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2 **Effects of involving children in artistic plating of food.** *Food Qual Prefer* 2019, **77**:172–183.

3 RUNNING HEAD: SENSORY EXPLORATION OF VEGETABLES: A CULINARY

4 INTERVENTION

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6 **Sensory exploration of vegetables combined with a cookery class**

7 **increases willingness to choose/eat plant-based food and drink**

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ABSTRACT

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17 We report a study conducted at Underhill School in North London designed to assess the
 18 immediate impact of a culinary class with a chef on the students' willingness to choose and to
 19 eat unfamiliar vegetable-based food and beverage options. A total of 98 school children were
 20 randomly assigned to take part in either a 40-minute sensory exploration and cooking class
 21 with chef Jozef Youssef and the Kitchen Theory team (the experimental condition) or else to
 22 take part in a creative origami class (the control condition) instead. The results demonstrate
 23 that Year 2 children (aged 6-7 years) were significantly more willing to choose unfamiliar
 24 vegetable-based food and drink offerings after having taken part in the sensory exploration and
 25 cooking class than after taking part in the control origami class. These results therefore
 26 highlight the potential relevance of sensory exploration and a brief chef-based cooking lesson
 27 on young children's willingness to choose and eat plant-based food.

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29 KEYWORDS: GASTROPHYSICS; VEGETABLE CONSUMPTION; CHEF-BASED
 30 SENSORY INTERVENTION; CHILDREN.

1. Introduction

The majority of the population do not currently meet the nutritional guidelines in terms of their consumption of sufficient fruits, vegetables, and leafy greens (Spence, 2020). This problem is particularly prevalent amongst young children (Alexy, Sichert-Hellert, & Kersting, 2002; Dennison, Rockwell, & Baker, 1998; cf. Dinehart, Hayes, Bartoshuk, Lanier, & Duffy, 2006; Walker, Hill, & Millgram, 1973). Indeed, according to (sensationalist) press headlines, as many as one in five children in the UK has never even tried a vegetable (Pickles, 2016). The problem is, in fact, so serious that some in the human-computer interaction (HCI) community have even raised the possibility of using motivational robots to try and encourage children to eat more fruits and vegetables (Baroni, Nalin, Zelati, Oleari, & Sanna, 2014; cf. Spence, Mancini, & Huismans, 2019). The provision of nutritional guidelines (such as eating five, or perhaps even eight, portions of vegetables and fruits a day; Harcombe, 2011), or messages about sustainability (Willett et al., 2019) appears to have little effect on the food behaviour of adult consumers (cf. Deroy, Reade, & Spence, 2015), and one can imagine, even less on younger children.

Over the years, a number of different short-term strategies/interventions have been examined in order to explore whether they might help to nudge consumers toward a healthier (and more sustainable) diet. These include peer-modelling and reward-based interventions (Horne et al., 2009; Horne, Tapper, Lowe, Hardman, Jackson, & Woolner, 2004; Lowe, Horne, Tapper, Bowdery, & Egerton, 2004; Wardle, Herrera, Cooke, & Gibson, 2003). Meanwhile, amongst toddlers, exposure to vegetables in picture books shows promise as an intervention strategy (Heath, Houston-Price, & Kennedy, 2014). Another line of experimental research has involved assessing the impact of familiarization with the sensory qualities of vegetables away from the pressures of the dining table (Allirot, Quinta, Chokupermal, & Urdaneta, 2016). Based on previous research, one might well imagine that involving children in the process of food creation would increase liking (Dohle, Rall, & Siegrist, 2014).

There are a number of possible accounts as to why familiarizing young children with a wider array of vegetables in a culinary context might be expected to reduce their neophobia, increase their familiarity, and thereafter, possibly increase their liking. On the one hand, there is a literature showing that people tend to like things more if they have had a hand in their preparation/making (e.g., Dohle et al., 2014; Norton, Mochon, & Ariely, 2012). Separately there is a literature on the benefits of exposure to the sensory properties of foods away from

the potentially stressful confines of the family meal (e.g., Roberts, Cross, Hale, & Houston-Price, 2022). Thirdly, it has also been reported that adult consumers' culinary preferences can be influenced by the recommendations of a (celebrity) chef (e.g., see Legendre, & Baker, 2021; Nolan, 2013; Singh, 2009; Zhou, Rajamohan, Hedrick, Patiño, Abidi, Polys, & Kraak, 2019; cf. Demirkol & Cifci, 2020). One might wonder, therefore, whether the same would be true of young children. To be clear, the focus in the present article will be on investigating the efficacy of sensory strategies to help nudge young children toward trying a wider range of fruits and vegetables as part of promoting a healthier and well-balanced diet (Fadnes, Økland, Haaland, & Johansson, 2022; cf. Diktas, Roe, Keller, Sanchez, & Rolls, 2021).

2. Materials and Methods

The protocol and procedures used in this study were approved by the Basque Culinary Center (BCC) scientific committee, which stated a waiver consent. All articles from the Declaration of Helsinki and the 2016/679 EU Regulation on the protection of natural persons regarding the processing of personal data and on the free movement of such data were met. The research also abided by the Data Privacy regulation from the European Union. The participants were assigned a unique numerical code to ensure their anonymity.

2.1. Experiment design

A convenience sample of 98 children, aged 6-7 years, were recruited from Year 2 at Underhill School, located in High Barnet, London. Underhill is a large mixed gender school with over 600 pupils coming from a diverse range of ethnic and sociodemographic backgrounds. The children's parents were informed of the aims and objectives of the proposed study by means of a letter sent out by the school's principal. Once the parents provided written confirmation that their child could take part in the study, questionnaires were sent out to be completed by the children's parents. Questionnaire selection was based on similar previous research (see Alliot et al., 2016). The questionnaires requested information from parents concerning their child's involvement in cooking (van der Horst, Pascucci, & Bol, 2014), their eating habits, and any food allergies that they might have. Questions about eating habits assessed frequency of eating in the school canteen, as well as the frequency of fruit and vegetable intake. Furthermore, due

to our interest in assessing the impact of a culinary class on the selection of new or unfamiliar options, neophobia was assessed using the Food Neophobia Scale (FNS; Pliner & Hobden 1992). The children's parents were instructed to indicate on a 7-point Likert rating scale the extent to which they agreed with each item (endpoints: strongly disagree, strongly agree). The experimental sessions took place at Underhill School in High Barnet (London, U.K.). Sixteen children took part per session (17 in two of the control groups). In each of six such sessions, the children were randomly divided into one of two groups (of eight): the experimental and control groups (see **Figure 1**). Each of the workshops lasted for approximately 40 minutes, leaving the remaining 20 minutes to make the food and eat it.

INSERT FIGURE 1 ABOUT HERE

2.1.1. Experimental group: The sensory exploration and cooking workshop was divided into two parts: sensory exploration and cooking (48 children). This group experienced a 20-minute session involving sensory exploration with food. During this time, a variety of vegetables were presented to the children including zucchini, broccoli, apples, tomatoes, peppers, beetroot, pak choi, carrots, lettuce, garlic, and onions. The children had the opportunity to touch, smell and explore each of the ingredients and describe their sensory qualities. One of the chefs guided the children through this sensory evaluation stage. The chef also provided the children with bite-sized bits of information concerning why vegetables are good for our health and how we can enjoy them (see **Figure 2**).

INSERT FIGURE 2 ABOUT HERE

As the children passed the ingredients around, the chef would ask: 'What does this 'fruit/vegetable/insect' look like? How would you describe its texture? How does it feel under your fingertips? What does it smell like? What do you think it tastes like?' Each item was described visually first (cf. Urbányi, 1982). The children were then invited to describe the shape and colour of each ingredient and imagine what it would taste like. They were asked: 'Does it look delicious?'; 'Would you eat it?' Next, the children had to describe the feel of each item (e.g., using terms such as rough, smooth, bumpy, grainy, soft, hard, squishy, crunchy; Kessler, Wansink, Zampollo, Shimizu, & Atakan, 2018; cf. Fillion & Kilcast, 2002). The children were then asked to describe each of the items by smelling them, first in terms of what the vegetables smelled of, and thereafter in terms of how intense was the aroma. The children were given a few raw vegetables samples (carrot, zucchini) to taste and some thyme, and asked whether it

met with their sensory expectations (cf. Piqueras-Fiszman & Spence, 2015). At the end of this first part of the workshop, the researchers showed the children a bowl of dried mealworms and asked them whether they would be willing to try the insects. They were then invited to try the mealworms if they wanted (Legendre & Baker, 2021).

After this 20 minute session, the children were involved in the preparation of the foods for a further 20 minutes. The children were involved in the preparation of zucchini spaghetti, pepper omelette, and apple and beetroot juice (i.e., the less familiar foods). The children were divided into two groups of four at the start of the cooking session. Under the supervision of the chefs, the children carried out tasks such as making the zucchini spaghetti with the spiralizer, chopping the beetroot and apple, juicing the beetroot and apple, chopping the peppers, and whisking the eggs. The remaining tasks, such as cooking the omelette and boiling the zucchini, were carried by the chefs from Kitchen Theory. The children watched the chefs complete the cooking of the zucchini spaghetti and the pepper omelette. At the end of the session, the children in this group were asked about their willingness to try a mealworm cookie with a simple question: ‘Would you like to try a mealworm cookie?’ (Yes/ no). The children’s feelings about trying an insect cookie were measured using the “PrEmo tool” (see below for details). Unfortunately, it was not possible to make any meaningful analysis, given the small amount of data collected in this condition, and so it will not be discussed further here.

2.1.2. Control group: 50 children participated in the creative origami workshop. The workshop was conducted under the supervision of two employees from Kitchen Theory and an Underhill teacher in a room equipped with a table and a bucket of water. The first part of the workshop involved an origami class in which the children learnt how to make paper boats. Once all of the children had their paper boats ready, they started the second part of the workshop, in which they use the paper boats in order to take part in a boat race. This control session also lasted for 40 minutes.

2.1.3. Brunch snack (both groups): At the end of the cooking and creative workshops, all of the children queued up outside the rooms waiting to make their own food choices. The children lined up far behind the service table, coming forward one at a time to select their meal items. This helped to prevent the children from influencing each other’s decisions during the selection process. The researchers prepared the Brunch snack on a table. Three pairs of options (pasta spaghetti vs. courgette spaghetti; cheese omelette vs. pepper omelette; and beetroot-apple juice vs. Vimto juice; the latter product is a popular commercial blackberry drink amongst children

in the UK) were then presented. All of the portions were weighed before being handed to the children. Each child chose one of each pair of food items (i.e., one of the spaghetts, one of omelettes, and one of the juices), before taking their individually numbered tray back to their respective rooms. In this way, we were able to avoid any crossover effects between children from the different workshops.

Giving the children three opportunities to choose between a more or less familiar food item, enabled us to measure their willingness to choose unfamiliar foods containing vegetables, and to assess the effect of the cooking and the multisensory workshop on their choice behaviour. The food items that were considered as likely to be more familiar were the pasta spaghetti, the cheese omelette, and the Vimto juice drink. The food items considered as being less familiar were the zucchini spaghetti, the pepper omelette, and the beetroot-apple juice.

2.2. Measurements

The same measurements were performed in both the experimental and control groups and match closely the measurements that were collected in Alliot et al.'s (2016) previous study.

2.2.1 Subjective hunger or satiety: Subjective hunger or satiety were assessed twice during the experimental session: Once before the children made their food choices (T1), and then again at the end of the session (T2). We used Bennet and Blisset's (2014) hunger and satiety scale 'Teddy the Bear', adapted for primary school children for this. The scale consists of five black and white cartoon bear silhouettes. Varying amounts of 'food' were represented by black ovals in the region of each bear's stomach, which increased in size proportionally as the amount of food consumed and the satiety of the bear increased. A label placed above the silhouette of each of the five bears described the bear's level of hunger and satiety, going from one (not satiated at all/very hungry) to five (not hungry at all/very full). The children were given the following instructions: "I was wondering how hungry are you feeling right now; if you think about your own tummy and how empty or full it is right now, which Teddy would you say shows me how hungry or how full you are feeling? There's no right or wrong answer, this is just about how you feel". The data allowed us to determine any change in hunger/satiety scores between T1 and T2.

2.2.2. Willingness to choose and taste unfamiliar foods containing vegetables and food intake:

Three food pairs were displayed on the table. Food options (in more vs. less familiar formats) were displayed in food trays and served in plates as the children choose what they wanted. Three numbered stickers were given to each child when they started the workshop. This way, questionnaires, and food choices could be matched with each of the children. Children would put their stickers on their plate and glass, so we were able to match the weight of the left-overs to each child. Each child made their food choices individually. Once they had made their choice, portions were weighed out and written down matching with the child's number. After the session, the plates were weighed once again in order to determine how much food was left. With these data, we are able to calculate how much food each child had consumed.

2.2.3. Liking and emotions elicited by the food items:

After the brunch snack, the children were asked to complete two questionnaires about how much they liked the food that they had chosen, and the emotions triggered by their food choices. A 5-point hedonic facial scale consisting of five faces drawings representing (1) awful, (2) not very good, (3) good, (4) really good, and (5) brilliant was used to measure liking response (Allirot et al., 2016). In order to measure the emotional response, a Check-All-That-Apply (CATA) questionnaire, with the 14 images of PrEmo tool, was used. PrEmo is an emotion measurement tool that can be used cross-culturally because it does not require the respondents to verbalize their emotions (<https://emotion.studio/tools/premo>; Desmet, 2019; Laurans & Desmet, 2017). The children individually chose how they felt with the pictures of the PrEmo tool for each of the food preparations that they ate.

2.2.4. Data analysis:

Statistical analyses were performed using IBM SPSS v24.0 and XLSTAT v2020.2.2. To assess differences across the groups for baseline variables (i.e., gender, frequency of eating in the school restaurant, cooking involvement and frequency of eating fruit and vegetables) contingency table analyses were conducted. The actual response counts were analysed using the chi-square statistic. Furthermore, in order to measure the effect of the intervention, food neophobia and disgust level on unfamiliar or unfamiliar meal choices, contingency table analyses were conducted. To build the contingency table for neophobia and disgust, the children were divided according to their level of neophobia and disgust using terciles. Frequency counts of the contingency tables for intervention, food neophobia, and disgust level were evaluated using Fisher's exact test. For the other baseline variables (i.e., Food Neophobia score and Disgust scale), as well as for the measurement of hunger, individual

t-tests were performed. When statistically significant results were obtained, effect sizes for the differences between mean scores were calculated using Cohen's (1988) convention for small (0.2), medium (0.5), and large (0.8) effect sizes.

Separate univariate analyses of covariance (ANCOVAs), including the intake and liking of food items as dependent variables, were conducted. The condition (i.e., Experimental and Control) was entered into the models as the predictor variable, and the baseline variables that showed an association with the dependent variables were entered as covariates. In the ANCOVA, η^2 was used as an index of overall effect size, and the values were interpreted according to the guidelines provided by Kirk (1996): η^2 values of .010 were considered small effect sizes, values higher than .059 were considered medium effect sizes, and values higher than .138 were considered large effect sizes. All tests were two-tailed and differences were considered significant at $p < .05$. To analyse the emotional response elicited by the food choices obtained by means of the PrEmo tool, frequency counts on each emotion elicited by the food choices (familiar or unfamiliar) were obtained.

3. Results

Several data analyses were conducted in order to better understand the impact of the multisensory exploration and cooking class of the children's (aged 6-7 years) willingness of to choose the more unfamiliar vegetable-based options. A total of 98 children took part in the study, with 56 boys and 42 girls (57.1% vs. 42.9%, respectively), with no difference in gender distribution between the two groups (Experimental vs. Control). The differences found in baseline variables between the participants in the two groups are highlighted in Table 1. Importantly, no significant differences were found between the two groups, except for the food neophobia variable, with a small effect size ($t(92) = 2.16$, $p = .034$, $d = .441$).

Table 1. Differences in baseline variables of participants in the Experimental ($n = 46$) and Control groups ($n = 44$). Note that usable responses were returned by 90 of the parents.

	Experimental group	Control group	t or chi-square value	p
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Gender (% girls)	52.4	47.6	$\chi^2(1) = .340$.560
How often the child helps prepare the meal				
Never (%)	15.6	18.6	$\chi^2(5) = 4.19$	.522
Once a month (%)	17.8	27.9		
Twice a month (%)	17.8	18.6		
Once a week (%)	28.9	23.3		
3 times a week (%)	15.6	4.7		
5 times a week (%)	4.4	7		
Frequency of eating in the school canteen				
Never (%)	20.5	21.4	$\chi^2(3) = 2.97$	.396
Once a week (%)	4.5	0		
4 times a week (%)	2.3	0		
5 times a week (%)	72.7	78.6		
Frequency of fruit intake				
1-3 times per week (%)	4.3	13.6	$\chi^2(3) = 4.53$	.209
4-6 times per week (%)	26.1	13.6		
Once a day (%)	26.1	34.1		
More than 2 days (%)	43.5	38.6		
Frequency of vegetable intake	26.1	31.8	$\chi^2(3) = 1.30$	.728
1-3 times per week (%)	26.1	18.2		
4-6 times per week (%)	19.6	15.9		
Once a day (%)	28.3	34.1		
More than 2 days (%)				
Food Neophobia (mean & standard deviation)	30.54 (10.5)	35.38 (11.2)	t (92) = 2.16	.034
Food Disgust (mean & standard deviation)	38.41 (4.31)	38.04 (4.89)	t (89) = - 0.38	.704

Note. Statistically significant results are shown in **bold** font.

3.1. Subjective hunger/satiety

Hunger/satiety scores prior to making the food choices (T1) were $M \pm SD_{\text{control}} = 1.92 \pm 1.29$; $M \pm SD_{\text{experimental}} = 2.10 \pm 1.42$, and $M \pm SD_{\text{control}} = 2.85 \pm 1.62$; $M \pm SD_{\text{experimental}} = 3.04 \pm 1.56$ at the end of the session (T2). No differences were found between the two conditions

(Experimental and Control): at T1 $t(96) = -.673$, $p = .50$, and at the end of the brunch snack T2, $t(92) = -0.58$, $p = .56$. Note that the null effects on subjective hunger/satiety scores reported here are consistent with the lack of effect of experimental condition on overall food intake reported below.

3.2. Food intake

Table 2 highlights the intake of each food item and the total intake in each condition. No differences were observed between the Experimental and Control groups, with food neophobia as a covariate in the total consumption of the brunch snack ($F(1, 92) = 2.827$, $p = .096$, $\eta^2 = .030$), nor for the more familiar items (spaghetti, cheese omelette, and Vimto) ($F(1, 92) = 3.157$, $p = .079$, $\eta^2 = .034$), or the less familiar items (zucchini spaghetti, pepper omelette, and beetroot and apple juice) ($F(1, 92) = 1.342$, $p = .250$, $\eta^2 = .015$). Looking at food intake for each item individually, differences were observed in the intake of spaghetti, with the Experimental group eating less than the control group ($F(1, 92) = 7.893$, $p = .006$, $\eta^2 = .081$) with a medium effect size. The Experimental group ate more pepper omelette than the Control group ($F(1, 92) = 4.682$, $p = .033$, $\eta^2 = .050$), with a medium effect size. Here, it is interesting to note the increased consumption of the less familiar food (pepper omelette) amongst the children in the Experimental group, seemingly offset by a reduction in the consumption of the more familiar food (spaghetti).

Table 2. Mean intake of the foods (in grams) chosen in the brunch snack in the Experimental group ($n = 46$) and in the Control group ($n = 47$). Usable data were collected from 93 of the children.

	Intake (mean \pm SD)		ANCOVA models adjusted for neophobia		
	Experimental group	Control group	F (1,92)	P	η^2
Spaghetti	37.67 (20.66)	49.43 (18.64)	7.893	.006	.081
Zucchini spaghetti	7.13 (18.91)	0.91 (6.27)	2.385	.126	.026
Cheese omelette	8.15 (6.47)	8.40 (5.52)	.037	.848	.000

Pepper omelette	3.63 (6.32)	0.98 (3.44)	4.692	.033	.050
Vimto	117.39 (99.56)	153.19 (85.60)	1.674	.199	.018
Apple and beetroot juice	63.04 (82.62)	38.30 (76.76)	.706	.403	.008
Total intake	237.02 (51.03)	251.21 (40.43)	2.827	.096	.030
Total familiar intake	163.22 (110.14)	211.02 (88.86)	3.157	.079	.034
Total unfamiliar intake	73.80 (94.70)	40.19 (79.67)	1.342	.250	.015

Note. Statistically significant results are shown in **bold** font.

3.3. Willingness to choose unfamiliar foods

The results of the contingency tables provide information concerning any relationship between the culinary intervention, the level of neophobia, and the disgust level on the children's willingness to choose the unfamiliar foods. Table 3 highlights the frequency counts of the number of unfamiliar choices per group. A relationship between the session, control or cooking, and the number of unfamiliar choices was observed ($p = .031$). In particular, those children who participated in the sensory exploration and cooking session exhibited a greater willingness to choose the more unfamiliar choices (up to three choices) as compared to those who took part in the Control session.

Table 3. Contingency table of number of unfamiliar choices (0, 1, 2, 3) as a function of the session (Experimental vs. Control).

	Number of unfamiliar plant-based food choices			
	0	1	2	3
Control	37	10	2	1
Experimental	22	18	4	4

Note. Numbers in **bold** font correspond to those for which significant differences were identified according to Fisher's exact test, for a 95% confidence level.

The relationship between FNS and willingness to try unfamiliar foods was confirmed. These results agree with Olabi, Najm, Baghdadi, and Morton (2009) who reported that food neophilic participants exhibited a higher willingness to try unfamiliar and novel foods. A significant

relationship between FNS scores and willingness to try was found, the two qualitative variables depend on one another ($p = .004$). The “high neophobia” group were significantly less willing to try unfamiliar products, while the “low neophobia” group, who were neophilic, reported a higher willingness to try these unfamiliar products (see Table 4).

Table 4. *Contingency table of number of unfamiliar choices (0, 1, 2, 3) vs neophobic children profile*

Neophobia (tercile)	Number of unfamiliar plant-based food choices			
	0	1	2	3
Low	13	11	2	5
Medium	16	12	3	0
High	26	5	1	0

Note. Numbers in **boldface** correspond to those for which significant differences were identified according to Fisher’s exact test, for a 95% confidence level.

Regarding disgust level, no differences were found between the different disgust groups and the unfamiliar choices ($p = .890$). Table 5 shows the contingency table generated to study the dependence between both qualitative variables.

Table 5. *Contingency table of number of unfamiliar choices (0, 1, 2, 3) vs disgust level*

Disgust level	Number of unfamiliar plant-based food choices			
	0	1	2	3
Low	17	9	2	2
Medium	19	9	2	2
High	19	8	2	2

Note. No significant differences were identified according to Fisher’s exact test, for a 95% confidence level.

3.4. Liking of the food items

Table 6 shows the mean liking for each food item in each condition. In spite of the selection each children made for each food group, no differences were found in terms of liking between the Experimental (cooking) and Control groups with ANCOVA adjusted for neophobia variable ($P_{\text{Spaghetti liking}} = .096$; $P_{\text{Zucchini spaghetti liking}} = .887$; $P_{\text{Cheese omelette liking}} = .253$; $P_{\text{Pepper omelette liking}} = .511$; $P_{\text{Vimto liking}} = .079$; $P_{\text{Juice liking}} = .345$).

Table 6. Mean liking of the foods (in grams) chosen in the brunch snack in the Experimental ($n = 38$) and Control groups ($n = 44$).

Conditions	Liking (mean \pm SD)		ANCOVA models adjusted for neophobia		
	Experimental group	Control group	F	P	η^2
Spaghetti	3.89 (1.41)	4.30 (1.29)	$F(1, 81) = 2.839$	.096	.035
Zucchini spaghetti	4.00 (1.55)	4.00 (1.41)	$F(1, 7) = 0.022$	.887	.004
Cheese omelette	3.84 (1.49)	3.20 (1.65)	$F(1, 71) = 1.331$	.253	.019
Pepper omelette	4.18 (1.47)	3.50 (1.17)	$F(1, 14) = 0.459$	.511	.037
Vimto	4.04 (1.08)	4.36 (1.07)	$F(1, 61) = 3.187$	.079	.051
Apple and beetroot juice	3.26 (1.24)	2.78 (1.79)	$F(1, 27) = 0.928$	.345	.036

Note. No statistically significant results were obtained.

3.5. Assessment of non-verbal emotional responses

Regarding the emotional responses that were elicited by familiar or unfamiliar foods, **Figure 3** shows the citation frequency of the different images of the PrEmo tool that was used in the CATA question. In general, the more familiar foods elicited more positive emotions than the less familiar options. More than 80% of respondents indicated that familiar foods elicited “joy”, while the same emotion was elicited less than 20% of respondents by the unfamiliar foods. Another relevant difference between the more versus less familiar foods related to disgust. In particular, the less familiar foods elicited more feelings of disgust as compared with the familiar foods.

INSERT FIGURE 3 ABOUT HERE

4. Discussion

The results of the present intervention study provide suggestive evidence that the sensory exploration and chef-based school cooking intervention can give rise to an immediate (though possibly only short-lasting) increase in elementary students' willingness to try a variety of less familiar plant-based foods. The young children (6-7 yrs) who took part in the sensory exploration and cooking session (the Experimental group) were more willing to choose more unfamiliar choices (up to 3 choices) rather than those who took part in the control session. That said, it should also be stressed that this short-term chef-based sensory exploratory intervention failed to demonstrate a significant effect on the children's liking for the unfamiliar foods.

Separately, and as might have been expected, food neophobia was also shown to modulate the number of less familiar plant-based food choices made by the children, (Olabi et al., 2009). **Figure 3** shows the citation frequency of the different emotional responses that were elicited by familiar or unfamiliar foods images in the PrEmo tool used in the CATA question. In general, the more familiar foods elicited more positive emotions than the less familiar options. More than 80% of respondents indicated that familiar foods elicited "joy", while the same emotion was elicited in less than 20% of the children by the unfamiliar foods. The less familiar plant-based foods elicited more feelings of disgust than did the more familiar plant-based food options.

That said, there are a number of limitations to the present intervention that deserve to be highlighted. These include the fact that the longer-term effects of the culinary intervention investigated here were not assessed. As such, the possibility remains that the significant results of the chef-based intervention on food choice might well turn out to be relatively short-lasting in nature (and hence perhaps of limited relevance). It would therefore be interesting/important in future research to assess the longevity of such innovative approaches to sensory exploration and culinary intervention. Being able to demonstrate a longer-term impact on children's vegetable consumption would obviously be important in terms of justifying the likely effort/expensive associated with organizing such school visits from culinary professionals in the future. Nevertheless, to the extent that familiarity breeds liking (e.g., Balogh & Porter, 1986), this would nevertheless appear to constitute a promising first step. What is more, short-term interventions have typically been assessed in prior research.

Future research would benefit from long-term study and also to assess the link with the style of lunch served at school. Increasing young children's familiarity and literacy with respect to 'natural' food is likely also going to be very important in the long term. Ultimately, anything that can be done to address the important issue of food literacy in elementary education will likely have a beneficial effect (Kelly & Nash, 2021; cf. Ronto, Ball, Pendergast, & Harris, 2016, for a similar suggestion regarding the importance of food literacy in secondary education as well).

The chef-based intervention outlined here should ultimately be considered in the context of a number of other gastrophysics approaches that have already been demonstrated to influence the intake of fruits and vegetables. These include, in a much older student cohort, the importance of the sensory-descriptive naming of vegetable-based dishes (see Turnwald, Bertoldo, Perry, Policastro, Timmons, Bosso, Connors, Valgenti, Pine, Challamel, Gardner, & Crum, 2019; Turnwald, Boles, & Crum, 2017).¹ One other intriguing approach is to involve children in the artistic plating of food (see Maiz, Urkia, Bereciartu, Urdaneta, & Alliot, 2019; see also Spence, Okajima, Cheok, Petit, & Michel, 2016). Increasing colour variety has also shown promise amongst older consumers (König & Renner, 2018, 2019; Spence, 2020). One other factor here that might not be so obvious concerns research highlighting the negative influence of high levels of background noise, typically documented in the school cafeteria, on the choice of healthy foods (Graziose, Koch, Wolf, Gray, Trent, & Contento, 2019). Some commentators have even questioned whether 'sonic seasoning' might be used to mask the bitter taste of cruciferous vegetables (Denyer, 2017; Saner, 2017; cf. Anliker, Bartoshuk, Ferris, & Hooks, 2013).

Meanwhile, Debra Zellner and her colleagues have shown that serving a chef prepared family style school lunch can also increase liking and consumption on a school lunch (Zellner & Corbuzzi, 2016). The impact of choice on the consumption of vegetables is also relevant (Zeinstra, Renes, Koelen, Kok, & de Graaf, 2010; Zellner & Corbuzzi, 2017). In summary, a growing body of research now supports the claim that engaging children in food preparation/cooking activities (Alliot et al., 2016), as well as sensory familiarization (Dazeley & Houston-Price, 2015; Dazeley, Houston-Price, & Hill, 2012; cf. Van Stokkom, Blok, van

¹ Cf. the now-discredited research of Brian Wansink (e.g. Wansink, Just, Payne, & Klinger, 2012), on this theme.

Kooten, de Graaf, & Stieger, 2018), can help to increase willingness to eat, and choice behaviour toward vegetables.

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Author contributions

The study was planned and conducted by J.Z., M.M., and E.M. The data were analysed by M.M. and E.M. The manuscript was written by C.S., M.M., E.M., and J.Z.,

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APPENDIX: RECIPES

Mixed peppers omelette (10 pax)

- 250gr peppers
- 8 eggs

Julienne the peppers then pan-fry. Beat the eggs and mix together the ingredients. Pour the mix into a hot pan, and cook for 5 min on a medium heat and then flip it. Serves ten.

Cheese omelette (10 pax)

- 10 eggs
- 50 gr cheddar cheese

Beat the eggs and mix in with the cheese. Pour into a hot pan and cook for five min and then roll it in the pan.

Zucchini spaghetti (10 pax)

- 1 kg zucchini
- 300 gr tomato sauce

Spiralize the zucchini with the spiralizer, and then blanch in boiling salted water. Portion and serve with tomato sauce

Pasta spaghetti (10 pax)

- 1 kg spaghetti
- 300 gr tomato sauce

Beetroot and apple juice (10 pax)

- 1 kg apple
- 1 kg boiled beetroots
- 3 lemons
- 50 gr sugar

Wash and chop apples, and chop the beetroots. Juice them both in the juicer. Add the juice of the lemon and season with sugar if needed.

Vimto juice (10 pax) purchased from the supermarket.

FIGURE LEGENDS

Figure 1. Map of the experimental area, which consisted of two equally-sized rooms, both connected to the same corridor. The room on the left was the control (orange) session and on the right (green) was the cooking session. After the sessions, the children lined up behind the point marked by a table. The children walked up to the ‘choosing table’ individually. Once at the table, the children were offered a choice between plain spaghetti (orange rectangle) and zucchini spaghetti (green rectangle). The children were only allowed to choose one of the dishes. The chef (J.Z.) situated behind the table would then provide them with a portion of the chosen food. The plates were weighed, and the exact portion size alongside the food choice. Exactly the same procedure was executed for the omelette, plain (orange circle) versus pepper (green circle) and the juice, Vimto (little orange circles) and apple and beetroot (little green circles). The children ate in the room of their own group, around the table marked with “meal”.

Figure 2. Chef Jozef Youssef of Kitchen Theory interacting with the children of Underhill School during the Sensory experience session.

Figure 3. Ranking of frequency counts of the emotions for the more and less familiar plant-based food choices. The ‘meaning’ of the different PrEmo tool images, from left to right, are joy, hope, pride, admiration, satisfaction, fascination, attraction, sadness, fear, shame, contempt, dissatisfaction, boredom, and disgust (see text for details.)

Figure 1.

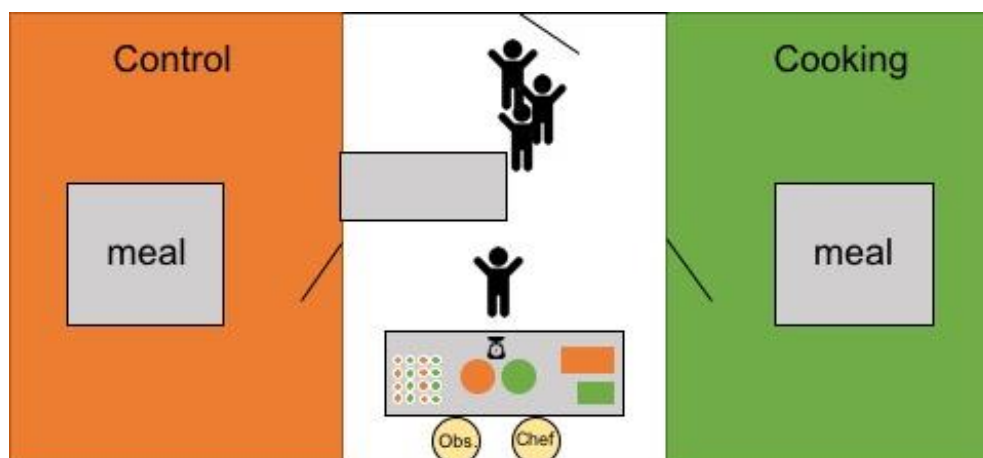


Figure 2.



Figure 3.

