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THE EFFECTS OF VARIETY ON THE FRUIT AND VEGETABLE INTAKE
OF PRE-SCHOOL AGED CHILDREN AT SNACK TIME

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ABSTRACT

Background: Preschool children's intake of fruits and vegetables is less than the recommended amounts. This study examines the effectiveness of strategically using variety to improve fruit and vegetable consumption in preschool children. As one of the first studies testing the effects of variety on children, it provides useful insight into whether providing children with a variety of fruit and vegetable options is an effective strategy to increase their intake of these foods.

Objectives: This study examined whether increasing the variety of fruit and vegetables served simultaneously before a meal 1) increases fruit and vegetable selection 2) increases fruit and vegetable consumption

Design: In this crossover study, 3-to-5-y-old children (n=61) were served an afternoon snack 2d/week for 4 weeks. At each snack period, the children were either served uniform-sized vegetable (cucumber, tomato, pepper or all 3 types) or fruit (apple, peach, pineapple) pieces. The children served themselves family-style and were able to take and eat as much as they wanted.

Results: Both fruit and vegetable selection ($P<0.0001$) and intake ($P<0.002$) increased when the children were offered a variety as opposed to only one fruit or vegetable option. Children chose some pieces at 94% of snacks with variety at 70% of snacks without variety. Offering a variety significantly increased intake by 31 ± 5 g ($P<0.0002$) and represented one sixth of the recommended daily amount.

Conclusion: These findings suggest that increasing the variety of fruit and vegetables served at snack is an effective strategy to increase fruit and vegetable consumption in preschool children and thereby improve their intake of low-energy dense foods.

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INTRODUCTION

With approximately 17%, or 12.5 million American children and adolescents aged 2-19 years obese (1) and the prevalence continuing to rise, it has become crucial to develop effective and practical nutritional strategies to improve the diet quality of children. Nationally-representative data suggest that children as young as 2 years old are consuming more than their energy requirements (2). Excessive energy intake in children often reflects poor diet quality, particularly with a high proportion of energy-dense foods but few nutrient-rich foods of lower energy density, such as fruits and vegetables. In order to improve the diet quality of children, it is important to identify effective strategies to improve their consumption of fruits and vegetables.

Fruits and vegetables contain a number of essential vitamins, minerals and dietary fiber important for a well-balanced diet and optimal health. Naturally low in calories, these nutrient-dense foods provide vitamins, minerals, and other substances that positively influence health without contributing a lot of additional calories. Thus, substituting fruits and vegetables for high-energy-dense foods may play an important role in weight management. In addition, increased intake of fruits and vegetables is associated with reduced risk of many chronic diseases including: type 2 diabetes, hypertension, and certain cancers (3). Inadequate fruit and vegetable consumption is associated with deficiencies in essential nutrients and phytochemicals and likely increases children's risk for multiple chronic diseases, including obesity.

Despite substantial evidence exhibiting the importance of adequate fruit and vegetable intake, children's intakes fail to meet national recommendations. Fruit and vegetable intakes in children as young as 2 years old are well below recommended levels (4-8). In fact, intake data from the 1999-2002 National Health and Nutrition Examination Survey suggests that on any given day, 78% of 2-to-5-year-old children do not meet recommendations for vegetable intake,

and 50% do not meet recommendations for fruit, and these percentages may be even lower if fruit juice and fried vegetables are excluded. A study conducted by Lorson and colleagues found that children's combined daily intake of fruits, vegetables, and juice averaged about 2 cups with French fries accounting for about one-quarter of children's vegetable intake and juice accounting for 40% of their daily fruit intake (9). Similarly, Nestle Nutrition conducted a Feeding Infant and Toddlers Study (FITS) to assess the nutrient intakes and eating patterns of children up to 4 years of age. The results of their cross-sectional study indicated that more than 25% of older infants, toddlers, and preschool children do not eat a single serving of fruit on a given day, and 30% do not eat a single serving of vegetables. In addition, FITS found that the main vegetable and fruit sources were French fries and fruit juice, respectively (10). Because of their lack of essential nutrients, fried starchy vegetables and sweetened fruit juices are not optimal fruit and vegetable sources and it is arguable whether they should be included in fruit and vegetable intake data. If the analysis had excluded these foods, the fruit and vegetable intakes would have been significantly lower. Therefore, it is likely that national data overestimates children's intake of the most nutritious fruit and vegetables. These studies demonstrate the need for identifying effective strategies to incorporate more fruits and vegetables in children's diets.

Dietary interventions aimed to encourage fruit and vegetable consumption should target preschool-aged children. Birch's literature review of the development of food acceptance patterns suggests that the establishment of eating patterns begins during the preschool years (11). A second review conducted by Kuhl's on the literature on the behavioral correlates of preschool children's eating habits concluded that food preferences are correlated with food consumption between ages 2 and 3, are established by age 4, and remain stable until at least age 8 (2). The

food environment provided in the preschool years molds children's preferences and food acceptance patterns. In preschool years, children's lifetime attitudes, habits and preferences regarding food begin to take shape (11-13). Because children establish lifelong eating habits in this stage of development, the preschool period is an optimal time to instill wholesome, long-term dietary behaviors in children. Thus, it is important to identify effective ways to promote fruit and vegetable intake in preschool children.

Strategies to increase preschool children's fruit and vegetable intake have been the objective of several recent studies. However, most of these studies have focused on enhancing acceptance for these foods. The results of these studies suggest that learned food preferences, early experiences, repeated exposure, peer and parental modeling, and availability influence children's acceptance for fruit and vegetables (11). While these studies have provided useful insight into the psychological and social factors motivating eating behaviors, it is also important to consider how variations in the way fruits and vegetables are presented may affect actual intake.

Offering a variety of food options is one proven method for increasing intake. A number of studies in animals and humans have explored how dietary variety affects intake. After analyzing observational and experimental results from 42 studies exploring the variety effect, Remick concluded that people eat more both within and across meals if a variety of food is presented (14). For example, a study conducted by Rolls and colleagues served participants either a varied four-course meal or four courses of the same food option. Those participants served the varied four-course meal consumed 44% more food and 60% more energy than those receiving the same food for each course (15). A more recent study conducted in 2007 had similar findings. In the Brondel study, participants offered fries and brownies with condiments,

as opposed to the two foods alone, had increased energy intakes (1195 ± 552 vs. 1485 ± 582 kcal) (16). The results of these studies and studies like them demonstrate that dietary variety increases intake. However, most of the research on variety has been concentrated in adult populations using high-energy-dense foods.

While the positive correlation between variety and intake can have negative implications if a variety of high-energy-dense foods are provided, desirable results could potentially be achieved if multiple low-energy-dense food options were made available. However, few studies have explored this strategy. Whether the age of the participants, or the energy density and palatability of the available foods influence the positive correlation between variety and intake is unclear (17).

Temple's study on how dietary variety impairs habituation in children is one of the first to explore the variety effect not only with low-energy dense foods but also with a younger population. While the study primarily focused on the psychological impact of variety on rate of habituation, it also investigated whether dietary variety increased children's energy intake. Conducted in 2008, the study explored the effects of offering a variety of low-energy-dense foods to 35 children aged 8-12. Participants chose their favorite high-energy-dense food or low-energy-dense food from the list of foods available in the study. The low-energy-dense foods were four fruits, one vegetable, and two dairy products. In the food trials, participants were either served their favorite food repeatedly or a variety of all the foods. Participants in the variety groups consumed 32% more weight of food than participants in the same-food groups, regardless of the energy density of the foods (18). This finding demonstrates that variety had equally positive effects on intake with high and low-energy dense foods. These results are

important because they suggest that responding to variety is not dependent on energy density. In addition, this study offers the only evidence that the variety effect may apply to children.

One proposed explanation for the corresponding increase in intake seen with the addition of variety is a phenomenon known as sensory-specific satiety (SSS). Sensory-specific satiety refers to the difference between the change in perceived pleasantness of food that has just been eaten compared to the change in foods that were tasted but not eaten (19). SSS is a biologically driven tendency to seek out variety. Originally modeled in animals, a number of studies with a broad array of subjects ranging from rodents to humans have indicated that there is a general decline in hedonics for consumed food compared to uneaten foods. In other words, palatability for food decreases as it is consumed and therefore the preference for that particular food in relation to other foods declines (20). There are a number of studies that demonstrate this effect. One study demonstrating the effects of SSS is Rolls' study using chocolate candies. Using different colored chocolate candies, the study examined subjects' hedonic ratings of foods before and after consumption. After eating chocolates of one color, participants rated the pleasantness of the taste of the eaten colored candy as well as the other colors. The subjective liking of the eaten color candy declined more so than that of the non-eaten colors of chocolates (21). This change in hedonic response to the candy eaten is what is referred to as SSS. The results of this study illustrate the general findings on sensory-specific satiety, that is that the satisfaction animals experience from eating a certain type of food seems to decline, resulting in a consequential renewed appetite for a new flavor or food. Increasing variety of food options diminishes SSS and encourages people to increase intake. To benefit from this natural tendency to seek out variety, interventions should focus on increasing the variety of low-energy-dense foods available while limiting access to high-energy-dense foods. Furthermore, the effects of

SSS were found to occur within minutes of eating the food and are most pronounced in adolescents (22). Thus, the property of SSS can be used advantageously in intervention strategies to promote fruit and vegetable consumption in children.

It is important to have a sound understanding of how energy density, food variety, and SSS interact when developing strategies to modify children's eating behavior to enhance their fruit and vegetable intake. While the positive effects of variety have been well-documented in adult populations with high-energy-dense foods, the variety effect has not been well investigated with different foods, particularly fruits and vegetables, or younger populations, specifically preschool children. The current study examined how offering a variety of low-energy-dense fruits and vegetables in an afternoon snack affects preschool children's selection and intake of these foods. It was hypothesized that increasing the variety of vegetable and fruit options would 1) increase vegetable and fruit selection and 2) increase vegetable and fruit intake.

METHODS

Experimental design

Conducted between February and April 2011, the experiment used a crossover design with repeated measures within subjects to test whether offering a variety of vegetables and fruits to preschool children impacted selection and intake. On two days a week for four weeks, subjects were given a snack in their classrooms at the childcare facility. The 61 enrolled preschool children were either offered fruit or vegetables pieces as their afternoon snack on 8 separate occasions across the 4-week span. Vegetables were served at four of the snacks. The vegetable provided was varied across occasions; in three of the conditions a single type of vegetable (cucumber, yellow pepper, or tomato) was offered and in one condition a variety of all three vegetables was offered. On the other four snack occasions, fruit was served in a similar manner; three times a single fruit was offered (apple, peach or pineapple) and one time a variety of all three fruits was offered. At each table in the classroom, there were three serving bowls with 300g (approximately 30 pieces) of the fruits or vegetables offered that particular day. Maintaining a consistent weight ensured that regardless of the snack option provided, the total weight of fruit or vegetables offered remained the same across conditions. Children served themselves from these serving bowls and were able to select and eat as many pieces as they wanted. The participants were from 4 different preschool classrooms at the daycare center. Each classroom of participants was presented the 8 snack conditions in different orders. By presenting the eight conditions in a counterbalanced order across subjects, the order effects in pooling all the subjects' data balanced out.

The research project was led by two honors students, Erin Iiams and myself. However, we each had our own roles in the project. We had separate classrooms for which we were expected to recruit participants, prepare the snack foods, orient the research assistants, ensure the proper procedures were followed, collect and analyze the data. In addition, we were both individually responsible for organizing and writing research papers.

Participants

Preschool children from the Bennett Family Center at the University Park campus of The Pennsylvania State University were recruited through letters addressed to their parents. Letters were distributed to parents with children aged 3-5 years who were enrolled in daycare at the Bennett Family Center. If children were allergic to any of the foods being served at snack, they were not considered eligible and thus were excluded from the study. Other than allergies, no exclusions were made and after parents or guardians provided informed written consent, children were enrolled in the fruit and vegetable study. Participants in each of the four daycare classrooms were assigned a subject letter for identification. Prior to the start of the study, the subjects were briefed on how snack time would slightly differ from their usual routine in basic terms. The Pennsylvania State University Office for Research Protections reviewed and approved all procedures.

The study included 61 children aged 3 to 5 years, whose characteristics are shown in Table 1 on the following page. Body weight and height measurements for 56 of the children were taken. Using the children's height and weight measurements, their sex-specific BMI-for age percentiles were calculated with a software program from the CDC (23). The girl participants (n=32) had a mean age of 4.2 ± 0.7 y and a mean sex-specific BMI-for age percentile of 52.7 ± 25.9 . In

contrast, the boy participants (n=29) had a mean age of 4.6 ± 0.7 y and a mean sex-specific BMI-for-age percentile of 58.5 ± 23.6 . Of the 56 children, 7 (13%) of the children had a sex-specific BMI-for-age percentile above the 85th percentile for national data and thus classified as overweight or obese (CDC 2011). The mean age, height, and weight were significantly higher for boys than girls ($P < 0.03$); otherwise, the BMI percentiles did not differ significantly between girl and boy participants. The children were ethnically diverse: 56% were white, 29% Asian, 11% black or African American, and 4% Pacific Islander.

In order to improve participation rates, no demographic information was collected from parents and guardians. However, results of a recently published research study conducted at the same childcare facility indicate that most parents and guardians using the Bennett Family Center have a college degree and household income above the national average (24).¹

Table 1

Characteristics of preschool children in a study that tested the effect of serving a variety of types of vegetables and fruits on intake at an afternoon snack

Characteristic	Girls (n = 32)		Boys (n = 29)	
	Mean \pm SD	Range	Mean \pm SD	Range
Age (y)	4.2 ± 0.7	3.1 - 5.4	$4.6 \pm 0.7^*$	3.1 - 5.6
Weight (kg)	17.2 ± 2.2	12.0 - 21.7	$18.9 \pm 2.4^*$	15.1 - 28.5
Height (cm)	105.0 ± 6.1	93.5 - 118.2	$108.5 \pm 5.0^*$	98.0 - 124.1
Sex-specific BMI-for-age percentile ¹	52.7 ± 25.9	2.4 - 91.5	58.5 ± 23.6	11.0 - 94.8

* Mean for boys is significantly different from mean for girls according to an unpaired *t*-test ($P < 0.03$)

¹ Calculated from sex, age, height, and weight using a software program based on nationally representative data from the year 2000 (CDC 2011).

Table 2

Characteristics of vegetables and fruits served to preschool children in a study that tested the effect of serving a variety of types at an afternoon snack

Food	Preparation	Composition per 100 g ¹				
		Energy (kcal)	Carbo-hydrate (g)	Sugar (g)	Fiber (g)	Water (g)
Vegetables						
Cucumber	Raw slices, with half the peel removed in strips	14	2.9	1.5	0.6	96.0
Yellow pepper	Raw chunks	27	6.3	4.2 ²	0.9	92.0
Tomato	Raw whole grape-type	18	3.9	2.6	1.2	94.5
Fruits						
Apple	Raw unpeeled chunks	52	13.8	10.4	2.4	85.6
Peach	Slices canned in juice, drained and cut in chunks	61	15.7	10.6	0.7	83.4
Pineapple	Rings canned in juice, drained and cut in half	60	15.6	14.3	1.3	83.5

¹ Food composition data from the National Nutrient Database (USDA 2010)

² Value for red pepper; no data is available for yellow pepper

Experimental menu

This study used a design of 8 experimental conditions. The test foods in this experiment were 3 types of vegetables and 3 types of fruits, prepared as shown in Table 2 above. These fruits and vegetables were chosen because they had previously been served at the childcare facility and had contrasting tastes, colors, and textures that allowed the preschool children to not only easily identify the vegetables but also to easily distinguish them from one other. Because fruits and vegetables are innately similar, fruit and vegetable types with sensory properties as different as possible were chosen to minimize sensory specific satiety.

The fruits and vegetables were served in uniform bite-size pieces ranging between 8 to 12 g/piece, with an average weight of 10 g/piece. Serving the snacks in bite-sized pieces not only enabled the children to easily serve themselves but also facilitated the observers' ability to assess individual intakes. In terms of volume, 3 to 4 pieces were equivalent to a quarter-cup serving (60 ml), which represents one-sixth of the recommended daily intake of vegetables for most children aged 3 to 5 years (3).

In addition to the fruit and vegetables offered, all children were also provided with a small wedge of pita bread (16 g; 43 kcal) and 250 ml water bottle to provide nutritionally balanced meals in compliance with the Child Nutrition Program (25).

Snack Procedures

Each child was provided with a paper plate and water bottle labeled with their designated subject letter. The water bottle and plate with the small pita bread wedge were set at the children's usual places at the table before the snack began. In addition, each table was provided with 3 serving bowls with a fixed quantity of 300 g (approximately 30 pieces) of fruit/vegetables pieces. In six of the conditions, a single fruit or vegetable option was available. In these single-

type conditions, each of the three bowls at the table contained the same type of fruit or vegetable. In the remaining condition, the three fruit or vegetable options were served side-by-side in separate bowls. Each of the three serving bowls contained a different type of fruit or vegetable in this variety condition. The snack was served in the daycare center at its usual time, between the hours of 2:30 and 4, in each of the 4 classrooms following either a nap or quiet play time. At their scheduled snack time, the children were served the fruits or vegetables family style at their usual tables. Following usual classroom protocol, the snack was served to tables that had 3 to 6 children and 1 adult.

The bowls were passed around the table and the children served themselves using spoons or tongs. They were instructed to select as many pieces as they wanted and place them on their plates using the utensils provided. Children were able to select as many or as few fruit or vegetable pieces as they wanted and were neither required to take nor eat anything. To ensure that the amount of fruits and vegetables available at the table remained relatively consistent, any emptied serving bowl was promptly replaced by another full bowl.

The adult sitting at the table made sure that all children had access to each type of fruit or vegetable. In order to prevent any modeling effects, the adults did not eat at snack time. Before the onset of the study, all of the adult participants were told to avoid commenting on the food or children's eating behaviors. They were instructed to ignore any comments about the food and change the conversation to another topic.

The snack was served in the daycare center at its usual time in each of the 4 classrooms following either a nap or quiet play time. All of the children in the classroom had the same snack; however, the intakes of those not participating in the study were not recorded. At snack

time, the children sat and ate at a table with 2-6 other children and one adult. The children sat in the same groups at the same tables across all snack occasions and were free to leave their table whenever they had decided they had eaten what they wanted.

Assessments

Two research assistants sat in the vicinity of each table and independently observed and recorded the number of fruit or vegetable pieces taken by each child in the study. After the snack session, the observers checked their recordings with each other for accuracy. In the rare occasion that there was a discrepancy between the numbers of fruit or vegetable pieces each observer recorded a child selecting, an average of the two recorded numbers was used in the child's fruit or vegetable selection data for that day.

When children finished eating, dropped food was returned to the correct plate, and these items were cleared. In addition to the number of dropped pieces, the number of uneaten fruit or vegetable pieces on each child's plate was recorded to the nearest half piece. Then, the number of fruit or vegetable pieces consumed by each child was determined by subtracting the number of uneaten and dropped pieces on his/her plate from the total number of pieces originally selected by that child

Total snack time food and beverage intake was determined by weighing back the water bottle as well as the uneaten and dropped vegetables pieces and remaining pita on each child's plate. All uneaten food and beverage items were weighed after the meal using digital scales (models PR5001 and XS4001S; Mettler-Toledo, Inc., Columbus, OH). These weights were used to determine intake of pita bread and water and verify the accuracy of the counts of fruit or vegetable pieces.

Within one week of the completion of all snack sessions, liking and preference rankings were completed by 54 of the 61 enrolled participants. The children's liking and preference rankings for the 6 experimental snack options were assessed at the usual snack time using a procedure developed by Birch (26). Using three cartoon faces, children were instructed to indicate whether they thought a food was "yummy", "okay", or "yucky." The research assistants went through the cartoons with each child to ensure that they understood what each face represented. In addition, they also explained to the children that they did not have to put a food sample on each of the cartoon faces. In other words, each sample's liking rating was independent of the other food samples offered. After these instructions, each child was presented with the six food samples in a randomly assigned order. The child was asked to taste each food and indicate his/her liking for it by placing it on a card with the appropriate cartoon face. After children rated their liking of all six samples, they were then asked to compare them. The children ranked their preference for the foods within each liking category, resulting in a rank of 1 (favorite) to 6 (least favorite). Data was collected for 54 children; no data exists for the remaining 7 subjects enrolled in the study because they were either absent or unwilling to participate.

Within one week of completing the final snack session, the body weights and heights of the participants were also measured using a portable digital scale (Seca Onda model 843; Seca Corp., Hanover, MD) and portable stadiometer respectively (model 214; Seca Corp., Hanover, MD). For the purpose of ascertaining the accuracy of measurements, body weights and heights were each measured twice to the nearest 0.1 kg and 0.1 cm respectively. Using a CDC program based on national data from 2000, sex-specific BMI-for-age percentiles were then calculated for

each child from his/her recorded height, weight, and age (Centers for Disease Control and Prevention 2011).

Data analysis

Measuring Outcomes

The primary outcomes of interest in the study were the total number of fruit or vegetable pieces selected and consumed. Based on the design of the study, selection had a determining effect on intake. If the child never selected any fruit or vegetable pieces from the serving bowls, then clearly he/she could not consume any. Therefore, the first step in determining intake was to assess the binary outcome of whether or not children selected any fruit or vegetable pieces as a snack. However, there were several additional outcome measures that also were of interest including: number of food types selected across all snack sessions, influence of individual characteristics of participants, and the effects of food liking and preference.

Statistical Analysis

Data were analyzed using a non-linear mixed model with repeated measures ((SAS 9.2; SAS Institute Inc., Cary, NC). The fixed factors in the model were the variety condition (single type or a variety of all three types), food group (fruit or vegetable), and snack session. Food preference was also examined. The interactions between these factors were tested for significance before examining their main effects. Differences between the characteristics of male and female participants were examined using unpaired t tests. Results for count outcomes are reported as predicted counts from the non-linear model (mean \pm SEM) and results for binary outcomes are reported as odds ratios with 95% confidence intervals (CI). Results were considered significant at $p < 0.05$ and are reported as mean \pm SEM.

RESULTS

Effects on the likelihood of food selection and consumption

As indicated in Figure 1, the number of children who selected fruit or vegetable pieces in the variety conditions (condition 4 and 8) was significantly higher than in the associated single-type conditions. When a variety of either fruit or vegetable options were available, children were more likely to select some pieces for their snack, rather than not serving themselves any ($P < 0.0001$; Figure 1). As demonstrated in Figure 1, the number of children who selected and ate some snack pieces increased in the variety condition for both fruit and vegetable sessions. Compared to the single-type conditions, the likelihood of selecting some vegetables or fruits improved in the variety snack sessions (odds ratio 7.3; 95% CI 3.3 - 15.9). Data from all of the snack sessions indicates that children selected some pieces at 94% of the variety snacks and 70% of the single-type snacks. The positive effect of variety on selection did not differ significantly between fruits and vegetables.

Although significant differences were not seen with the positive effect of variety based on food group offered, there was a significant difference based on food group in the probability of selecting any pieces independent of the variety effect ($P < 0.0001$). Children were more likely to serve themselves snacks when fruit was offered (odds ratio 4.4; 95% CI 2.8 - 7.1). Children served themselves some pieces at 63% of the vegetable snacks and 88% of the fruit snacks.

Once selected, variety did not have any additional effect on the likelihood that a child would actually eat the selected pieces (odds ratio 1.8; 95% confidence interval 0.8 - 3.9; $p = 0.14$). Children ate some of the selected pieces at 90% of both the variety and single-type snacks. However, children were more likely to eat the fruit pieces they selected than the vegetables (odds

ratio 7.5; 95% confidence interval 3.2 - 17.6; $P < 0.0001$). Children ate some of the selected pieces at 82% of the vegetable snacks and 97% of the fruit snacks. The pooled effect of the probability of selection and of intake was that children ate some pieces at 52% of vegetable snacks and at 85% of fruit snacks.

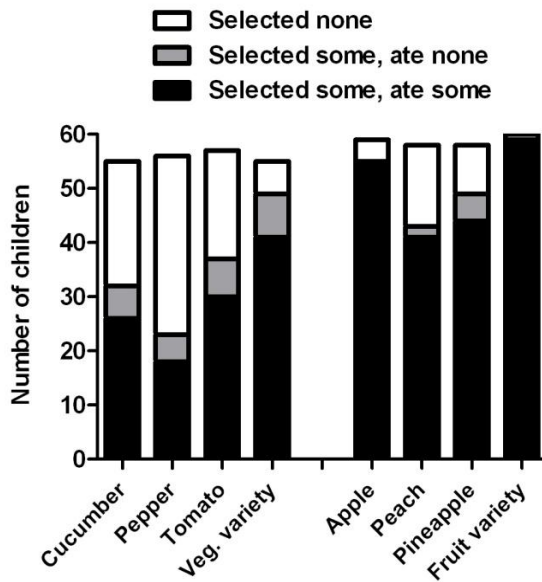


Figure 1. Number of preschool children who did and did not select and eat any pieces of vegetables at a snack, out of a total of 61 children enrolled in the study. On different occasions, the children were offered each of three single types of vegetables and a variety of all three types. Children were more likely to select some vegetables in the two variety conditions than they were in the single-type conditions according to repeated measures logistic regression ($P < 0.0001$). Means are reported for both sexes combined because there were no differences in vegetable intake between sexes across all conditions.

Effects on the amount of food selected and consumed

The number of pieces selected and eaten increased in the variety conditions, compared to the single-type snack sessions. Variety had a positive effect on the total number of fruit and vegetables pieces children selected ($P < 0.0001$; Table 3) and consumed ($P = 0.0002$; Figure 2) with no significant differences seen between food groups. The children ate an average of 7.7 ± 0.5 pieces in the variety conditions compared to 4.6 ± 0.2 pieces in single-type. Thus, intake increased by an average of 3.1 pieces (67%) when a variety of options was offered. With each fruit or vegetable piece averaging about 10g, this increase correlated to about 31 g or one-quarter cup (60 mL). Based on the current $1 \frac{1}{2}$ c recommendation for both fruit and vegetables, the one-quarter cup increase in intake seen with the variety condition is equivalent to one-sixth of the recommended daily intake for preschool children

As indicated in Table 3, selection and consumption differed between fruits and vegetables after accounting for the variety effect (both effects $P < 0.0001$; Table 3). Across all the snack sessions, children ate more fruit pieces (8.4 ± 0.3) than vegetable pieces (2.2 ± 0.1).

In the variety conditions, there were more pieces selected but not eaten than in the single-option conditions. Children selected more pieces but also left more pieces on their plates ($P < 0.0001$). Children left a mean of 1.84 ± 0.1 pieces in the variety conditions and 0.57 ± 0.02 pieces in the single-type conditions, a difference of 1.27 pieces or approximately 13 g.

Variety and food group did not significantly impact bread intake (both $P > 0.32$; data not shown). Because pita bread intake remained consistent across all conditions, energy intake during snack sessions depended solely on intake of fruit and vegetable pieces. Energy intake was greatest in the fruit variety conditions. Variety ($P = 0.0004$) and food group ($P < 0.0001$) independently affected overall intake. Children consumed a mean of 40 ± 3.0 kcal at the single-

type snacks and 54 ± 4.5 kcal at the variety snacks, and a mean of 24 ± 2.2 kcal at the vegetable snacks.

The effects of variety and food group on the probability and amount of fruit or vegetable intake were not influenced by personal characteristics of the participants including: age, sex, and sex-specific BMI-for-age percentile ($P > 0.20$). However, overall older children ate less fruit and vegetables in all snack conditions ($P = 0.01$).

Table 3

Number of pieces of vegetables and fruits selected and eaten by 61 preschool children in a study that tested the effect of serving a variety of types on intake at an afternoon snack.

	Number of children at snack	Number of pieces selected ¹			Number of pieces eaten ¹		
		Mean \pm SEM ²	Median	Range	Mean \pm SEM ²	Median	Range
Fruit condition							
Apple	55	7.3 \pm 0.4*	6	0 – 26	6.1 \pm 0.4*	6	0 - 26
Peach	56	9.0 \pm 0.5*	5.5	0 – 45	8.5 \pm 0.5	5	0 - 43
Pineapple	57	8.0 \pm 0.4*	6.5	0 – 51	7.5 \pm 0.5*	6	0 - 45
Fruit variety (all 3 types)	55	14.1 \pm 0.8	12	0 – 46	11.4 \pm 0.7	9	0 - 45
Vegetable condition							
Cucumber	59	1.6 \pm 0.1*	1	0 – 7	1.1 \pm 0.1*	0	0 - 7
Yellow pepper	58	1.7 \pm 0.1*	0	0 – 11	1.3 \pm 0.1*	0	0 - 10
Tomato	58	3.2 \pm 0.2	1	0 – 45	2.6 \pm 0.2	1	0 - 40
Vegetable variety (all 3 types)	60	5.4 \pm 0.3	4	0 – 26	3.6 \pm 0.2	2	0 - 26

¹The mean weight per piece was 10 g.

²Mean values are estimated from a nonlinear mixed model because the count data was zero-inflated and overdispersed. The model estimated the likelihood of a zero count using binary logistic regression and then estimated the non-zero counts using a regression model with a negative binomial distribution.

* The mean in the single-type condition differed significantly from the mean in the associated variety condition according to a nonlinear mixed model ($P < 0.05$).

Figure 2

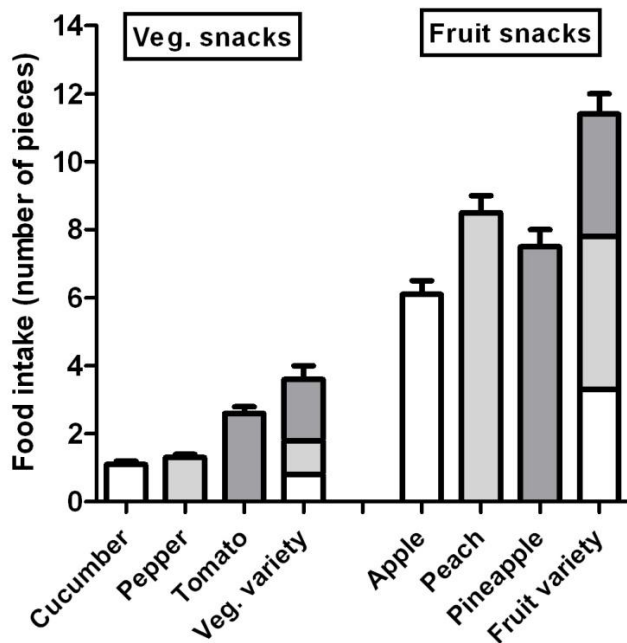


Figure 2. Mean (\pm SEM) number of pieces of vegetables consumed by 61 preschool children in a study that tested the effect of serving a variety of types on intake at an afternoon snack. On different occasions, the children were offered each of three single types of vegetables and a variety of all three types. Means are from a nonlinear mixed model that estimated the likelihood of a zero count using binary logistic regression and then estimated the non-zero counts using a regression model with a negative binomial distribution. Children consumed a greater number of pieces when a variety of types was offered than when a single type was offered ($P = 0.0002$). The mean weight per piece was 10 g.

Effects on the variety of food selected and consumed

When a variety of vegetable options were available, children were neither more nor less likely to incorporate all of the options in their snack. Variety had no significant correlation with the number of different types of vegetables children served themselves ($P = 0.24$ by the Friedman test; Table 4). Of the children who attended all four vegetable snack sessions, most selected a consistent number of types of vegetables regardless of whether it was a single-type or

variety condition. As indicated in Table 4 below, the number of children who selected snacks in each single-type condition did not significantly differ from the number of children who served themselves at least one of each vegetable option in the variety condition. For example, 11 children (26%) selected some vegetables in all three of the single-type conditions and 12 (29%) selected some of all three vegetables in the vegetable variety condition.

However, variety did significantly impact the number of different types of fruits children served themselves. Compared to the three single-type conditions, children selected fewer types of fruits in the variety condition ($P = 0.0007$). Of the children who attended all four fruit snack sessions, 35 (65%) chose some fruit in all three of the single-type conditions while only 22 (41%) selected some of all three fruits in the fruit variety condition.

Table 4

Number of children who selected each possible number of types of vegetables and fruits as a snack (out of three types of each) in a study that tested the effect of serving a variety of types on intake at an afternoon snack

	Number of types selected as a snack				Total
	0	1	2	3	
Vegetable snacks					
Single vegetable (three separate occasions)	7	12	12	11	42
Variety of vegetables (one occasion)	6	8	16	12	42
Fruit snacks					
Single fruit (three separate occasions)	0	7	12	35	54
Variety of fruit (one occasion)	1	17	14	22	54

Data include only children who attended all four fruit snacks or all four vegetable snacks.

Effects of liking and preference of vegetables and fruit

Table 5 shows the fruit and vegetable liking and preferences of the 54 children who completed the ratings. As can be expected, there were significant differences between vegetables and fruits in the number of types that children rated as yucky ($P = 0.0002$ by Bowker's test of symmetry). Children were more likely to rate at least one vegetable as "yucky" than they were for fruit. As shown in Table 5, 29 of the children (54%) rated one or more of the vegetables as yucky, whereas only 7 children (13%) rated one or more of the fruits as yucky. The "yucky" ratings for vegetables had no influence on the positive effect of variety (interaction $P = 0.39$). Even though children disliked some of the vegetable options, they were still likely to select and consume more vegetables when a variety of options were offered. However, pooled data from all vegetable snack conditions shows that if children rated more vegetables as yucky, they ate less vegetable pieces in all the snack sessions ($P < 0.0001$). Because very few children rated any fruits as yucky, the effect of ratings on intake could not be assessed for fruits.

Of the 54 children with preference data, 11 (20%) preferred a vegetable and 43 (80%) preferred a fruit. The most preferred vegetable was the tomato followed by sweet yellow peppers, and cucumbers as shown in Table 5 below. The most preferred fruit was the apple followed by the pineapple and peaches. When comparing the number of preferred food pieces consumed (7.2 ± 1.6 pieces) to the total number consumed in the variety condition (9.7 ± 1.5 pieces), the intake in the variety condition was greater. However, the difference just missed statistical significance ($P = 0.06$).

Food preference influenced likelihood that children would select and consume any pieces at snack. The 11 children who indicated that a vegetable was their favorite food had comparable

likelihoods of selecting (82% of snacks) and consuming (80% of snacks) fruits and vegetables across all conditions. However, the 43 children who preferred a fruit were less likely to choose and eat vegetables than fruits. For example, they selected fruit at 89% of snacks and vegetables at 61%, and ate the fruit at 86% of snacks and vegetables at 45% of snacks.

Table 5

Ratings of liking and preference of vegetables and fruits offered to preschool children in a study that tested the effect of serving a variety of types on intake at an afternoon snack. Ratings were provided by 54 of the 61 children in the study.

Food	Liking rating						Preference ranking					
	Yummy		Okay		Yucky		Rank 1 (most favorite)	Rank 2	Rank 3	Rank 4	Rank 5	Rank 6 (least favorite)
	<i>n</i>	%	<i>N</i>	%	<i>n</i>	%	<i>n</i>	<i>n</i>	<i>n</i>	<i>n</i>	<i>n</i>	<i>n</i>
Fruits												
Apple	47	87%	6	11%	1	2%	13	11	16	4	4	6
Peach	39	72%	10	19%	5	9%	14	12	10	5	8	5
Pineapple	45	83%	7	13%	2	4%	16	12	9	8	5	4
Vegetables												
Cucumber	27	50%	15	28%	12	22%	5	3	5	23	14	4
Yellow pepper	23	43%	7	13%	24	44%	2	8	4	7	12	21
Tomato	29	54%	9	17%	16	30%	4	8	10	7	11	14

Summary of Results

In summary, offering a variety of either fruit or vegetable options had a number of significant results that were neither impacted by what food group was offered nor participants' personal characteristics (age, sex, BMI %). Variety positively related to likelihood of selection, number of pieces selected (10.0 variety condition vs. 5.2 single-type condition), and number of pieces eaten (7.7 variety condition v 4.6 single-type condition). Children were more likely to serve themselves vegetable and fruit pieces when a variety of options was presented to them. However, once selected, variety had no additional effect on the likelihood that children would actually eat the pieces they served themselves. Variety had a positive effect on both the amount of pieces children selected and consumed. Thus, in the variety condition, children not only served themselves more but also ate more fruit and vegetables. Although it just failed to reach significance, the increased intake with variety exceeded that of the preferred item.

Although there are a number of positive results, it also important to account for the undesirable consequences of offering variety. Waste increased in the variety condition. The number of uneaten pieces increased (1.84 in variety condition v 0.57 single-type condition) when the three options were available. In addition, offering a variety reduced the number of different fruits children selected and consumed (no effect on vegetable types).

There were also some interesting findings comparing vegetables and fruits. As one might expect, more children preferred fruits to vegetables and rated at least one vegetable as yucky. If children had more vegetables rated as "yucky", they ate fewer vegetables in all snack sessions. In addition, children whose favorite food was a fruit were more likely to select and consume fruits compared to vegetables. Data from all snack sessions indicated that children selected (9.6

vs. 3.0) and ate(8.4 vs 2.2) a greater number of fruit pieces. However, the number of uneaten fruit pieces also exceeded that of vegetables (1.1 vs. 0.7).

DISCUSSION

The current study showed that presenting children with a variety of fruit and vegetable options could be an effective strategy to increase their intake of these foods and thereby improve the overall quality of their diets. The main findings of the study indicate that serving a variety of fruits and vegetables to preschool-aged children significantly increased both their selection and intake of these foods. Although previous research with high-energy-dense foods in adults has shown similar results (16, 17, 27), this study provides some of the first experimental evidence demonstrating the positive effects of offering a variety of healthy, low-energy-dense foods to children. When preschool children were offered 3 vegetable or fruit options as opposed to just one, they were not only more likely to serve themselves pieces as a snack but also selected and ate significantly greater amounts. Although children preferred fruit to vegetables, the positive effects of variety did not significantly differ between the food groups. Overall intake increased by an average of $\frac{1}{4}$ cup, corresponding to about one-sixth of the recommended daily fruit and vegetable intake for most preschool children. Achieving this increase in intake during a single snack session is significant and points to important practical implications. The recommended daily amount of fruit and vegetables for most preschool-aged children is 1.5 cups (3). Hence, an increased intake of $\frac{1}{4}$ cup may help children achieve this goal. With the majority of children not meeting their fruit and vegetable requirements, this finding suggests that there may be a potentially simple strategy to improve the diet quality of young children. Offering a variety of fruits and vegetables may be an effective and realistic approach to increasing preschool children's consumption of healthy, low-energy-dense foods.

Most of the previous research in preschool children has focused on identifying determinants of intake and effective interventions to increase exposure and liking. Between the ages of 2 and

3, children typically develop a reluctance to try new or unfamiliar foods known as neophobia (8). Using observational designs, previous studies sought to identify effective strategies to eliminate this reluctance and encourage the development of healthier food preferences among children. For example, repeated exposure and observing peers consuming target foods have improved acceptance in children. While this research has provided valuable insight into improving the acceptance of healthier food options, changing the way food is presented may be an easier solution.

Little previous research exists exploring the effects of offering variety in children younger than school age. One of few studies in young children, a study conducted by Gerrish demonstrated how flavor variety enhanced food acceptance in formula-fed infants. The infants' acceptance of novel foods and overall energy intake were positively associated with exposure to a variety of vegetables (28). Exposure to a variety of vegetables increased infants' acceptance of all vegetables as well as novel nonvegetable foods. In 2009, Temple and colleagues found similar results in their study investigating how dietary variety impacted habituation and energy intake in children. Variety significantly increased intake of both high- and low-energy-dense foods in a group of 9-to-12-year-old children (18). The results of the current study support the findings of Gerrish and Temple. Thus, several studies suggest that providing children with a variety of fruit and vegetable options will improve their consumption of these foods.

Other recent studies have focused on strategies that manipulate how fruit and vegetables are presented in order to increase children's intake. Serving larger portions of low-energy-dense foods is one strategy that has been successful. A study conducted by Spill in preschool children found that total vegetable consumption at a meal increased when larger portions were served. However, the effect was limited by the children's food preferences (24). In the present study, the

positive effect of variety on intake just failed to reach significance in increasing intake compared to the children's preferred item. This further validates the importance of children's preferences. With the use of three well-liked fruits or vegetables, offering variety could have significantly greater results. For example, if a child indicated that his 3 favorite vegetables were grape tomatoes, carrots, and celery, offering him all three options during snack rather than one could substantially increase his intake.

Although offering a variety of well-liked fruits or vegetables can have a beneficial effect on children's intake, it should not be the only strategy utilized. While increasing fruit and vegetable intake is the main focus, it is also important that children incorporate a variety of different fruits and vegetables in their diets. Repeated exposure, modeling, and rewards have been shown to improve children's liking for originally disliked foods (29-31). To improve children's acceptance and consumption of a variety of healthy foods, a variety of strategies should be used to ensure that children experience different forms of fruits and vegetables.

As one of the only experimental studies targeted at preschool children, the current study provides insight into factors that influence young children's eating behaviors, specifically the influence of dietary variety and energy density. A major strength of the current study was that it was well-controlled. Each child enrolled in the study was tested in every condition and the order of conditions varied. Portion size was held constant across all conditions and the daycare's usual snack time protocols were followed. Snack was served at its scheduled time in each classroom following either a nap or play time. It is possible that children's appetite varied depending on how active they were that day or whether they were sleeping or playing prior to snack. However, this would likely account for a small differences. A limitation of the current study is that the findings may not be generalizable to all children. Although ethnically diverse, the

children enrolled in the study had parents who were highly educated and had above average incomes. Future research should include children from a more diverse population.

In conclusion, offering a variety of fruit and vegetable options has the potential to have a significant impact on children's fruit and vegetable consumption. The preschool age is an optimal time to implement this strategy because children are establishing life-long eating habits. This study has shown that variety could impact the number of children who meet their fruit and vegetable recommendations. With the majority of children not meeting daily fruit and vegetable requirements, nearly all children can benefit from an increase in fruit and vegetable intake. In conjunction with other techniques like larger portions and repeated exposure to fruit and vegetables, the use of variety is a simple intervention that can easily be employed in both institutions like daycares, schools, hospitals, and homes to improve children's consumption of fruits and vegetables.

REFERENCES

1. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of obesity and trends in body mass index among US children and adolescents, 1999-2010. *JAMA* 2012; 5:307.
2. Kuhl Elizabeth S, Clifford Lisa M, Stark Lori J. Obesity in Preschoolers: Behavioral Correlates and Directions for Treatment. *Obesity* 2012; 20.
3. U.S. Department of Agriculture and U.S. Department of Health and Human Services. Dietary Guidelines for Americans, 2010. 7th edition, Washington, DC: U.S. Government Printing Office, December 2010.
4. Guenther PM, Dodd KW, Reedy J, Krebs-Smith SM. Most Americans eat much less than recommended amounts of fruits and vegetables. *J Am Diet Assoc* 2006; 106: 1371-9.
5. Krebs-Smith SM, Cook A, Subar AF, Cleveland L, Friday J, Kahle LL. Fruit and vegetable intakes of children and adolescents in the United States. *Arch Pediatr Adolesc Med* 1996; 150:81-6.
6. Fox MK, Pac S, Devaney B, Jankowski L. Feeding infants and toddlers study: What foods are infants and toddlers eating? *J Am Diet Assoc* 2004; 104:22-30.
7. Healthy People 2010. Washington DC. US Department of Health and Human Services Web site. <http://www.healthypeople.gov>. Accessed March 2012.
8. Cooke LJ, Wardle J, Gibson EL, Sapochnik M, Sheiham A, Lawson M. Demographic, familial and trait predictors of fruit and vegetable consumption by pre-school children. *Public Health Nutr* 2004; 7:295-302.
9. Lorson Barbara MS RD LD, Melgar-Quinonez Hugo R. Md PhD, Taylor Christopher A PhD RD LD. Correlates of Fruit and Vegetable Intakes in US Children. *J Am Diet Assoc* 2009; 109: 474-78.

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10. Siega-Riz AM, Kinlaw A, Deming DM, Reidy KC. New findings from the Feeding Infants and Toddlers Study 2008. *J Am Dietetic Assoc* 2011; 68:83-100.
 11. Birch LL, Fisher JO. Development of eating behaviors among children and adolescents. *Pediatrics* 1998; 101: 539-49.
 12. Birch LL. Preschool children's food preferences and consumption patterns. *J Nutr Educ* 1979; 11: 189-92.
 13. Galloway MY, Lee Yoona, Birch Leann. Predictors and consequences of food neophobia and pickiness in young girls. *J Am Diet Assoc* 2003; 103: 692-98.
 14. Remick Abigail K, Polivy Janet, Pliner Patricia. Internal and external moderators of the effect of Variety on Food Intake. *Psychological Bulletin* 2009; 235(3): 434-51.
 15. Rolls BJ, Van Duijvenvoorde PM, Rolls ET. Pleasantness changes and food intake in a varied four-course meal. *Appetite* 1984; 5:337-48.
 16. Brondel L, Romer M, Van Wymelbeke V, Pineau N, Jiang T, Hanus C, Rigaud D. Variety enhances food intake in humans: role of sensory-specific satiety. *Physiol Behav.* 2009; 97:44-51.
 17. Raynor Hollie A, Epstein Leonard H. Dietary Variety, Energy Regulation and Obesity. *Psychological Bulletin* 2001; 127(3): 325-341.
 18. Temple Jennifer L, Giacomelli April M, Roemmich James N, Epstein Leonard H. Dietary Variety Impairs Habituation in Children. *Health Psycholog* 2008; 27(1): S10-S19.
 19. Rolls B, Barnett RA. *The volumetrics weight-control plan: feel full on fewer calories.* New York: HarperTorch; 2003.
 20. Rolls B. Sensory-specific Satiety. *Nutrition Reviews* 2009; 44(3): 93-101.

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21. Rolls BJ, Rowe EA, Rolls ET. How sensory properties of food affect human feeding behavior. *Physiol Behav* 1982; 29(3): 409-17.
 22. Hetherington M, Rolls BJ, Bruley VJ. The time course of sensory-specific satiety. *Appetite* 1989; 12:57-68.
 23. Centers for Disease Control and Prevention. A SAS program for the CDC growth charts. Available from: <http://www.cdc.gov/nccdphp/dnpao/growthcharts/resources/sas.htm>. Accessed 22 September 2011.
 24. Spill Maureen K, Birch Leann L, Roe Liane S, Rolls Barbara J. Hiding vegetables to reduce energy density: an effective strategy to increase children's vegetable intake and reduce energy intake. *The American Journal of Clinical Nutrition* 2011; 94(3): 735-741.
 25. US Department of Agriculture. Food and Nutrition Service. Nutrition standards and menu planning approaches for lunches and requirements for afterschool snacks. Available from: <http://www.cfr.vlex.com/vid/menu-approaches-lunches-afterschool-snacks-19903579> (cited 22 March 2012).
 26. Birch LL. Dimensions of preschool-aged children's food preferences. *J Nutr Educ* 1979; 11:77-80.
 27. Epstein Leonard H, Robinson Jodie L, Temple Jennifer L, Roemmich James N, Marusewski Angela L, Nadbrzuch Rachel L. Variety influences habituation of motivated behavior for food and energy intake in children. *American Journal of Clinical Nutrition* 2009; 89: 746-54.
 28. Gerrish
 29. Rasmussen Mette, Krolner Rikke, Klepp Knut-Inge, Lytle Leslie, Brug Johannes, Bere Elling, Due Pernille. Determinants of fruit and vegetable consumption among children

and adolescents: a review of the literature. Part 1: quantitative studies. *International Journal of Behavioral Nutrition and Physical Activity* 2006; 22(3).

30. Cooke, L. The importance of exposure for healthy eating in childhood. *J Human Nutrition and Diet* 2007; 20: 294-301.

31. Anzman-Frasca Stephanie, Savage Jennifer S, Marini Michele E, Fisher Jennifer O, Birch Leann L. Repeated exposure and associative conditioning promote preschool children's liking of vegetables. *Appetite* 2011.

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- Prepared and weighed food for research subjects
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Student Support Services Program

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Carmen's Seafood Restaurant

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Waitress

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- Presented 100-item menu in appealing way that highlighted the nightly specials

- Answered any questions patrons had about menu items
- Coordinated with 3-part kitchen to serve food in timely manner
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Desk Attendant

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- Answered and directed incoming calls
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