Variety in snack servings as determinant of acceptance in school-aged children

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Abstract:

Variety within a meal is known to increase intake. However, intake of certain food items (e.g. vegetables) in children is consistently below recommendations, and increasing the consumption of such food would lead to health benefits. This study investigated how different levels of food variety influence children's acceptance. A total of 132 children, aged from 9 to 11 years, were exposed to vegetables, fruits and nut snacks during mid-morning break at school. Two different sets of stimuli were used in a within subject design: Classical Variety (CV), i.e. serving of different foods and Perceived Variety (PV), i.e. serving of the same food in different shapes. For each set, three levels of variety in the servings were tested: low, medium, and high. Intake and liking were determined for each serving set. ANOVA results showed that intake of CV set decreased according to the level of variety, whereas results of PV set only showed an increase of liking with increasing levels of variety. Adding more variations of products appeared to be less successful on consumption despite changing the liking of the products, may be because consumption is more affected by acceptability and familiarity for the stimuli than by variety.

Keywords: food variety, children, fruits, vegetables, consumption, liking

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1. INTRODUCTION

Children population surveys indicate the need to increase the intake of fruits and vegetables (Fox, Condon, Briefel, Reidy, & Deming, 2010). Indeed, in most countries daily consumption of fruits and vegetables is well below the recommendations of five portions a day (Lorson, Melgar-Quinonez, & Taylor, 2009; National Obesity Observatory (NOO), 2012; WHO, 2006). Moreover, recent studies on children's food preferences showed that vegetables are still the least liked food category, particularly among school-aged children and adolescents (Lanfer, Hebestreit, Ahrens, Krogh, Sieri, Lissener et al., 2011). Considering that the pattern of fruits and vegetables consumption persists into adulthood (Lien, Lytle, & Klepp, 2001), it is important to establish healthy habits from childhood.

On one hand, dietary variety is an important component of a healthy diet, but on the other hand it may also lead to a negative outcome. Variety within a meal is known to be one of the most powerful ways to increase energy intake, with a larger amount of food being consumed in meals characterized by high variety. Earlier studies (Rolls et al., 1981; Rolls et al., 1982; Speigel, & Stellar, 1990; Hollis, & Henry, 2007) explained this behavior by the mechanism of sensory-specific satiety (SSS); when a variety of foods is available, there is the tendency to switch from one food to another because of the decrease in palatability in any one food after consumption (Rolls, 1986). McRory, Fuss, McCallum, Yao, Vinken, Hays, & Robert, (1999) and Norton, Anderson, & Hetherington, (2006) have shown that dietary variety is associated with increased energy intake and body fat in adults. Thus, offering a meal with high variety could potentially lead to overeating. Unfortunately, few studies have been addressed to children (Epstein, Robinson, Temple, Roemmich, Marusewski, & Nadbrzuch, 2009; Avena & Gold, 2011; Bucher, Siegrist & van der Horst, 2014).

One of the first experiments conducted on food variety in children suggested that it influenced intake of low energy density foods as well as high energy density alternatives (Epstein, 2009). Temple, Giacomelli, Roemmich, & Epstein (2008) investigated the effects of a varied diet in children, and showed that offering a high variety of foods could increase energy intake, but the response was not related to energy density. This suggested that, also for low energy dense foods, such as fruits and vegetables, increasing the variety of foods offered may increase their consumption. Thus, variety may be used as an alternative approach for promoting intake of particular healthy products, such as fruits and vegetables.

Variety has rarely been used to encourage children's vegetables consumption. Roe, Meengs, Birch, & Rolls (2013) tested several familiar fruits and vegetables as snack with pre-school children, and successfully found that providing a variety of foods increased the likelihood that children would select some of them as well as the amount they actually chose and ate.

Most of the previously mentioned studies considered food variety as the variation of number of products but relatively little is known about what food variety actually means for children. It is likely that varying sensory properties such as taste, texture, size, shape, and color will influence perceived variety since such attributes have previously been demonstrated to affect SSS (Rolls et al., 1982). In vegetables, shape is known to affect liking in children aged 9-12 years, who prefer to have their vegetables cut and presented in more complex serving styles (Olsen, Ritz, Kramer, & Møller, 2012a; Zampollo, Kniffin, Wansink, & Shimizu, 2012). Olsen et al. (2012a) also demonstrated that size did not matter when vegetables were cut, but when served as a whole or as chunks the ordinary size was preferred over the smaller size. The present study investigated the effect of two different types of variety on fruits and vegetables snacks intake and acceptance in school children; *Classical Variety* (CV), i.e. serving of different foods and *Perceived Variety* (PV), i.e. serving of the same food in different shapes. The aim was to investigate if the CV and PV choice varieties influence acceptance and intake of snack servings in a similar way in Danish school-aged children.

We hypothesized to obtain a lower consumption of PV set compared to CV set, since in the first one only the appearance and remotely the texture were changed.

Eating habits and frequency of consumption of fruits and vegetables were also investigated, through a questionnaire completed by the children's parents.

2. MATERIAL AND METHODS

2.1 Participants

One-hundred-fifty-three children from a public school in Copenhagen (Denmark) were enrolled in the study. Children were aged from 9 to 11 years, 63 (47.7%) were girls and 69 (52.3%) were boys. Participant characteristics are given in **Table 1.**

A total of seven classes were involved: four 3rd graders (9-10 years) and three 4th graders (10-11 years). One 3rd class was involved in a pilot study (n=18) only, whereas all other children (n=132) took part in the main

experiment. Teachers and parents were thoroughly informed about the study and parents gave written consent and completed a short questionnaire on food allergy or whether their child followed a specific diet prior to study start. None of the children involved in the present experiment followed specific diets. Children who suffered from allergies for pilot study products were not served these products in their servings. Children's participation in the study was voluntary and classes received mixed toys (value: 80 US dollars) as a small reward for their participation. The study complied with the Helsinki declaration, and after reviewing the study protocol, the Danish National Committee on Biomedical Research Ethics found that it did not require formal ethical approval.

2.2 Pilot study

A pilot study was carried out to select the stimuli for the main experimental study. Fifteen snack foods were tested for liking, familiarity, frequency of consumption, and preferred serving styles by one of the school classes. The presented fruits and vegetables were: pear, red apple, dried cranberry, almond, parsley root, beetroot, white cabbage, plum, green apple, red currant, hazelnut, parsnip, carrot, kohlrabi, and Brussels sprout. Products were selected on the basis of suitability as a snack food and conformed with recommendations for the New Nordic Diet (Mithril, Dragsted, Meyer, Tetens, Biltoft-Jensen, & Astrup, 2013). All products, except cranberries and almonds, were organically produced, as well as complied with seasonal availability from the Danish suppliers. They were further selected on easiness to handle and divide in portions.

Testing took place in the classroom. Children were instructed how the questions were phrased and how to use the scales. This was practiced a couple of times in plenum. For each food, children were asked about familiarity *(*before tasting the food*)*: "Do you know this food?' on a 3-point scale: "No, I've never seen it before", "I've seen it, but not tasted", and "Yes, and I've tasted it". Then children tasted the food and rated liking: "How much do you like this food?", on a 7-point hedonic facial scale adopted from Chen, Resurreccion, & Paguio (1996) with the descriptors: "really bad", "very bad", "bad", "okay", "good", "very good", and "really good". Finally, children assessed their frequency of consumption: "How often do you eat this food?" and answered through a 5-point scale with the descriptors: "Never", " A few times a year", " A few times a month", "A few times a week", "Every day".

During tasting, children were offered a small piece/bunch (around 30 g) of each food one at a time in a mid-morning break. To minimize peer interaction and the effect of serving order, during assessments, two serving orders were used, so children sitting next to each other would not evaluate the same food at the same time. Half of the children received the foods in the order mentioned above, and the other half received the opposite order. Products were served with a small break between each serving. After each tasting children took a sip of water for palate cleansing. Results are shown in **Table 2**. Familiarity is reported as the percentage of children answering "I know this vegetable and I've tasted it" (score 3), while frequency of consumption was measured as the sum of the percentage of children answering "A few times a week" and "Every day" (scores 4 and 5).

In order to choose stimuli shapes for the main study, after the tasting session, children rated their liking of pictures of green apple and carrot presented in four different serving styles: small chunks, slices, sticks, and triangles. The eight serving shapes were arranged with each vegetable in a similar position in identical plates. Children evaluated liking of each serving shape individually: "How much do you like this serving style?" and answered on the 7-point hedonic facial scale described above. Children were instructed not to influence their classmates with facial expression or comment about the food they tasted, and it was carefully emphasized that there were no right or wrong answers. Results showed that, for both green apple and carrot, children's liking increased significantly from simpler shape (small chunks) to more elaborated cutting (sticks and triangles).

2.3 Main study

2.3.1 Stimuli

Selection of stimuli for the eating sessions was based on liking of the products rated in the pilot study, but also based on practical considerations. Practical issues included for instance ease of handle and storage. Several products were excluded due to browning during storage. Familiar and liked products were chosen to minimize the effect of rejection of novel or disliked foods.

The final products chosen and their serving shapes were: carrot chunks (a), sticks (b), slices (c); green apple chunks (d), slices (e), triangles (f); plum chunks (g); white cabbage quadrangular pieces (h); dried cranberry (i); almond (l). Two stimuli sets were served: 'Classical Variety' (CV), in which the number of different

foods varied, and 'Perceived Variety' (PV), in which only serving styles shape of green apple and carrot were varied. For each set, three levels of variety were tested: low (2 stimuli), medium (4 stimuli), and high variety (6 stimuli). Stimuli were arranged in transparent plastic boxes giving 6 different serving styles. The total amount of each serving box was 200 g, thus the amount of each product changed on the basis of set and level of variety. Exact content of the 6 servings is described in **Table 3**. **Total** amount of calories in the servings were 84 kcal /200 g for PV levels and CV low level; 227 kcal/200 g for CV medium level; and 340 kcal/200 g for high level. Nuts and dried fruits, that are commonly used as snack in Danish children, were added to increase the variation in the CV set, despite their energy density varied from that of fresh fruits and vegetables. All snack foods were served raw, except for cranberries and almonds.

2.3.2 Experimental study design

The study consisted of five separate phases (**Table 4**): Baseline measurements, intake measurement, overall rated and ranked liking measurements, anthropometric measurements and parent's questionnaire.

- *Baseline measurements:* Baseline measurements were performed during the first two days, at midmorning at school, in the presence of a teacher and an experimenter. To increase ecological validity, children were tested in a familiar environment, their classroom (because Danish children usually eat in their classrooms). The number of children in the 6 classes ranged from 18 to 25. The experimenters were thoroughly trained in order to give all instructions in a standardized manner. Testing of familiarity, liking and frequency of consumption of each selected snack vegetable, followed the same procedure as described for the pilot study, with the main difference being that in the main study, the following foods were assessed: apple, carrot, almond, plum, cranberry, cabbage, cucumber and celery. These last two products were added as warm up samples and were chosen because they were known, from earlier experience (Olsen, Ritz, Kraaij, Møller, 2012b), to be respectively among the most preferred and the most disliked vegetables for children.
- *Intake measurements:* 2 sessions were scheduled per week, with at least a 2 day break between visits, for a total duration of 3 weeks. Each of the six different servings was served to each class in a randomized, but balanced order. All children in a class always received the same serving at a given day. At the beginning of children's habitual midmorning break, a serving box was delivered to each child, and they were invited to eat as much or as little as they wished during the duration of the break (20 minutes). Parents had been

instructed not to give their children any snack foods for this break during study days. To determine individual intake, each box was marked with the child's name and the exact amount of each food item in a serving was determined with a 1 g precision (Sartorius TE1502S, Data Weighing Systems Inc., IL, USA). Participants were instructed not to share food with each other, and if anything was spilled, it was putted back to the box when the child had finished eating. After serving, the boxes were taken back to the lab to establish exact intake of each food item. No second servings were allowed. A jug of water was also offered to the children during the eating session. Products were prepared few hours before serving, apples were dipped in water added citric acid to avoid browning, and all the products served at room temperature

- *Overall rated and ranked liking measurements:* After the end of the serving phase, in the following week, the overall assessment of the 6 serving sets took place. To allow direct comparisons between them, all six serving sets were presented simultaneously to the children in their plastic boxes. Children evaluated the servings individually outside the classroom. They performed a visual overall liking test (7-point facial scale) and then a visual ranking test by elimination by asking them the following question: "Which of these servings do you prefer?". The box chosen as the favorite one was removed and the question was repeated for the remaining servings until a full ranking was given. In the control group, children were also asked to rank the servings after perceived serving size.

- *Anthropometric measurements:* Children were weighted (Tanita, BWB-600, Tanita Corporation, Japan) and measured for height (SECA Leicester portable height measure, Medisave, UK) in stocking feet and light clothing. Height and weight were converted to body mass index (BMI= kg/m^2), and BMI z-scores were calculated using the WHO 2007 (De Onis et al., 2007) data as reference.

- *Parents' questionnaire:* Questionnaire included basic demographic questions about the parents (age, sex, education level, job, height, weight) and the child (height, weight, breast feeding, weaning). Children's fruits and vegetables consumption was assessed using the following questions: 'How much does your child like fruits/vegetables?' (answer ranged from 1, 'very bad', to 5, 'very good'); 'How often does your child eat fruits/vegetables?' (answer ranged from 1,'everyday', to 5, 'never'); 'How many portions of fruits/vegetables does your child eat per day?'; 'Are there usually vegetables available at your home?'; 'Are there usually vegetables, that your child likes, available at your home?' (answer ranged from 1, 'always', to 5, 'never'); 'Who prepare snack vegetable for your child?' (Answers: 'my child prepares', 'sometimes my

191 child prepares', 'I prepare', 'my child doesn't eat vegetable for snack'). Child Eating Behavior Questionnaire
192 (CEBQ) sub-scales (Wardle, Guthrie, Sanderson, & Rapaport, 2001) were also used to have insights on
193 children's food habits. The following variables of the CEBQ were measured (score ranged from 1 to 5):
194 Satiety Responsiveness (SR), Fussiness (FU), Food Responsiveness (FR), Enjoyment of food (EF), Desire to
195 drink (DD), Emotional undereating (EU), Emotional overeating (EO). Parents also answered questions about
196 child food neophobia traits through a reduced version of 6 items of Food Neophobia Scale (FNS) (score
197 ranged from 6 to 30) (Pliner and Hobden, 1992).
198
199 **2.4 Data analysis**
200 The General Linear Model (GLM) procedure was used to perform ANOVA. *Liking* and *Intake,* calculated as
201 percentage of grams and kilocalories consumed over the amount delivered, were considered as dependent
202 variables. *Children* and *Class* were considered as random factors in the model, whereas *Gender, Set of*
203 *variety* (CV and PV), *Level of variety* (low, medium and high) and their interaction were considered as
204 factors. *Age* and *BMI z-score* were considered as covariates in the model. When the ANOVA showed a
205 significant effect ($p<0.05$), post-hoc LSD test was applied. Pearson correlation coefficients were calculated
206 to investigate the relationship between intake and liking data.
207 To investigate the influence of background variables, another GLM analysis was performed: *Intake* and
208 *Liking* were considered as dependent variables, whereas *Fruits and vegetables consumption, Availability at*
209 *home, Availability of liked vegetable at home, Availability of preparation scores, CEBQ variables, Food*
210 *neophobia* were used as covariates in the model. The reason these analyses were run separately and in
211 addition to the analyses mentioned above is the relatively low response rate among parents (34.8%). The
212 analysis was performed with SAS 9.1.3 (SAS Institute INC., Cary, NC, USA).
213
214 **3. RESULTS**
215 **3.1 Baseline measurements**
216 Familiarity was calculated as the percentage of children answering the question "I know this vegetable and
217 I've tasted it" (score 3), while frequency of consumption was measured as the sum of the percentage of
218 children answering the question "A few times a week" and "Every day" (scores 4 and 5, respectively).

Average familiarity, liking scores and frequency of consumption of each snack vegetable are presented in **Table 5**.

Mean liking scores ranged from 6.5 to 4.3. All the stimuli were evaluated as familiar by more than 50% of the children, whereas the number of participants with a weekly/daily frequency of consumption largely varied (from 86.6 % to 11.8%). Familiarity data perfectly reflected liking scores. The most preferred products, apple and carrot, were familiar for more than 95% of participants; liking of almond and plum decreased gradually with the decreasing of their familiarity and frequency of consumption. Finally, cranberry and white cabbage were the least liked stimuli, although they received a somewhat high liking score; they were known by participants but the weekly/daily consumption was very low.

3.2 Intake measurements

Intake data of each type of serving are shown in **Figure 1.** To standardize the data across different weights of food items and energy densities, the data are expressed as a percentage; the consumed amount in grams divided by the served amount in grams converted to percentage**.** A significant effect ($df=2$, $F=3.85$; $p<0.05$) of the interaction between sets of variety and variety levels on intake was found. In the CV set, intake values were significantly higher for the low level (containing apple and carrot) (M_{CVlow}=59 %), followed by high and medium levels (M_{CVmed}=48.5 % g; M_{CVhigh}=51.2 %) which were in turn comparable. No differences in intake were found in the PV set among levels of variety. Furthermore, comparing the low level of the two sets of variety, which contained the same stimuli (i.e., apple and carrot) cut in different ways (apple chunks and carrot chunks; apple slices and carrot sticks), intake value was higher in the CV than in the PV.

Based on analysis of parental questionnaires (n=46), serving intake was influenced by the availability of preparation ($df=1$, $F=7.82$, $p<0.05$). Half of the parents declared that sometimes their child prepares his/her own snack vegetables, while the other half usually prepared the snack vegetables for their child. In all the CV set levels (low, medium and high), the intake was higher for the children that are sometimes involved in their snack preparation than those that are not. On the contrary, for the PV levels an opposite trend was observed, showing a higher intake of servings for children that don't participate in snack preparation, except for high level.

247 Intake data for each individual type of stimuli in the servings are illustrated in **Figure 2**. Intake mean of the
248 six servings was 106.3 ± 65 g. ANOVA results showed that apple was the most consumed snack in all the
249 servings ($p<0.001$). In the CV medium set ($p<0.001$) apple intake was followed by carrot stick, whereas
250 cranberry and white cabbage were consumed in low amounts and did not differ from each other. In the high
251 level of CV set, significant differences among the snacks intake were found ($p<0.001$). Carrot stick, plum,
252 almond intake amounts did not differ and they were followed by cranberry and white cabbage. Comparing
253 the PV medium and high levels, no differences among the intake of the snacks presented in different shapes
254 (carrot chunk, stick and slices; apple chunk, slice and triangle) were found in both set levels.
255 Total energy intake consumed of each of the different servings expressed as the percentage over the served
256 kilocalories, is shown in **Figure 3.** A significant effect ($df=2$, $F=14,9$; $p<0.001$) of the interaction between
257 sets of variety and variety levels on energy intake values was found. A lower amount of kilocalories was
258 obtained in the CV set medium and high levels ($M_{CVmed}=34.5$ %; $M_{CVhigh}=37.7$ %) compared to low level
259 ($M_{CVlow}=60.7$ %), while no significant differences were found in the energy intake among the three levels of
260 PV set. Moreover, confirming intake in grams data, energy intake in the CV low level was higher compared
261 to the PV low level.
262
263 **3.3 Overall rated and ranked liking**
264 Children's rated liking (from 1 to 7 points) of the different serving sets are shown in **Figure 4**. A significant
265 effect ($df=2$, $F= 5.9$; $p<0.01$) of the interaction between serving sets and variety levels on rated liking score
266 was found.
267 Although not significant, an increase of liking according to levels of variety was seen for the PV set. Within
268 the CV set, the high level received significantly higher scores ($M_{CVhigh}=5.7$) than the other levels, followed
269 by the low and the medium level ($M_{CVlow}=5.4$; $M_{CVmed}=5.0$). The comparison between CV low and PV low
270 levels (apple slices and carrot sticks; apple chunks and carrot chunks) showed no significant differences in
271 the overall liking scores.
272 Considering questionnaire variables, an effect of child fussiness on rated liking of the six serving sets was
273 found ($df=2$, $F= 3.57$, $p<0.05$). To further interpret the relationship between rated liking and fussiness,
274 children were divided according to their level of fussiness into 3 groups: group 1 (children with scores in the

lower 25th percentile of fussiness scores, score ≤ 1.8, n=12), group 2 (children with scores between the 25th and 75th percentiles, 1.9 ≤ score ≤ 3.3, n=19) and group 3 (children with scores in the upper 25th percentile, score ≥ 3.4, n=15). Across the CV set's three levels (low, medium and high), liking scores significantly decreased with increases in child fussiness; whereas in PV levels the overall liking scores increased with the increasing of level of fussiness.

Ranked liking was measured asking children to rank the 6 serving styles according to their preference. Ranked liking scores (ranked from 1 to 6) of the different servings are presented in **Figure 5**. According to ANOVA results, the interaction between serving sets and variety levels was significant (df=2, F=2.82; $p<0.05$). The high levels of both variety sets were ranked significantly higher than low and medium levels (M_{CVlow}=3.5; M_{CVmed}=3.7; M_{CVhigh}=4.2; M_{PVlow}=2.7; M_{PVmed}=3.1; M_{PVhigh}=4.0) (F=2.82; $p<0.05$). Comparing rated and ranked liking results, both measurements showed an increase of liking from low to medium and high levels, in both serving set. Ranked liking provided a clearer hedonic discrimination than rated liking between variety levels in both serving sets.

The correlation between intake in grams of each serving set and their rated and ranked liking scores was calculated (**Table 6**). With exception of low levels, significant relationships between snack vegetables intake and the corresponding rated liking were found. However, the intake was not correlated with ranked liking.

4. DISCUSSION

This study investigated whether and how different levels of two sets of variety of snack servings influenced 9-11 year old Danish children's intake and liking. The results did not confirm our hypothesis that intake increases according to the level of variety. In the CV set, the highest intake was observed in the serving with lowest variety, and in the PV set intake was consistent across variety levels.

For the CV set, the finding was surprising and may be explained with the baseline liking, familiarity and frequency data. Cranberry and white cabbage, which were included in the less consumed serving sets, were less liked compared to the other stimuli, probably due to the fact that they were less familiar and for their sour and bitter taste, respectively. Apple and carrot liking scores were high, potentially because they were perceived as sweet and among the most familiar items. In children, sweetness and familiarity have been identified as the most important determinants for preferences (Laureati and Pagliarini, 2013). Almonds and plum were liked but less frequently consumed compared to CV low products. Therefore, adding less liked and familiar stimuli (i.e., plum, white cabbage and cranberries) to high and medium serving sets potentially produced a gradual decrease in intake values. This suggests that intake is more affected by acceptability and familiarity for the single stimulus included in the serving snack than by variety as such.

Furthermore, perception of portion size could potentially contribute to the lower intake of the CV set observed with the medium and high level of variety. Wadhera & Capaldi-Phillips (2014) reported that larger portions sizes are visually more appealing and may influence food intake by leading children to take large bites and consume more foods. It is indeed possible that children did not perceive the portions to be of equal size.

Another possible explanation for the lower intake of the medium and high levels of the CV set may be that some of the items in these servings were composed of small pieces (e.g. almonds and cranberries), and this will naturally lower bite size and thus increase oral processing time – two things which, in adults, have been demonstrated to reduce intake (Zijlstra, De Wijk, Mars, Stafleu, & De Graaf, 2009). Thus, the reduced consumption of these servings could be due to difficulties of eating the entire portion in the limited time period of the mid-morning break due to the increased oral processing time.

Finally, children may have adjusted their intake of these servings due to the increased energy density of the servings due to compensation. However, in general, ability to adjust or compensate for varying energy

density is primarily seen in much younger children (Cecil, Palmer, Wrieden, Murrie, Bolton-Smith, Watt, Wallis, & Hetherington, 2005).

The fact that adding more types of food has not effect on intake can be considered a positive finding from a practical point of view since parents do not have to insert several different fruits and vegetables in a meal to increase the child's consumption.

For the PV set, variety induced by using different serving styles of each stimulus within a serving did not influence intake. There is evidence that the more different the sensory properties (taste, smell, color, shape, texture) of the food are, the greater the effect of variety (Rolls, et al., 1981). For the PV set, the properties of the stimuli might not be different enough. Previous research has shown that increasing the number of colors of jelly beans in an organized serving led to greater consumption (Kahn & Wansink, 2004). Based on this finding, changing the appearance of apple and carrot by adding more cuttings of them was thought to have similar effects. This was, however, not the case.

Energy intake of the low level of the CV set and all PV serving sets significantly differed, despite they were composed of the same stimuli in equal amounts. It could be due to the fact that the servings were tested during break time in school classes, a time were children eat more of a food if it is convenient for them to do other things simultaneously (such as playing games and talking to peers). It is indeed easier for a child to hold a couple of big chunks of apple or carrot in the hand, as served in the PV low set, rather than the smaller pieces used in the PV low.

Based on the results of intake in grams, the children consumed an average intake of approximately 100 grams. Information about daily consumption of fruits and vegetables during the intake measurement days were not obtained in the current study, and it is therefore not clear whether the offered mid-morning snack substituted the daily fruit and vegetable consumption or not. However, an average intake of about 100 grams of the stimuli sets is equal to half the amount that Danish children normally eat in one day (Yngve et al., 2005), and corresponds to about 20% of the recommended daily intake (Pedersen et al., 2010). In Danish children, about 4% of vegetables and 9-10% of fruits eaten in one day are consumed as a mid-morning snack, whereas the majority of vegetables are consumed at lunch and dinner, whereas fruits are mainly eaten as an afternoon snack (Hoppe et al., 2009). If 100 grams of fruits and vegetable are already eaten in the mid-morning, it should be manageable to consume the recommended amount of fruits and vegetables.

As for the intake data, rated liking affected intake within the CV but not the PV serving set. Rated liking of CV medium set was significantly lower than the other variety levels. This difference might be explained by the low liking obtained at the baseline for white cabbage and cranberry, which were added to CV medium set to enhance variety. For PVs liking scores, the three levels did not differ significantly. Thus, we can assume that stimuli shapes were not influential enough to make a change in children preference. A previous study has demonstrated that more advanced cuttings were preferred over simple cuttings (Olsen, Ritz, Kramer, & Møller, 2012a), which was also confirmed in the pilot study of the present work. It is possible that, in the present study, more advanced cuttings, e.g. stars or dinosaurs, would have led to higher intakes and liking.

The same trend of rated liking was observed for ranked liking in CVs, whereas within PVs the differences between variety levels were more pronounced than that measured with the rating scale. However, correlation analysis between intake and liking data showed that only rated liking correlated with children's consumption of the snack servings. Often the terms "preference" and "liking" are used interchangeably, and preference is frequently misused as a synonym for liking. However, preference indicates that among two or more products, one product is preferred over another, whereas liking refers to an immediate qualitative, hedonic evaluation of a product without a direct comparison with other products (Mela, 2001).

Despite a correlation between ranking and rating has been clearly demonstrated in child studies (Liem & Zandstra, 2009; Olsen, Kildegaard, Gabrielsen, Thybo, & Møller, 2012) the two methods evaluate two different things, preference and liking, respectively. The ranking test provides information on which of the products the children prefer least and most as a ranking test forces children to make a rank order of the products. A test of children's preferences does not necessarily provide information about whether children actually like the products. In contrast, the rating method gives children the possibility to state the degree of how much they like the products. It is essential to be aware of this difference (Kildegaard et al., 2011).

Other variables that can have an impact on intake and liking of fruits and vegetables were investigated in the present study. Children's intake of the snack servings was influenced by the person who prepared it (e.g. parent or child) (Hearn, Baranowski, Baranowski, Doyle, Smith, Lin, & Resnicow, 1998). As earlier mentioned, since children come to like what become familiar to them, involving children in the preparation of their foods could be a good method to increase the consumption.

A negative relationship between fussiness, measured through CEBQ, and liking for the CV set was found. Fussiness describes the unwillingness to eat many kind of foods (Dovey, Staples, Gibson, & Halford, 2008; Galloway, Lee, & Birch 2003). Our result is consistent with data from several previous works that showed the inverse relation between children food neophobia and liking or consumption of new and disliked product, such as fruits and vegetables (Carruth, Skinner, Houck, Moran, Coletta, & Ott,1998; Koivisto, Hursti, & Sjöden, 1997; Laureati, Bergamaschi, & Pagliarini, 2014; Laureati, Bergamaschi, & Pagliarini, 2015). For PV set an unexpected positive relation between liking scores and level of fussiness was shown. It could be due to the stimuli used for the three PV set levels, apple and carrot, as they are both very familiar to children, so they are liked even among fussy children (Laureati, Bertoli, Bergamaschi, Lewandowsky, Giussani, Battezzati, & Pagliarini, 2015).

In conclusion, the hypothesis that CV sets would be consumed in greater amounts than PV sets due to the greater sensory variability of the products was not confirmed. Our study indicates that adding more foods to a serving in a meal can decrease the consumption and that adding different cuttings of the same foods doesn't influence children's intake. Results also suggest that consumption is more affected by acceptability and familiarity for the stimuli than by variety.

Exposing children at school during mid-morning break to a variety of snacks consisting of fruits, nuts and vegetables may be a good method to increase children's familiarity, liking and thus intake of these foods.

This study shows that variety in a meal may influence food consumption in school-aged children and it is worth considering to promote healthy eating.

One of the strengths of the present paper is that it is an ecological study conducted in an actual mealtime situation. The school as a naturalistic environment is an important point to consider when studying factors linked to food behavior, especially with children. The present study had some limitations. The study participants all attended the same school placed in Copenhagen, and this population might not give an adequate representation of Danish children. The stimuli used were not the same across the CV. To establish whether the modification of energy intake was due to variety and not other influencing factors, research in a more controlled environment might be needed. Also, the stimuli used might have to be more similar with regard to sensory attributes such as texture, appearance, bite size, oral processing time, energy density, and liking level among. It is however uncertain how similar the stimuli can be and still produce an effect of

403 variety. It should further be investigated how many foods should be added to a serving to see an effect of
404 variety on intake and liking.
405
406 ***Contribution to the paper***
407 The author's responsibilities were as follows: A. O., V. B. and W. B. designed the study,
408 V.B., A.O. and S. Z. conducted research, V. B. and M. L. analyzed data, all the authors interpreted the data,
409 V. B. wrote the paper, and V. B. and A.O. had primary responsibility for the final content. All authors
410 revised the manuscript, read and approved the final version.
411
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415 *Diet'*. The authors report no conflicts of interest.
416
417

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536

537 **Table 1.** Participants' description.

Characteristics	Number or mean ± SEM
Children	132
Gender distribution	69 boys, 63 girls
Age (years)	9.60 ± 0.05
Class	59 3rd grade, 73 4th grade
BMI (kg/m^2)	17.2 ± 0.2
BMI z-score[1]	0.39 ± 0.08

[1]The WHO2007 data are used as reference population (De Onis, Onyango, Borghi, Siyam, Nishida, Siekmann, 2007)

538

539 **Table 2.** Familiarity degree (score 3), average liking scores (range 1-7, means ± SEM), and frequency of

540 consumption degree (scores 4 and 5), of the pilot study products.

Products	Familiarity %	Liking score[1]	Frequency %
Pear	83.3	6.6^{a} ± 0.3	55.6
Red apple	94.4	6.3^{a}± 0.4	83.3
Cranberry	44.4	5.1^{b}± 0.4	22.2
Almond	83.3	5.6^{b}± 0.4	50.0
Parsley root	16.7	3.6^{d} ± 0.4	0.0
Beetroot	22.2	3.8^{d}± 0.4	5.6
White cabbage	61.1	5.2^{b}± 0.4	27.8
Plum	94.4	6.4^{a}± 0.3	55.6
Green apple	88.9	6.4^{a}± 0.2	72.2
Red currant	50.0	4.9^{bc}± 0.4	0.0
Hazelnut	66.7	4.6^{c}± 0.5	11.1
Parsnip	22.2	4.2^{c}± 0.4	11.1
Carrot	94.4	6.3^{a}± 0.2	100.0
Kohlrabi	16.7	4.1^{c}± 0.5	5.6
Brussel sprout	44.4	4.3^{c}± 0.5	5.6

[1] Average liking scores with different letters are significantly different ($p<0.05$).

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542

543 **Table 3.** Serving sets stimuli presentation, ('Classical Variety', CV and 'Perceived Variety', PV) and their
544 variety levels (*l*ow, medium and high).

	'Classical Variety' (CV) (number of different food varies)	'Perceived Variety' (PV) (serving style varies)
Low **(2 items)**	green apple (slices) 100g – carrot (sticks) 100g	green apple (chunks) 100g – carrot (chunks) 100g
Medium **(4 items)**	green apple (slices) 50g – carrot (sticks) 50g dried cranberry (whole) 50g – white cabbage (pieces) 50g	green apple (chunks) 50g – carrot (chunks) 50g green apple (slices) 50g – carrot (sticks) 50g
High **(6 items)**	green apple (slices) 33g – carrot (sticks) 33g dried cranberry (whole) 33g – white cabbage (pieces) 33g plum (slices) 33g – almond (whole) 33g	green apple (chunks) 33g – carrot (chunks) 33g green apple (slices) 33g – carrot (sticks) 33g green apple (triangles) 33g – carrot (slices) 33g

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548 **Table 4.** Overview of the main study experimental design.

Baseline measurements	2 days	Measurement of familiarity, liking and frequency of consumption for each presented snack vegetable
Intake measurement	3 weeks (2 sessions per week)	Presentation of the six serving styles to each class. Measurement of each serving styles intake.
Overall rated and ranked liking measurements	1 days	Measurement of overall liking and overall ranking of liking for the six serving styles served
Anthropometrics measures	1 day	Measurement of height and weight
Parent questionnaire	2 weeks	Delivery and collection of the parent questionnaire to each child involved

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550

551 **Table 5.** Average familiarity (score 3), liking scores (range 1-7) ± SEM, and frequency of consumption

552 (scores 4 and 5) of the main study products (n=135).

Stimuli	Familiarity %	Liking score[1]	Frequency %
Apple	98.3	$6.5^{a} \pm 0.1$	86.6
Carrot	97.5	$6.2^{ab} \pm 0.1$	89.1
Almond	94.8	$5.9^{b} \pm 0.1$	63.0
Plum	90.9	$5.9^{b} \pm 0.1$	52.1
Cranberry	64.0	$5.0^{c} \pm 0.1$	18.5
White cabbage	54.2	$4.3^{d} \pm 0.1$	11.8

[1]Average liking scores with different letters are significantly different ($p<0.05$).

553

554 **Table 6.** Correlation coefficients and their p values between intake of serving sets (CV and PV) and levels

555 (low, med, high) and corresponding rated and ranked liking scores.

Serving sets		Rated liking		Ranked liking	
		r	p value	r	p value
CV set	low	0.14	0.12	0.07	0.44
	med	0.32	<0.001	0.16	0.08
	high	0.29	<0.001	0.20	0.06
PV set	low	0.12	0.16	-0.02	0.84
	med	0.23	0.01	-0.17	0.06
	high	0.22	0.01	0.08	0.36

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Figure 1. Mean intake values (± SEM) of Classical Variety (CV) and Perceived Variety (PV), and their variety levels (low, medium, high); (different letters denote significant differences between and within the different variety condition).

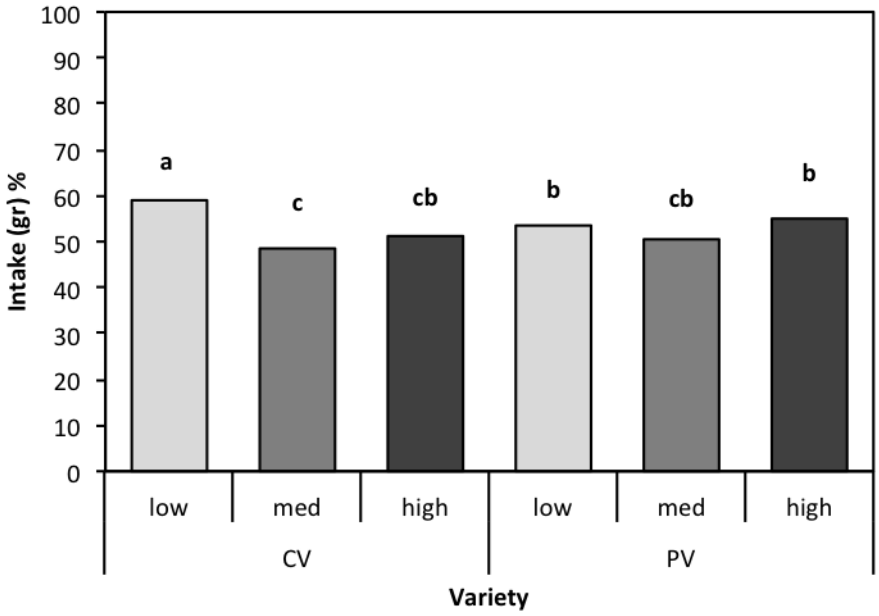


Figure 2. Intake of single snack item composed Classical Variety (CV) and Perceived Variety (PV)

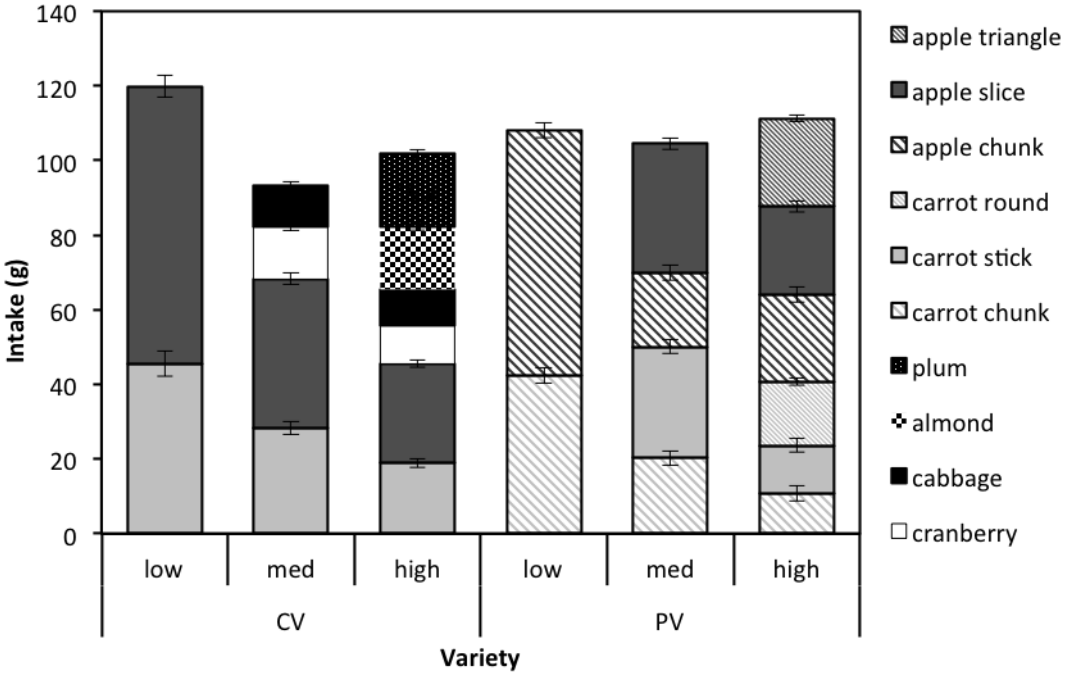


Figure 3. Energy intake (kcal) ± SEM of snack vegetables composing serving sets, Classical Variety (CV) and Perceived Variety (PV), and their variety levels, *low*, *med*, *high;* (different letters denote significant differences between and within the different variety condition).

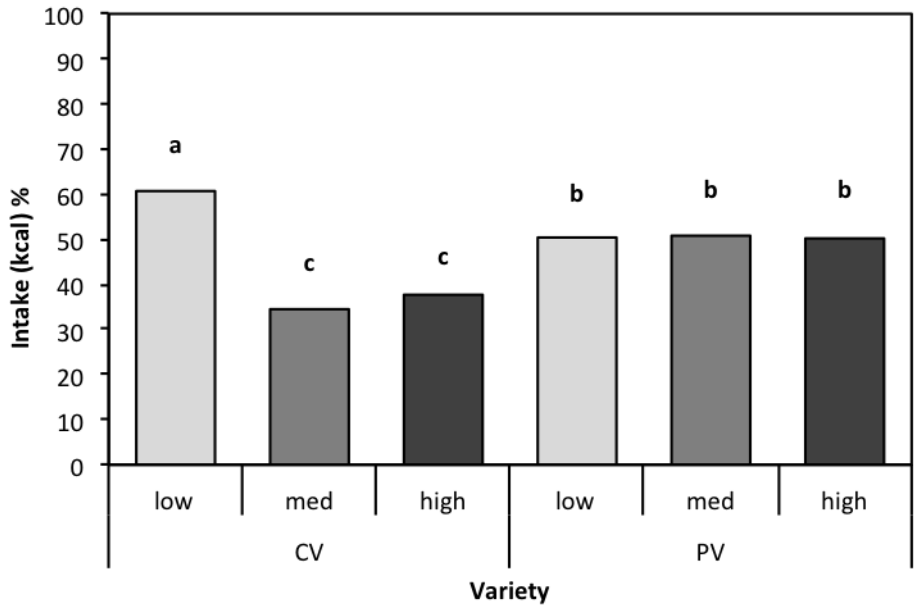
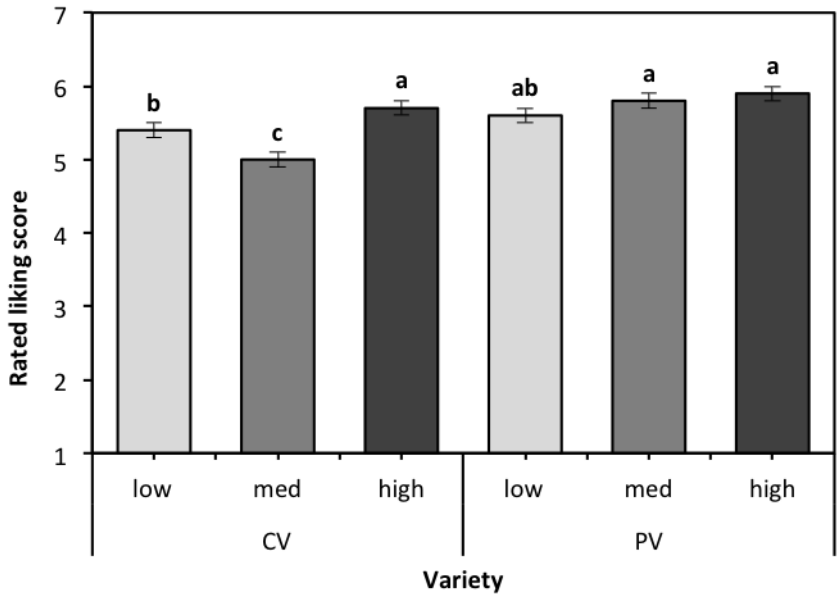
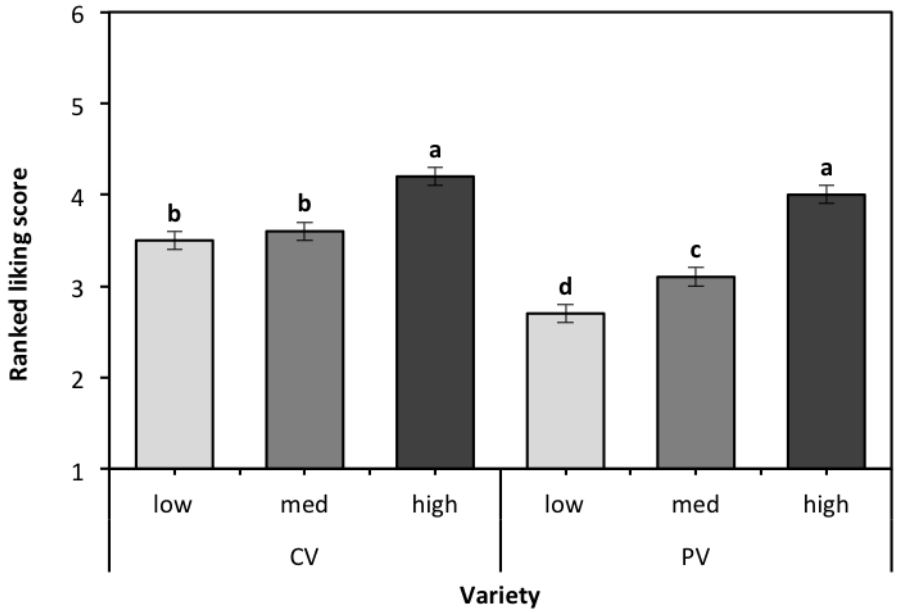


Figure 4. Mean rated liking (degree of liking from 1 to 7 point scale) scores (range 1-7) for Classical Variety (CV) and Perceived Variety (PV), and their variety levels (low, medium, high); (different letters denote significant differences between and within the different variety condition).



575 **Figure 5.** Ranked liking (categorization from most to less preferred) scores for Classical variety (CV) and
576 Perceived variety (PV), and their variety levels (*low, med, high*); (different letters denote significant
577 differences between and within the different variety condition).



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