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Sensory-based food education in early childhood education and care, willingness to choose and eat fruit and vegetables, and the moderating role of maternal education and food neophobia

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Abstract

Objective: To investigate an association between sensory-based food education implemented in early childhood education and care (ECEC) centres and children's willingness to choose and eat vegetables, berries and fruit, and whether the mother's education level and children's food neophobia moderate the linkage.

Design: The cross-sectional study involved six ECEC centres that provide sensory-based food education and three reference centres. A snack buffet containing 11 different vegetables, berries and fruit was used to assess children's willingness to choose and eat the food items. The children's parents completed the Food Neophobia Scale questionnaire to assess their children's food neophobia.

Setting: ECEC centres that provide sensory-based food education and reference ECEC centres in Finland.

Subjects: 3–5-year-old children in ECEC (N=130) and their parents.

Results: Sensory-based food education was associated with children's willingness to choose and eat vegetables, berries and fruit. This association was stronger among the children of mothers with a low education level. A high average level of neophobia in the child group reduced the children's willingness to choose vegetables, berries and fruit. No similar tendency was observed in the group that had received sensory-based food education. Children's individual food neophobia had a negative association with their willingness to choose and eat the vegetables, berries and fruit.

Conclusions: Child-oriented sensory-based food education seems to provide a promising method for promoting children's adoption of vegetables, berries and fruit in their diets. In future sensory

food education research, more focus should be placed on the effects of the education at the group level.

Keywords

food neophobia, sensory education, taste education, children, day care

Introduction

Children's low vegetable, berry and fruit consumption is a considerable nutritional challenge in Finland^(1,2) and around Europe⁽³⁾. Vegetables, berries and fruit are an essential source of phytochemicals⁽⁴⁾, and their nutritional properties, such as low energy and high nutrient density, provide a way of promoting health.

Increasing children's consumption of vegetables, berries and fruit is challenging because food choices are affected by both environmental input and individual characteristics⁽⁵⁾. For example, the former is affected by parents' socioeconomic factors, which reflect on their food choices, varying parenting practices related to food, and lack of conscious food education in ECEC. The latter involves factors such as children's fussiness and food neophobia, which challenge children's learning in eating vegetables, berries and fruit.

ECEC has crucial potential for food education: the majority of Finnish children participate in high-quality early childhood education⁽⁶⁾ which includes supervised, nutritious meals and where the children are involved in various pedagogic activities. Some ECEC centres in Finland implement sensory-based food education in addition to standard curriculum-based ECEC, which emphasises the role of the centre in children's food education. In Finland, the experiences gathered from child-oriented sensory-based food education provided in ECEC have been positive and encouraging. Consequently, an increasing number of municipalities and ECEC centres have included sensory-based food education in their local early childhood education curricula⁽⁷⁾. In order to guide ECEC to implement sensory-based food education, more evidence-based knowledge is needed about its association with children's fruit and vegetable choices as well as the related moderating factors. Knowledge of associations between sensory-based food education in ECEC and children's vegetable, berry and fruit consumption would benefit early educators and help understanding the role of ECEC in children's food education and related opportunities.

Sensory food education encourages children to explore food options using all the five senses⁽⁸⁾. Vegetables, berries and fruit are excellent food items for this type of education, as they are rich in qualities perceived through the senses of hearing, vision, olfaction, taste, and touch. Sensory food education activities encourage children to participate, generate positive food experiences, and instil the joy of eating in the children. Sensory food education has displayed potential in promoting children's vegetable and fruit consumption⁽⁹⁾.

Sensory food education has mostly been studied from the point of view of school-aged children. Previous studies have indicated that the education increases children's abilities to describe food⁽¹⁰⁾, promotes food talk⁽¹¹⁾, and broadens children's food preferences^(12,13) and their willingness to eat unfamiliar foods^(14,15). Based on these studies, sensory food education seems to have benefited school-aged children, although a recent study found a school-based sensory food education programme, "Taste Lessons", to have produced no effect on children's willingness to taste vegetables and fruit⁽¹⁶⁾.

Few studies have explored sensory food education among under-school-aged children. Research has thus far shown that food education increases the willingness of under-school-aged children to eat vegetables, berries and fruit⁽¹⁷⁻¹⁹⁾. However, it remains unclear how such food education embedded in the ECEC curriculum would alter children's attitudes towards vegetables, berries and fruit. Therefore, the hypothesis of the present study is that there is an association between sensory-based food education integrated into the ECEC routine and higher willingness to choose and eat vegetables, berries and fruit.

As a form of environmental input, parental education levels directly and proportionately affect the amount and frequency of children's vegetable, berry and fruit consumption⁽²⁰⁻²²⁾. Low consumption is particularly related to the mother's low level of education, indicating social inequity and the significance of price in consumption patterns⁽²³⁾. We hypothesised that the children of parents with lower socioeconomic status would have lower willingness to choose and eat vegetables, berries and fruit.

Children's individual characteristics may also be relevant in affecting the variety of foods consumed and seem to be inversely associated with vegetable and fruit consumption^(24,25). Neophobia, defined as reluctance to try and eat unfamiliar foods, is a common trait among children, and can be alleviated by sensory food education^(12,14). Food neophobia, measured using a 10-item questionnaire⁽²⁶⁾, is typically considered an individual trait, although children are also responsive to

social interaction, for example in child groups in ECEC. Hence, also considering food neophobia at the group level can provide insight into the perceptual world of children in social eating situations. Our final hypothesis is that food neophobia is inversely associated with participation in sensory-based food education in ECEC.

Using naturalistic settings and photographs in measuring young children's food choices and intake is gaining popularity and has been found to be a valid and feasible research method⁽²⁷⁻²⁹⁾.

Methodologically, one of this study's merits is measuring children's vegetable, berry and fruit consumption and preferences in an objective and child-oriented manner, which allows the children to eat in a natural, real-life group situation. This method takes both children's abilities and their developmental stage into account.

Our aim was to investigate whether sensory-based food education implemented in early childhood education and care (ECEC) is associated with children's willingness to choose and eat vegetables, berries and fruit. Furthermore, we studied the possible moderating role of socioeconomic status and food neophobia.

Methods

Participants

This study compared children attending two types of ECEC centres: six ECEC centres implementing sensory-based food education and three standard ECEC centres.

This study was participated by a total of 68 children in 10 child groups at the sensory-based food education centres (SENs) and 62 children in 8 child groups in the standard centres, which served as a reference group (REF).

We excluded children who were not present at the snack buffet or had participated in ECEC at the centres for less than 10 months. It was necessary to set this participation period criterion to investigate the role of the food education in children's behaviour towards vegetables, berries and fruit^(10,13). We also excluded children with food allergies, type 1 diabetes, and coeliac disease.

The SEN and REF groups were similar in terms of the children's ages, ECEC participation, family size, living arrangements (Table 1) as well as parental age, education level, and working arrangements. The children were 3–5-year-old boys and girls participating in ECEC during daytime

on most weekdays while most of their parents were at work. The majority of the children lived with their mother and father, and the families had on average four members. Parents were typically in their thirties, and a half of the mothers and one third of the fathers had a university degree.

TABLE 1 ABOUT HERE

We collected our data in autumn 2014 and autumn 2015, each of the ECEC centres participating either in 2014 or 2015. The SEN ECEC centres, which had been providing sensory-based food education since 2011, were located in Western Finland and the REF ECEC centres, which did not carry out equivalent food education, were in Eastern Finland. We selected the SEN centres from the ECEC centres that had been among the first to introduce sensory-based food education in Finland and were actively using the method. We selected the REF centres from municipalities which matched the regions of the SEN centres in terms of population and urban/ruralness to the extent possible.

The municipal directors of early childhood education and care and the managers of the participating ECEC centres also gave their consent. Parents signed an informed consent form, allowing their children to participate.

Sensory-based food education in Early Childhood Education and Care

Half of the children participated in ECEC implementing sensory-based food education. In ECEC in Finland, sensory-based (Sapere) food education is a modification from the French *Le gout de l'enfant* by Jacques Puisais⁽⁸⁾. This modified version is a system whose educational activities have been developed to suit the age and developmental level of the young children in ECEC^(7,30).

The method is integrated with daily routines and weekly ECEC activities. It is child-oriented and facilitates sensory learning by playing. The method values children's experiences, encourages their self-expression, and promotes participation and enthusiasm. Early educators collaborate with children, making meals enjoyable, creating positive memory traces, and instilling natural curiosity about food in the children.

In practice, this means including sensory sessions with food in the ECEC activities, integrating food education into food preparation and meals at ECEC, and inserting food themes into other ECEC activities^(7,31). The practices, facilities, tools and frequencies used by the ECEC centres to implement sensory-based food education during meals and sensory sessions are described in Table

2. In the sensory sessions, where special emphasis is given to health-promoting foods such as vegetables, berries and fruit, children explore food items through the senses of hearing, vision, olfaction, taste and touch, and describe their observations together. Children participate in meal preparation by baking, preparing salads and desserts, and growing vegetables, fruit and berries together in an ECEC centre orchard, garden or windowsill. The children are given an active role at meals to portion their meals, set the tables and butter their bread. Special attention is also given to the way food is served, for example by separating salad ingredients. Food education is also integrated into short day trips, which involve visiting farms, markets or forests to learn about the origin of food. Other ECEC activities, such as playing, drawing, reading, singing, and physical activities, include food themes that make food items and eating more familiar and more present for the children. The ECEC centres with sensory-based food education can also employ a pedagogical menu, a tool that facilitates organising sensory sessions and collaboration between early educators and catering staff. A pedagogical menu includes daily meals similarly as a regular ECEC menu. In addition, it integrates sensory sessions into meals by including a selection of food items to explore through the senses⁽⁷⁾.

Before the implementation of sensory-based food education in ECEC centres, their education personnel had been trained on the topic. All the early educators had participated in a six-hour training including lectures on child nutrition, the five senses and the principles of the sensory-based food education method as well as sensory activities with vegetables, berries and fruit. After this training, four-hour workshops had been organised in the municipalities and had the purpose of seeking ways to put the method into practice in the ECEC centres. Additional training of 6 to 12 hours had been offered on child nutrition and the Nordic Nutrition Recommendations for all ECEC educators, catering staff and the managers of ECEC centres in the municipalities. Finally, one or two ECEC educators per municipality, who had participated in a Sapere instructor training for the total of 24 hours, were put in charge of coordinating local activities, enhancing collaboration and providing information about the method in their municipality. Each participating ECEC centre also received a handbook on sensory-based food education and its implementation in ECEC⁽³¹⁾. Moreover, all the training material and inspiration to the implementation was available for everyone through a web site.

TABLE 2 ABOUT HERE

As a part of the municipal early childhood education curriculum, sensory-based food education brings together mathematical, scientific, historical, sociological, aesthetic, ethical and religious

education contents of ECEC⁽³⁰⁾. In comparison with standard ECEC, food is not only served and eaten in the ECEC with sensory-based food education, but is also perceived as a way of pedagogy integration.

Questionnaire for the parents

Parents filled in a questionnaire on family background and the children's Food Neophobia Scale (FNS), whose Finnish version focuses on children^(12,26). The FNS is a validated and widely-used instrument measuring the respondents' willingness to try novel and unfamiliar foods. Parents rated their level of agreement with their children's behaviour for 10 statements, for example *My child doesn't trust new foods*, on a 7-point Likert scale, 1=strongly disagree, 7= strongly agree. We combined the scale items (in part reverse coded) to arrive at a food neophobia score ranging from 10 to 70; higher scores indicated higher food neophobia.

Snack buffet method

We developed an innovative approach, also known as the snack buffet method, for measuring children's food choices in a naturalistic setting^(19,32). During the development process, we took basic taste characteristics and the consumption of items in Finland into consideration to make sure we included both familiar and unfamiliar food items in the buffet. The buffet consisted of 11 vegetables, berries and fruit with a wide variety of flavours (pickled cucumber, green olives, lingonberry, grapefruit, blackcurrant, apple, honeydew melon, banana, cherry tomato, tinned champignon mushrooms, kohlrabi). The basic taste characteristics and profile of these items were preliminarily determined by sensory assessors at the University of Eastern Finland. The taste profiling was based on one session where the assessors were first asked to describe all perceived basic flavours, and subsequently to indicate a dominant taste for each item. As a result of the profiling, the following dominant basic flavours were recognised: salty (pickled cucumber and green olives), sour and bitter (lingonberries and grapefruit), sour (blackcurrants), sweet and sour (apple), sweet (honeydew melon and banana), sweet and umami (cherry tomatoes), salty and umami (tinned champignon mushrooms), sweet and bitter (kohlrabi).

The buffet was served to the children at the ECEC centres during the regular snack time (2 pm). Full plates of vegetables, berries and fruit were placed on similar round porcelain serving dishes in the order listed above. We rinsed the pickled cucumbers, olives and tinned mushrooms, thawed the frozen lingonberries and blackcurrants, peeled and cut the grapefruit, honeydew melon and bananas

into bitesize pieces, and cut the apples in bitesize pieces. A whole vegetable or fruit was placed next to each item that had been cut into pieces.

Children formed a line and one by one chose the items that they wanted from the buffet with assistance by the ECEC educators in spooning the food on their plates when necessary. The plates were replenished when needed. The educators instructed the children that they could have extra portions and did not have to eat everything. Early educators were advised neither to name the buffet items, nor to encourage children to choose any particular items, and to behave similarly as during a regular afternoon snack. We used codes to refer to the children and their plates. We photographed⁽³³⁾ the plates each time the children selected items from the buffet, before they emptied their leftovers in the waste bin, and once they had finished eating. Water was served to drink. The images of the snack buffet, taken with a Samsung PL 20 camera, were coded and categorised into selected items, leftovers and finished sets. The photographs were assessed by a single researcher trained on the matter. Reliability was assessed by having the single researcher assess all digital photographs independently on two occasions, which took place at least 2 months apart. In addition, a reliability testing was performed, involving a trained registered dietitian scoring a sample of the photographs. This testing resulted in a consistency of 98.9% for willingness to choose and 94% for willingness to eat.

The children participated in the snack buffet once, on average in groups of 10, each session lasting approximately 30 minutes. The snack buffet was piloted during spring 2013 and found to function well in practice.

After the snack buffet, the children were offered their regular afternoon snack, which typically contained porridge/yogurt/berry or fruit soup, bread and margarine, skimmed milk and fresh fruit or vegetable. We noticed a slight difference in the afternoon snack menus between the centres: the SEN ECEC centres regularly served fresh fruit or vegetables on a daily basis whereas the REF ECEC centres did so once or twice a week.

Variables

The two main variables of the study were: 'willingness to choose' and 'willingness to eat'. These were formed based on the photographs by analysing what the children had chosen and eaten, item by item. The former was a sum of the portions chosen, assessed as 0=none, 1=one or little, and 2=two or more; the latter was a sum of the portions eaten, assessed as 0=took none, 1=took some but ate none, 2=ate half, and 3=ate most or all. One portion or a little portion was considered to

include one bitesize piece of vegetable or fruit or a teaspoonful of berries, and two or more portions were considered to include at least two bitesize pieces of vegetable or fruit and more than a teaspoonful of berries.

For the analysis, we also included the following variables:

sensory-based food education (SEN, REF), maternal education level (low, high), children’s food neophobia (continuing variable), children’s age (continuing variable, years), and gender (boy, girl). Maternal education was dichotomized as low (primary education, vocational college or upper secondary education) or high (education in a university of applied sciences or university) level of education.

Statistical analysis

Associations with willingness to choose and willingness to eat were analysed using linear mixed-effects models. This method was used due to statistical dependencies among the children within the ECEC centres and child groups in the data. Dependencies on two levels were discovered in this study. First, children socially influence each other in ECEC groups, and second, their work is framed by the practices, staff and facilities of the ECEC centre. The linear mixed-effects model analysis method allowed us to take these dependencies into account. The model consists of a systematic and a random part. The systematic part in the model assimilates to a regression model where observation units must be independent. The random part in our linear mixed-effects models takes into account the dependencies among children in the ECEC centres and child groups within each centre.

The response of child k in group j within the ECEC centre i was analysed using the linear mixed effects model as follows:

$$y_{ijk} = \mathbf{x}'_{ijk}\boldsymbol{\beta} + u_i + v_{ij} + e_{ijk},$$

where u_i and v_{ij} are normally distributed, $u_i \sim N(0, \sigma^2_{ECEC})$ and $v_{ij} \sim N(0, \sigma^2_{child\ group})$, random effects and child groups are nested within centres and e_{ijk} is a zero-mean residual error with constant variance.

In our willingness-to-choose model, statistically significant interactions were found between sensory-based food education and maternal education, and sensory-based food education and average food neophobia in the SEN and REF groups. Consequently, the systematic part $\mathbf{x}'_{ijk}\boldsymbol{\beta}$ of the

model included sensory-based food education, maternal education level, and interaction between the food education and maternal education level and the children's food neophobia, age and gender as well as the average food neophobia of the SEN and REF groups of children.

In our willingness-to-eat model, statistically significant interaction was found between sensory-based food education and maternal education. Therefore, the systematic part $x'_{ijk}\beta$ included sensory-based food education, maternal education level, and interaction between the food education and maternal education level, and the children's food neophobia, age, and gender.

We performed mixed effects model analyses using R version 3.2.5 and its nlme-package⁽³⁴⁾. We based model checking on visual inspection of different residual plots, and diagnostic plots on random effects.

Results

Children's choices and eating from the snack buffet

From the snack buffet, the children chose 6.9 ± 2.9 items in the SEN groups and 6.3 ± 2.6 items in the REF groups. Out of these selected items, the children consumed at least half of 4.8 ± 2.4 items in the SEN groups and 4.9 ± 2.2 in the REF groups. Children most commonly chose sweet and sour items from the buffet: bananas, apples, blackcurrants, and honeydew melon (Figure 1A). Other commonly chosen items were sweet and umami-flavoured cherry tomatoes and sour and bitter grapefruit and lingonberries. Less than half of the children chose kohlrabi, pickled cucumber, green olives and tinned champignon mushrooms, rendering 'salty' the least popular basic taste.

FIGURE 1 ABOUT HERE

The most common items consumed from the buffet were the sweet-flavoured bananas, apples, honeydew melon and cherry tomatoes (Figure 1B). Overall, items with sour, bitter and salty taste were eaten the least.

The comparison between selected (Figure 1A) and eaten (Figure 1B) items shows an interesting trend in the children's choices. Although blackcurrants and lingonberries were fairly common choices, less than half ate them in considerable amounts. On the other hand, kohlrabi and pickled cucumber were selected by less than half of the children, but eaten to a greater extent by those who chose them.

Associations between sensory-based food education and willingness to choose and eat

The highest willingness to choose was found among the children in the SEN groups whose mothers had a low education level. Sensory-based food education had a positive association with willingness to choose. This association was stronger among children of mothers with a low education level (Figure 2A).

A significant interaction was found between sensory-based food education and maternal education (Table 3, Figure 2A). In the SEN group, high maternal education decreased children's willingness to choose (Figure 2A, $\beta=-3.91$, adjusted for group neophobia). By contrast, among the REF children, no similar effect of maternal education level was found and the decrease caused by maternal education level was non-significant (Figure 2A, $\beta=-3.50$ for low and $\beta=-3.80$ for high maternal education level).

The highest willingness to eat was found among the children in the SEN group whose mothers had a low education level. Sensory-based food education had no statistically significant link to willingness to eat, but there was a positive tendency when we included it in the model (Table 3).

Sensory-based food education and maternal education also interacted with willingness to eat (Table 3, Figure 2B). Among the children in the SEN group, high maternal education level decreased the children's willingness to eat (Figure 2B, $\beta=-3.13$). By contrast, in the REF group, the decrease caused by maternal education level was non-significant (Figure 2B, $\beta=-1.96$ for low and $\beta=-2.81$ for high maternal education level).

Children's food neophobia significantly predicted both willingness to choose ($\beta=-0.09$, $P=0.002$) and willingness to eat ($\beta=-0.15$, $P<0.001$) (Table 3). The associations between gender and willingness were non-significant.

TABLE 3 ABOUT HERE

FIGURE 2 ABOUT HERE

There was variation between ECEC centres and between child groups within the ECEC centres. The model's standard deviations were as follows. For the willingness to choose, the SD was 1.86 between ECEC centres and 1.37 between child groups in the centres. For the willingness to eat, the standard deviations were .0007 between ECEC centres and 2.47 between the groups of children in these centres.

Average neophobia in the groups of children and their willingness to choose

There was significant interaction between sensory-based food education and children's average group neophobia with their willingness to choose (Table 3). Interestingly, the average food neophobia of the groups of children in this study, especially the REF ones, affected their willingness to choose ($\beta=-0.03$, $p=0.816$ for SEN and $\beta=-0.38$, $p=0.068$ for REF). In other words, in our REF groups of children, willingness to choose decreased as average group neophobia increased. In the SEN groups, no such association was found. However, no similar effect could be found in connection with the willingness to eat.

Discussion

The results showed that sensory-based food education implemented in ECEC was associated with children's willingness to choose vegetables, berries and fruit; this association was stronger among children of mothers with a low education level.

This study also found that the group neophobia of the children in the REF ECEC towards vegetables, berries and fruit seemed to play a role in children's willingness to choose these food items. Interestingly, the sensory-based food education in ECEC appeared to intervene in this group neophobia by diminishing its influence. At the same time, in individual children, food neophobia had a negative association with the willingness to choose and eat vegetables, berries and fruit.

Benefits of sensory-based food education

This study has a two-fold contribution to the increasing scientific evidence for the effectiveness of sensory activities in facilitating the introduction of health-promoting foods to children's diets. First, sensory-based food education can play a role in reducing health inequity among children, and second, positive effects of such food education can also emerge at the group level.

Our findings support the hypothesis that sensory-based food education, integrated into the ECEC routine, promotes children's willingness to choose vegetables, berries and fruit, but only with the children of mothers with a low level of education. Our results also mirror previous sensory education studies that have mostly concentrated on school-aged children. In Finland, sensory education has been shown to encourage children to taste unfamiliar foods⁽¹⁰⁾, and improve children's skills in describing their food perceptions⁽¹²⁾. A Dutch school programme, Taste Lessons, implementing sensory food education at schools, was found to produce minor positive effects on

children's willingness to taste vegetables⁽¹⁵⁾, though these disappeared in further method evaluation using objective taste test measures⁽¹⁶⁾. In France, taste sessions at schools increased children's willingness to choose vegetables, but this effect was only temporary⁽¹⁴⁾. In Finland the positive effects of sensory education mainly occurred among younger school children, which encourages implementing such activities with even younger children in ECEC⁽¹⁰⁾. In the context of under-school-aged children, a Finnish intervention study⁽¹⁹⁾ explored the impact of sensory-based food education focused on vegetables and berries, and found that such food education increased children's willingness to eat these food items. Similarly, in the UK, non-taste sensory activities⁽¹⁸⁾ and sensory play⁽¹⁷⁾ with vegetables and fruit in ECEC increased children's willingness to taste them.

Our results indicate that children of mothers with a low education level might benefit more from sensory-based food education. It is somewhat surprising and different from our hypothesis that lower socioeconomic status increased children's willingness to choose and eat vegetables, berries and fruit in the sensory-based food education group in the present study. Families with low socioeconomic status have been found to consume less vegetables, berries and fruit⁽²⁰⁾, and are therefore less likely to provide them to children at home⁽³⁵⁾, which reduces their children's familiarity with these foods⁽³⁶⁾. It is not clear why children from lower socioeconomic families chose vegetables, berries and fruit more willingly. Earlier findings indicate that high quality ECEC might be more beneficial for children from families with a lower socioeconomic status compared to their peers with a higher socioeconomic status⁽³⁷⁾. It is possible that children of mothers with lower education levels benefit more from sensory-based food education than children of mothers with higher education. More highly educated mothers are probably more aware of healthy eating for children and offer a wider variety of vegetables and fruit at their homes^(20,35).

Children's individual food neophobia came as no surprise, and was a factor reducing both the children's willingness to choose vegetables, berries and fruit as well as their willingness to eat them. This finding is consistent with our hypothesis and previous research that show negative association between food neophobia and vegetable intake⁽³⁸⁻⁴⁰⁾.

However, no individual association between sensory-based food education and neophobia existed, although sensory lessons have been shown to reduce neophobia in Finnish⁽¹²⁾, French⁽¹⁴⁾ and Korean^(41,42) school-aged children.

Children's group neophobia decreased their willingness to choose. In the reference group, the average level of neophobia reduced the children's willingness to choose vegetables, berries and fruit. By contrast, the sensory-based food education group showed no similar tendency. This result supports previous findings that positive peer modelling increases novel food consumption^(43,44) and that peer modelling can also reduce food neophobia⁽⁴⁵⁾ with school-aged children. Therefore, one benefit of sensory-based food education could be the enhancement of a positive atmosphere in children's groups in relation to food. This is in line with a Swedish study⁽⁴⁶⁾, which noted that ECEC children learn from and with each other also in relation to food.

Strengths and limitations

To the best of our knowledge, this study is the first to assess sensory-based food education implemented by ECEC centres themselves and its association with children's willingness to choose and eat vegetables, berries and fruit. It is important to study the factors associated with young children's vegetable, berry and fruit choices and food education at ECEC, as diets adopted in childhood are likely to persist into adolescence⁽⁴⁷⁾ and adulthood⁽⁴⁸⁾, and food education in ECEC can have long-term benefits to children's health.

The snack buffet method is a new assessment tool which allows measuring young children's willingness to choose and eat vegetables, berries and fruit in a naturalistic setting. Other strengths of the method include enabling both children and parents to work as informants, and the presence of a reference group. Furthermore, as a novelty, this study examined food neophobia at the child group level and found this to be positively influenced by food education.

The study has three main limitations that may weaken the generalisability of the findings. First, obtaining all necessary information about the implementation of sensory-based food education in each ECEC centre turned out to be difficult. To get a more detailed picture about this topic, we explored existing documents and asked early educators for more information about related practices, facilities and tools. Second, our data lacks information about children's food preferences. However, according to earlier research, the vegetable and berry choices and eating habits of under-school-aged children appear to correlate weakly with their parents' predictions about their child's preferences⁽¹⁹⁾. Third, minor weaknesses in the arrangements of the snack buffet and coding of the photographs might have affected our results. As the method is further developed, the number of items served could be further considered to avoid misrecognition; the order of the positions of the items could rotate, or the items served could be placed on a round table to remove the emphasis on

items that are placed in the first position. As sensory properties, such as shape and colour, affect children's choices⁽⁴⁹⁾, they should be taken into account when reconsidering the included items. Furthermore, some challenges may concern the coding of photographs and the photographs should, therefore, be assessed individually by two trained researchers. Despite these limitations, our experience suggests that the snack buffet provides a child-oriented and promising method for assessing young children's willingness to choose and eat vegetables, berries and fruit.

Practical implications

This study suggests that children whose mothers have a low level of education may benefit from sensory-based food education in ECEC and encourages wider introduction of the method to ECEC centres. This interesting finding concerning food education and low maternal education consolidates early educators' role as food educators in promoting a diverse diet. We thus recommend sensory-based food education as a method for enhancing nutritional equality among under-school-aged children.

Sensory-based food education can be useful for increasing positivity towards food and eating as well as decreasing the effect of food-neophobic individuals in a group. In future research, when observing the effects of food education on children, more focus should be put on changes at the child group level. There is a need for further research determining the most effective sensory activities in promoting children's vegetable, berry and fruit intake.

In conclusion, sensory-based food education is a promising and child-oriented method for promoting children's adoption of vegetables, berries and fruit in their diets.

References

- (1) Kyttälä P, Erkkola M, Kronberg-Kippilä C *et al.* (2010) Food consumption and nutrient intake in Finnish 1-6-year-old children. *Public Health Nutr* **13**, 947-956.
- (2) Talvia S, Räsänen L, Lagström H *et al.* (2006) Longitudinal trends in consumption of vegetables and fruit in Finnish children in an atherosclerosis prevention study (STRIP). *Eur J Clin Nutr* **60**, 172-180.
- (3) Lynch C, Kristjansdottir AG, Te Velde SJ *et al.* (2013) Fruit and vegetable consumption in a sample of 11-year-old children in ten European countries - The PRO GREENS cross-sectional survey. *Public Health Nutr* **17**, 2436-2444.
- (4) Liu RH. (2013) Health-promoting components of fruits and vegetables in the diet. *Adv Nutr* **4**, 384S-392S.
- (5) Johnson SL. (2016) Developmental and Environmental Influences on Young Children's Vegetable Preferences and Consumption. *Adv Nutr* **15**, 220S-31S.
- (6) OECD. (2016) *Education at a Glance 2016: OECD Indicators*, OECD Publishing, Paris.
- (7) Sandell M, Mikkelsen BE, Lyytikäinen A *et al.* (2016) Future for food education of children. *Futures* **83**, 15-23.
- (8) Puisais J, Pierre C. (1987) *Le goût et l'enfant (Taste and The Child)*. Paris: Flammarion.
- (9) Dazeley P, Houston-Price C, Hill C. (2012) Should healthy eating programmes incorporate interaction with foods in different sensory modalities? A review of the evidence. *Br J Nutr* **108**, 769-777.
- (10) Mustonen S, Rantanen R, Tuorila H. (2009) Effect of sensory education on school children's food perception: A 2-year follow-up study. *Food Qual Prefer* **20**, 230-240.
- (11) Jonsson IM, Ekström MP, Gustafsson I. (2005) Appetizing learning in Swedish comprehensive schools: an attempt to employ food and tasting in a new form of experimental education. *Int J Consum Stud* **29**, 78-85.

- (12) Mustonen S, Tuorila H. (2010) Sensory education decreases food neophobia score and encourages trying unfamiliar foods in 8–12-year-old children. *Food Qual Prefer* **21**, 353-360.
- (13) Reverdy C, Schlich P, Köster EP *et al.* (2010) Effect of sensory education on food preferences in children. *Food Qual Prefer* **21**, 794-804.
- (14) Reverdy C, Chesnel F, Schlich P *et al.* (2008) Effect of sensory education on willingness to taste novel food in children. *Appetite* **51**, 156-165.
- (15) Battjes-Fries MC, Haveman-Nies A, Renes RJ *et al.* (2015) Effect of the Dutch school-based education programme 'Taste Lessons' on behavioural determinants of taste acceptance and healthy eating: a quasi-experimental study. *Public Health Nutr* **18**, 2231-2241.
- (16) Battjes-Fries MCE, Haveman-Nies A, Zeinstra GG *et al.* (2017) Effectiveness of Taste Lessons with and without additional experiential learning activities on children's willingness to taste vegetables. *Appetite* **109**, 201-208.
- (17) Coulthard H, Sealy A. (2017) Play with your food! Sensory play is associated with tasting of fruits and vegetables in preschool children. *Appetite* **113**, 84-90.
- (18) Dazeley P, Houston-Price C. (2015) Exposure to foods' non-taste sensory properties. A nursery intervention to increase children's willingness to try fruit and vegetables. *Appetite* **84**, 1-6.
- (19) Hoppu U, Prinz M, Ojansivu P *et al.* (2015) Impact of sensory-based food education in kindergarten on willingness to eat vegetables and berries. *Food Nutr Res* **59**, 287-295.
- (20) Fernandez-Alvira JM, Bornhorst C, Bammann K *et al.* (2015) Prospective associations between socio-economic status and dietary patterns in European children: the Identification and Prevention of Dietary- and Lifestyle-induced Health Effects in Children and Infants (IDEFICS) Study. *Br J Nutr* **113**, 517-525.
- (21) Fernández-Alvira JM, Mouratidou T, Bammann K *et al.* (2013) Parental education and frequency of food consumption in European children: The IDEFICS study. *Public Health Nutr* **16**, 487-498.

- (22) Sausenthaler S, Kompauer I, Mielck A *et al.* (2007) Impact of parental education and income inequality on children's food intake. *Public Health Nutr* **10**, 24-33.
- (23) Rehm CD, Monsivais P, Drewnowski A. (2015) Relation between diet cost and Healthy Eating Index 2010 scores among adults in the United States 2007-2010. *Prev Med* **73**, 70-75.
- (24) Dovey TM, Staples PA, Gibson EL *et al.* (2008) Food neophobia and 'picky/fussy' eating in children: a review. *Appetite* **50**, 181-193.
- (25) Lafraire J, Rioux C, Giboreau A, *et al.* (2016) Food rejections in children: Cognitive and social/environmental factors involved in food neophobia and picky/fussy eating behavior. *Appetite* **96**, 347-357.
- (26) Pliner P, Hobden K. (1992) Development of a scale to measure the trait of food neophobia in humans. *Appetite* **19**, 105-120.
- (27) Nicklas TA, O'Neil CE, Stuff J *et al.* (2012) Validity and Feasibility of a Digital Diet Estimation Method for Use with Preschool Children: A Pilot Study. *J Nutr Educ Behav* **44**, 618-623.
- (28) Martin CK, Newton RL, Anton SD, *et al.* (2007) Measurement of children's food intake with digital photography and the effects of second servings upon food intake. *Eating Behaviors* **8**, 148-156.
- (29) Perez-Rodrigo C, Artiach Escauriaza B, Artiach Escauriaza J *et al.* (2015) Dietary assessment in children and adolescents: issues and recommendations. *Nutr Hosp* **31**, Suppl 3, 76-83.
- (30) Ojansivu P, Sandell M, Lagström H *et al.* (2014) *Lasten ruokakasvatus varhaiskasvatuksessa (Food Education in Early Childhood Education)*. *Publications of the Child and Youth Research Institute* no. 8/2014. Turku: Child and Youth Research Institute.
- (31) Koistinen A & Ruhanen L (editors) (2009) *Aistien avulla ruokamaailmaan. Sapere-menetelmä päivähoiton ravitse- mus- ja ruokakasvatuksen tukena (Handbook for Sapere Method in Early Childhood Education and Care)*. Helsinki: Sitra, Suomen itsenäisyyden juhlarahasto.

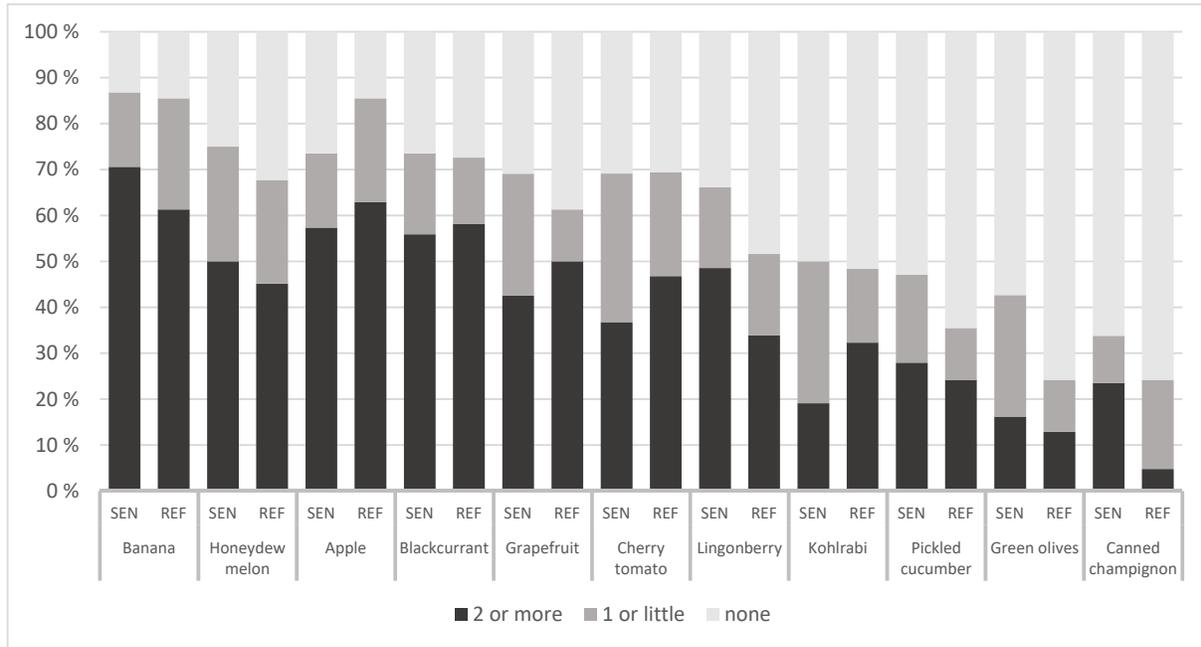
- (32) Bouhlal S, Issanchou S, Chabanet C *et al.* (2014) 'Just a pinch of salt'. An experimental comparison of the effect of repeated exposure and flavor-flavor learning with salt or spice on vegetable acceptance in toddlers. *Appetite* **83**, 209-217.
- (33) Gemming L, Utter J, Ni Mhurchu C. (2015) Image-assisted dietary assessment: a systematic review of the evidence. *J Acad Nutr Diet* **115**, 64-77.
- (34) Pinheiro J, Bates D, DebRoy S *et al.* (2013) Nlme: linear and nonlinear mixed effects models. R package version 3.1-111. <https://CRAN.R-project.org/package=nlme>
- (35) Lehto E, Ray C, te Velde S *et al.* (2014) Mediation of parental educational level on fruit and vegetable intake among schoolchildren in ten European countries. *Public Health Nutr* **18**, 89-99.
- (36) Cook LT, O'Reilly GA, DeRosa CJ *et al.* (2015) Association between home availability and vegetable consumption in youth: a review. *Public Health Nutr* **18**, 640-648.
- (37) Sylva K, Melhuish E, Sammons P *et al.* (2004). The effective provision of pre-school education (EPPE) project: Final report A longitudinal study funded by the DfES 1997-2004. London: The Institute of Education.
- (38) Cooke L, Wardle J, Gibson EL. (2003) Relationship between parental report of food neophobia and everyday food consumption in 2-6-year-old children. *Appetite* **41**, 205-206.
- (39) Cooke L, Carnell S, Wardle J. (2006) Food neophobia and mealtime food consumption in 4-5 year old children. *Int J Behav Nutr Phys Act* **3**, 14
- (40) Johnson SL, Davies PL, Boles RE *et al.* (2015) Young Children's Food Neophobia Characteristics and Sensory Behaviors Are Related to Their Food Intake. *J Nutr* **145**, 2610-2616.
- (41) Park BK, Cho MS. (2016) Taste education reduces food neophobia and increases willingness to try novel foods in school children. *Nutr Res Pract* **10**, 221-228.
- (42) Woo T, Lee KH. (2013) Effects of sensory education based on classroom activities for lower grade school children. *Nutr Res Pract* **7**, 336-341.
- (43) Greenhalgh J, Dowey AJ, Horne PJ *et al.* (2009) Positive- and negative peer modelling effects on young children's consumption of novel blue foods. *Appetite* **52**, 646-653.

- (44) Birch LL. (1980) Effects of peer model's food choices and eating behaviors on preschooler's food preferences. *Child Development* **51**, 489-496.
- (45) Laureati M, Bergamaschi V, Pagliarini E. (2014) School-based intervention with children. Peer-modeling, reward and repeated exposure reduce food neophobia and increase liking of fruits and vegetables. *Appetite* **83**, 26-32.
- (46) Sepp H, Hoijer K. (2016) Food as a tool for learning in everyday activities at preschool - an exploratory study from Sweden. *Food Nutr Res* **60**, 32603.
- (47) Kelder SH, Perry CL, Klepp K *et al.* (1994) Longitudinal tracking of adolescent smoking, physical activity, and food choice behaviors. *Am J Public Health* **84**, 1121-1126.
- (48) Wadhwa D, Phillips EDC, Wilkie LM *et al.* (2015) Perceived recollection of frequent exposure to foods in childhood is associated with adulthood liking. *Appetite* **89**, 22-32.
- (49) Dinnella C, Morizet D, Masi C *et al.* (2016) Sensory determinants of stated liking for vegetable names and actual liking for canned vegetables: A cross-country study among European adolescents. *Appetite* **107**, 339-347.

FIGURES

Figure 1. Vegetables, berries and fruit children selected (A) and ate (B) from the snack buffet. SEN, sensory-based food education group; REF, reference group.

A Selected vegetables, berries and fruit



B Eaten vegetables, berries and fruit

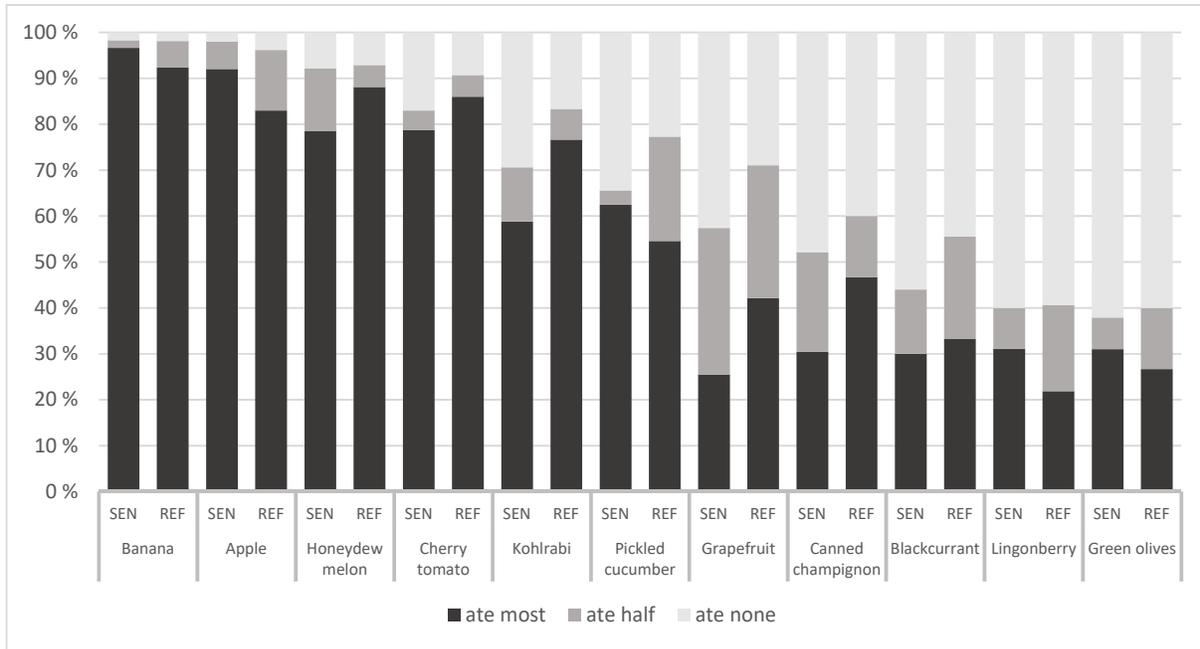


Figure 2. Interaction between sensory-based food education and maternal education in linear mixed-effects models for willingness to choose (A) and eat (B). Estimates presented in ellipses.

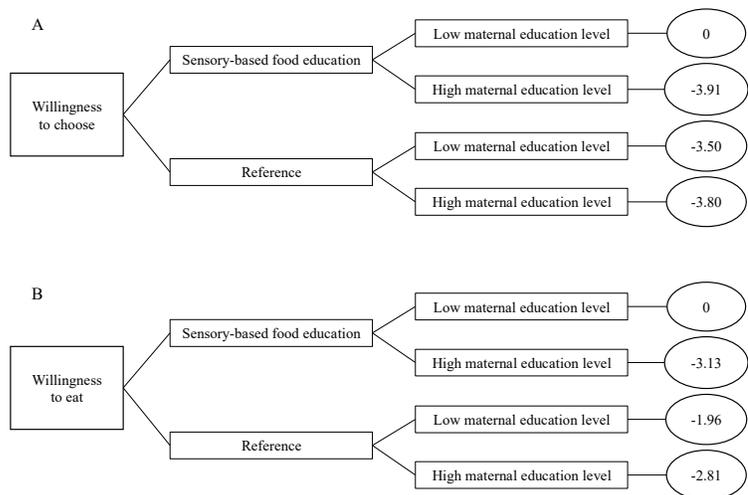


Table 1. Background information of the children and their parents.

	SEN, n=68			REF, n=62		
	Mean	SD	N (%)	Mean	SD	N (%)
Children						
Age, years	4.6	0.8		4.5	0.8	
Gender						
Girls			36 (52.9)			26 (40.3)
Boys			32 (47.1)			37 (59.7)
Number of months in ECEC	18.6	12		20.5	13	
Days in ECEC per month	18.5	3.4		16.8	3.8	
Number of meals at ECEC per week	13.7	1.9		11.6	3.2	
Family size	4.1	1.2		4.2	1.1	
Number of children in the family	2.3	1.0		2.3	1.0	
Lives with						
Mother and father			57 (83.8)			52 (83.9)
Mother or father or other arrangements			11 (16.2)			10 (16.1)
Food neophobia	38.3	13.3		35.8	11.2	
Parents						
Age, years						
Mother	35.2	5.3		34.0	5.4	
Father	36.8	5.9		36.6	5.7	
Level of education						
University level						
Mother			35 (51.5)			34 (54.8)
Father			23 (38.3)			22 (36.7)
Working						
Mother			50 (73.5)			51 (82.3)
Father			52 (86.7)			50 (86.2)
Regular day work						
Mother			42 (61.8)			31 (50.0)
Father			36 (52.9)			34 (54.8)

Missing data in some categories, statistics based on available data.

SEN, sensory-based food education groups

REF, reference groups

SD, standard deviation

ECEC, early childhood education and care

Table 2. Sensory-based food education practices, facilities and tools at early childhood education and care (ECEC) centres (n=6).

Practices	Facilities and tools
<i>Shared customs, since 2011</i>	
Early educators have a unanimous understanding of sensory-based food education	Training for personnel
Appointment of an early educator as a Sapere coordinator at the ECEC centres	Training, Sapere-handbook ³¹
Early educators share ideas for sensory-based food education between the ECEC centres	Regular meetings in the municipality, website
Seasonal themes or theme weeks, e.g. harvested food and berries in the fall	
<i>At mealtimes, daily</i>	
Children portion their own food (5/6 ECEC centres)	Tables are adjusted for children's height
Salad ingredients are served separately at lunch	
Fresh berries, vegetables or fruit served at every breakfast and as an afternoon snack	
Children are encouraged (and never forced) to choose and taste the served foods	
Children can explore food with their senses, e.g. smelling, touching, without tasting	
Early educators promote food talk and encourage children to describe food perceptions	
ECEC centres employ a pedagogical menu (2/6 ECEC centres)	
<i>Variety of sensory sessions, 1-2 times/month, mostly in small groups of 4 children</i>	

Getting familiar with one's own five senses	Food samples, smelling bottles, cloth bags or boxes with food samples
Baking with the five senses, e.g. bread, pies, cookies	A special "little kitchen" that has the dimensions of a kitchen suitable for children (3/6 ECEC centres), safe and appropriate kitchen utensils, aprons and chef hats, pictorial recipes, and ingredients reserved for children's use
Preparing salads and desserts with the five senses	
Growing vegetables, berries and fruit at the ECEC centre and preserving the harvest	Garden or orchard (2/6 ECEC centres) or windowsill planters, berry bushes, apple trees, pots, soil, seeds
Food as material for art, e.g. potato printing, blueberry painting	Food samples
Food themes during playtime	Food games, play kitchen, play food, play shop, food songs, books with food themes, stories
Short day trip, e.g. for berry picking	A nearby forest or market

Table 3. Linear mixed-effects model of willingness to choose and eat vegetables, berries and fruit from a snack buffet in 3-5-year-old children at early childhood education and care.

Dependent variable	Estimate	SE	p-value
Willingness to choose			
Sensory-based food education : Maternal education*	3.61	1.42	0.012
Sensory-based food education*	-3.50	1.86	
Maternal education (low vs. high)†	-3.91	1.04	
SEN: Group's average neophobia	-0.03	0.13	0.816
REF: Group's average neophobia	-0.38	0.18	0.068
Food neophobia	-0.09	0.03	0.002
Age	-0.06	0.46	0.903
Gender (boys vs. girls)	-1.03	0.71	0.146
Willingness to eat			
Sensory-based food education: Maternal education	2.28	2.08	0.274
Sensory-based food education	-1.96	1.90	
Maternal education (low vs. high)	-3.13	1.49	
Food neophobia	-0.15	0.04	<0.001
Age	1.76	0.69	0.011
Gender (boys vs. girls)	-0.01	1.05	0.995

SE, standard error

SEN, sensory-based food education groups

REF, reference groups

* adjusted for food neophobia

† less than a university degree vs. a university degree