore that to reduce variability a within subjects design was used but for replication a between subjects design might be usefully employed. The study is also limited in that it only explores the effects of repeated exposure to a vegetable puree. While the vegetables chosen for this experiment are commonly eaten in pureed or mashed form in the UK, it is not possible to predict whether familiarity with a pureed vegetable will generalise to the same vegetable prepared and offered differently. Studies have demonstrated that preparation methods can influence children's acceptance and liking of vegetables and that children tend to prefer vegetables that are prepared in a familiar way (Donadini, Fumi, & Porretta, 2012; A. A. M. Poelman &

Delahunty, 2011; Astrid A. M. Poelman, Delahunty, & de Graaf, 2013). Future studies could therefore expand on the results of the current study by exploring the effects of repeated exposure to vegetable purees on intake of those same vegetables offered in solid, pure form.

Current guidance advises parents that they may need to offer a new food ‘lots of times’ before it is accepted suggesting as many as 10-15 times may be necessary (NHS, 2013). This could be a process that parents find difficult to persevere with (Birch et al., 1987; Wardle et al., 2003) and previous research has suggested that parents tend to stop offering their children novel foods if they are initially rejected three times, identifying them as disliked (Maier et al., 2007). Reducing the recommendation or offering guidance on a pattern of food introduction, such as offering two or three similar vegetable purees on alternate days, may seem more achievable and help motivate parents to persevere (Maier et al., 2008; Sophie Nicklaus, 2009).

In line with previous research this study confirms the effectiveness of repeated exposure in promoting vegetable acceptance and intake in pre-school children. In addition the study demonstrates that offering children repeated experiences with a sweetened vegetable can increase consumption of that same vegetable when offered unsweetened. Both techniques can produce a significant increase in intake which can endure for up to six months post-intervention. The study demonstrates no added benefit of pairing vegetables with a pre-liked or sweet flavour suggesting that offering children vegetables in their pure form is the most effective technique for parents and caregivers to employ in promoting vegetable consumption.

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Highlights

- Children's vegetable intake increased significantly from pre to post intervention in all conditions
- Intake remained higher 1 month and 6 months after the intervention in all conditions
- Children under 24 months ate consistently more vegetable puree across the intervention than older children
- Repeated exposure to any variant of a vegetable puree significantly increased intake after 3 only exposures

Tables and Figures

Table 1. Nutritional composition and recipes of all purees used in the study

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

Figure 1. Summary of study procedure

<table>
<tr><td rowspan="2">Pre-Test</td><td rowspan="5">2-5 days</td><td colspan="8">Conditioning Phase</td><td rowspan="5">2-5 days</td><td rowspan="2">Post-Test</td><td rowspan="5">1 month</td><td rowspan="2">Follow Up</td><td rowspan="5">5 months</td><td rowspan="2">Follow Up</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr>
<tr><td>Vegetable 1</td><td>FFL</td><td>FFL</td><td>FFL</td><td>FFL</td><td>FFL</td><td>FFL</td><td>FFL</td><td>FFL</td><td>Vegetable 1</td><td>Vegetable 1</td><td>Vegetable 1</td></tr>
<tr><td>Vegetable 2</td><td>RE</td><td>RE</td><td>RE</td><td>RE</td><td>RE</td><td>RE</td><td>RE</td><td>RE</td><td>Vegetable 2</td><td>Vegetable 2</td><td>Vegetable 2</td></tr>
<tr><td>Vegetable 3</td><td colspan="8"></td><td>Vegetable 3</td><td>Vegetable 3</td><td>Vegetable 3</td></tr>
</table>

Figure 2. Mean intake of vegetable purees (g) from pre to post-intervention by condition (RE, FFL and control)

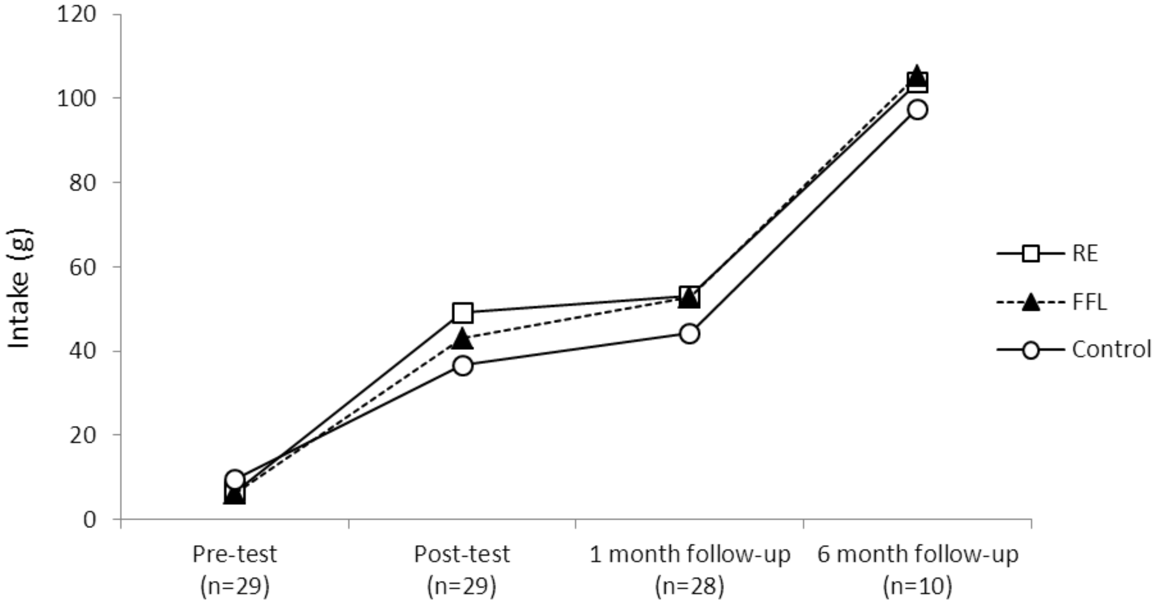


Figure 3. Mean intake of vegetable purees (g) across the intervention by age group (<24m and >24m) ±SEM

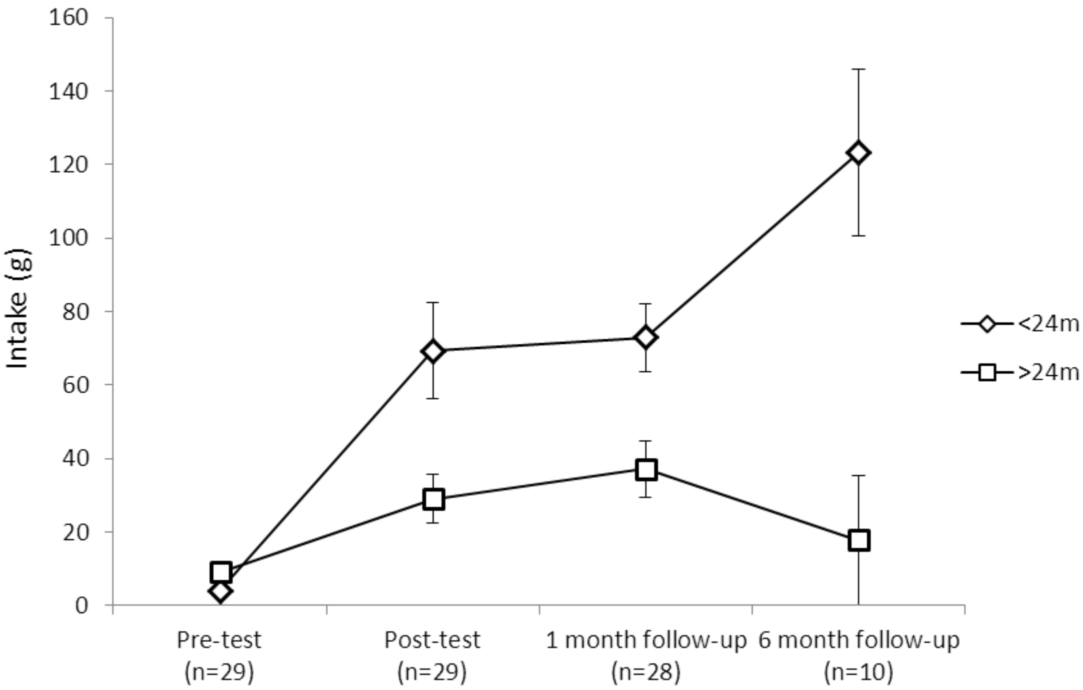
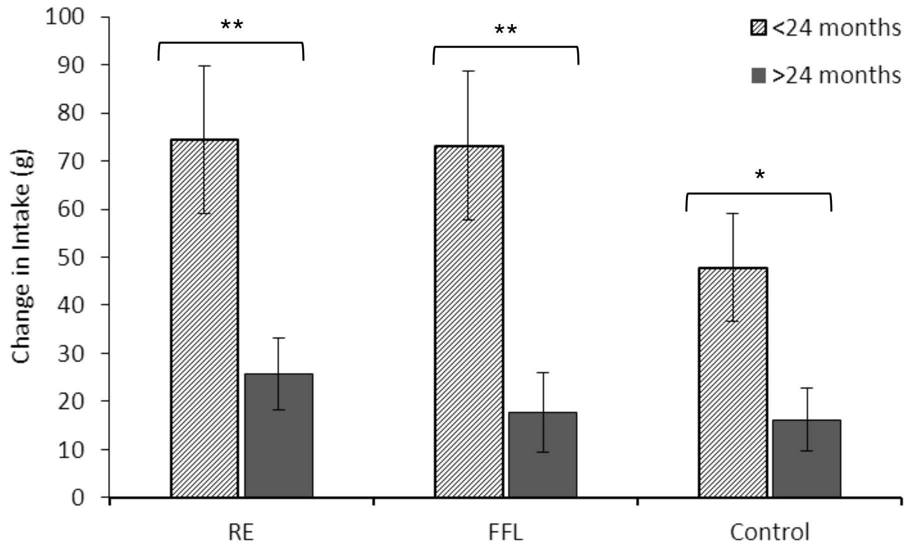


Figure 4. Mean change in intake (g) from pre to post-intervention by condition (RE, FFL and control) and age group (<24 months, >24 months) ±SEM(n=29)



*change in intake from baseline was significant at the 0.05 level
**change in intake from baseline was significant at the 0.01 level

Figure 5. Mean intake of vegetable purees (g) across exposures by age group (<24m and >24m) ±SEM (n=29)