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THE EFFECTS OF OFFERING A VARIETY OF FRUITS AND VEGETABLES ON
CHILDREN'S FOOD CONSUMPTION DURING SNACK TIME

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ABSTRACT

Background: Children ages 2-5 are consuming only 22% of their recommended intake for vegetables, and only 50% of their recommended intake for fruits. Because of taste preferences, the environment, or how the foods are presented, children can have variable intakes of fruits and vegetables. Therefore the goal of this study was to test whether increasing the numbers of options of fruit and vegetables provided would lead to increased intake.

Objective: To observe the effects of offering a variety of fruits and vegetables on children's intake of fruits and vegetables at snack time.

Design: 61 preschool children ages 3-5 were used in the fruit and vegetable study conducted at the Bennett Family Daycare Center on the campus of The Pennsylvania State University. Eight times during 4 weeks children were observed in 4 different classrooms in order to test how they would respond to being offered a variety of fruits and vegetables or a single-type of fruit or vegetable. At four of the snacks vegetables were served, 3 times a single vegetable was served (cucumber, sweet pepper, or tomato), and one time a variety of all three vegetables was offered. Likewise there were four snacks that served fruit, three of the four times a single fruit was offered (apple, peach, or pineapple), and one time a variety of all three fruits was served. Both selection and intake were observed in each condition, as well as between fruit and vegetable choices in the variety and single-type conditions.

Results: When the variety and single-type conditions were compared to one another, the variety conditions resulted in an increase in consumption of fruits and vegetables. Throughout all vegetable and fruit snacks it was found that the children ate a mean of 7.7 ± 0.5 pieces at the

variety condition snacks and 4.6 ± 0.2 pieces at the single-type condition snacks. When a variety of types were served an average increase in intake of 3.1 pieces (67%) resulted. The level of increase in the fruit and vegetable variety conditions however did not significantly differ from one another. Consumption did differ between fruits and vegetables overall because kids chose greater amounts of fruits during snack time when compared to the amounts of vegetables consumed. 52% of the children ate some vegetable pieces while 85% ate some fruit pieces.

Conclusion: Increasing the variety of fruits and vegetables offered at snack time can increase selection and intake among children.

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Chapter 1

INTRODUCTION

A. Fruit and Vegetable Consumption In Preschool Aged Children

i. The Importance of Fruits and Vegetables

Fruits and vegetables are important components of a daily diet because they are low-energy dense foods that provide a feeling of satiety without the extra calories associated with consuming large amounts of carbohydrates and high fat foods. Fruits and vegetables are also a great source of nutrients for the body such as fiber, folate, potassium, vitamin C, and vitamin A (4). They also help reduce the risk of having a stroke or heart disease by lowering blood pressure. The chance of developing certain types of cancer can also be reduced with a diet rich in fruits and vegetables because of phytochemicals like lycopene and carotenoids found in the foods (5).

ii. Current Statistics on Fruit and Vegetable Intake

It is recommended that children ages 2-3 receive a daily intake of 1 cup of fruits and 1 cup of vegetables. For children ages 4-8 it is recommended that both boys and girls eat at least 1.5 cups of fruit each day. The vegetable requirement for females of this age group is 1 cup, while the requirement for males is 1.5 cups per day (16).

In a study conducted that researched the correlates of fruit and vegetable intake in U.S. children, intake data was collected from 6,513 children, and it was found that boys consumed significantly higher amounts of vegetables when compared to girls (7). Fruit intake between the

two groups however did not vary significantly. The food intake data also identified the primary sources of fruits and vegetables for children in varying age groups. For children ages 2-5 it was found that the main vegetable source was French fries, which accounted for 28% of total vegetable consumption. When compared to the 6-11 year old age group, children ages 2-5 consumed significantly more French fries as their primary vegetable source, with a higher intake among boys. 100% fruit juice was discovered to be the major fruit source among children ages 2-5, again boys having a greater intake when compared to girls. Children in the 2-5 age group had a significantly greater intake of 100% fruit juice as their primary fruit source than children in age group 6-11 and 12-18 (7).

The study reported that only 50% of children ages 2-5 were meeting their recommended fruit intake, while only 22% of children ages 2-5 were consuming their recommended vegetable intake. These numbers indicate that 50% of children ages 2-5 are not eating enough fruits in their diet while 78% of children are not eating enough vegetables. Because of the low percentages of children eating enough fruits and vegetables, it is important to explore new ways of encouraging preschoolers and young children to eat the recommended amounts of fruits and vegetables.

B. Fruit and Vegetable Intake Studies

The Laboratory for the Study of Human Ingestive Behavior at Penn State University has conducted a number of studies to discover new ways of increasing vegetable consumption in young children. These studies helped lead into the children's study conducted observing the effects of offering a variety of fruits and vegetables on children's intake of fruits and vegetables at snack time.

A study was completed in 2010 that researched the effects of increasing portion sizes of low-energy-dense vegetables at a meal on children's food and energy intakes. The study involved 3-5 year old children in a daycare center who were served a test lunch once a week for 4 weeks. In 3 of the 4 served meals, children were provided with a first course that consisted of raw carrots portioned out into 30, 60, or 90g and no first course was served in the control meal. Children consumed the first course and then were given the main course of pasta, broccoli, applesauce, and milk. The results of the study showed that total vegetable consumption increased at the meals as the portion size of the carrots increased. Carrot consumption increased by 47% when the first course meal doubled in portion size. Therefore from this study it was concluded that increasing the portion size of a vegetable served as a first course can be effective in increasing vegetable consumption in preschool aged children (15).

Another study was conducted in 2011 that looked at hiding vegetables in foods to help reduce energy density and increase vegetable intake in children. 40 children ages 3-5 were served breakfast, lunch, dinner, and evening snacks that were reduced in energy density (ED) by increasing the proportion of puréed vegetables. The children were provided with the meals 1 day a week for 3 weeks and were given 100% ED (standard), 85% ED (tripled vegetable content), and 75% Ed (quadrupled vegetable content). The entrees provided to the children were served with unmanipulated side dishes and snacks and the children were instructed to eat as much or as little of the meals as they liked.

The study resulted in a 52 g (50%) increase in the 85% ED condition and a 73 g (73%) increase in the 75% ED condition when compared to the standard. The other interesting finding in the study was that the consumption of more vegetables in entrées did not affect the children's consumption of the provided vegetable side dishes. During the study children ate similar

weights of food across the conditions, therefore the daily energy intake decreased by 142 kcal (12%) from the 100% to 75% ED conditions. What the lab concluded from the research study was that the incorporation of large amounts of vegetables in entrées to reduce ED of foods is an effective strategy for both increasing vegetable consumption in children and decreasing their energy intake (14).

As evidenced by the studies conducted in the Laboratory for the Study of Human Ingestive Behavior at Penn State University, there are different ways to increase vegetable consumption in children. However rather than manipulating the composition of the food itself as was done in previous studies, with this study the lab wanted to alter the children's number of types of foods served to observe if selection and intake of fruits and vegetables was affected.

C. The Impact of Variety

Dietary variety and food consumption in adults has been a topic of research for years, and in one particular study it was found that when different foods were provided in successive courses, more food was consumed than when the same foods were provided in the same number of successive courses. Participants consumed 44% more food and 60% more energy when provided with a variety of food rather than the same foods in each course (12). This study showed that when offered different foods during mealtime, consumption and energy intake both increase.

A recently published study on increasing vegetable intake in 66 adults using variety as a strategy found that intake was significantly increased when adults were offered a variety of vegetables. In one condition, 600g of one type of vegetable was served (broccoli, peas, or carrots) with a meal of 600g cooked pasta and sauce while in another condition 200g of the 3

individual vegetables were served in separate dishes on the side, equaling a total of 600g. The condition that offered a variety of vegetables increased vegetable intake in men and women significantly more than when a single vegetable was served. The average increase in intake was 48 ± 6 g, which is more than one-half of a serving (17).

Similarly a study completed in adults in 2011 established an increase in vegetable selection when participants were offered a variety of vegetables. The 98 participants used in the study, 45.9 female and 54.1 male, were provided with food replicas of carrots, designated vegetable A, green beans, designated vegetable B, pasta, and chicken breast. Condition A in the study presented participants with carrots, pasta, and chicken. Condition B presented participants with beans, pasta, and chicken. Condition AB offered participants carrots, beans, pasta, and chicken. The mean average for condition A was 1453 kJ, condition B had a mean of 1561 kJ, and condition AB resulted in a mean total energy intake of 1399 kJ. The study found that when the 98 subjects were provided with the AB condition their total intake of vegetables was increased while their decreased their total energy intake (2).

There are many areas of food intake and eating behaviors that are commonly researched and studied; however the effects of variety on food selection and intake in children are areas that continue to lack data and support. Only a few studies have been published, one of them being a 2008 study that looked at how dietary variety can affect habitual eating patterns in children. The study's objective was to test if dietary variety decreases the rate of habituation and increases energy intake in children. The study was comprised of two different experiments, the first looked at salivation response to same or variety of foods after their consumption. The second experiment consisted of children completing a computer task to earn points for same or a variety of low or high-energy dense foods that were consumed following the task. The study found that

children placed in the “same” group habituated faster than children placed in the “variety” group. Experiment two found that the effect of variety was independent of energy density. Researchers concluded from this study that dietary variety disrupts habituation and increases energy intake in children. Similarly because the children’s responses to dietary variety were independent of their responses to energy density, it was suggested that increasing variety of low energy dense foods might increase their consumption (15).

i. Sensory Specific Satiety

Sensory specific satiety is one of the most accepted ideas related to the effects of variety on food intake. It involves the phenomenon that as food is eaten, its palatability gradually declines (10). A study conducted by B. J. Rolls, et al. in 1981 found that study participants had a greater dislike for food eaten in the first course than food that was not eaten. Therefore, participants consumed significantly more of a food when presented with a new food in the second course when compared to being offered the same food that was provided in the first course (12). This helped demonstrate that a decrease in the liking of a food is related to a decrease in consumption of that food.

Another study demonstrating the significance of sensory-specific satiety is a study completed in 1981 completed by B. J. Rolls, et al. in which study participants were fed yogurt in successive courses. Some participants were provided with the same type of yogurt in all of the courses while others were provided with different yogurt types in each course. Those who were given a different yogurt type in the successive courses ate more than those who were given the same type in all courses (9).

In an article addressing the subject of sensory specific satiety, Dr. Barbara J. Rolls explains how the process works and how it affects food intake. It is thought that if satiety is related to specific properties of food, then a variety of foods should increase intake (11). Similarly, the more different foods are, the greater the increase in food consumption as a result. Because of this understanding, the concept of variety and food consumption was incorporated into a children's feeding study.

D. Current Study

The purpose of the study was to test whether offering a variety of fruits and vegetables during snack time in a preschool classroom would increase consumption compared to offering a single version of a fruit or vegetable.

The effect of offering a variety of fruits and vegetables to preschool aged children during snack time was observed. Fruits and vegetables were served as the main foods during snack time and the children served themselves in a family-style setting that was accompanied by their teachers and teaching aides. Because the children served themselves, they were able to control how much food was added to their plate therefore their selection of foods was based upon their preferences. Because our main objective was to see how variety would affect both selection and intake of fruits and vegetables, observers were seated near the snack tables in order to record the quantity, type, and intake of food that was selected by each individual student.

The results of the study were used to determine how variety affected both selection and intake of fruits and vegetables compared to a single presentation during snack time. Within both variety and single type conditions intake and selection of fruits and vegetables were also compared so that it could be observed whether variety has a greater effect on fruits or vegetables.

E. Hypothesis

Offering a variety of fruits and vegetables compared to a single-type will increase both selection and intake of fruits and vegetables in preschool aged children.

Chapter 2

METHODS

A. Study Design

The experiment used was a crossover design with repeated measures that looked at the effect of offering a variety of fruits and vegetables to preschool children on the outcomes of selection and intake. On eight separate occasions during the span of 4 weeks, 61 preschool children ate snack under normal protocols of the childcare facility. At four of the snacks vegetables were served; 3 times a single vegetable was served (cucumber, sweet pepper, or tomato), and one time a variety of all three vegetables was offered. Likewise for the fruit, four of the snacks served were fruit; three times a single fruit was offered (apple, peach, or pineapple), and one time a variety of all three fruits was served. The study was conducted between February and April of 2011.

The fruits and vegetables used in the study were those familiar to the children (apple, peach, pineapple, yellow peppers, cucumbers, and whole cherry tomatoes). Each piece of cut fruit and vegetable were weighed out to approximately 8-12g prior to being served in the classrooms. On each classroom table there were assigned 3 bowls of either fruit or vegetable each weighing 300g. Along with the fruits and vegetables at snack time the subjects were also served $\frac{1}{4}$ piece of wheat pita on a plate designated for that particular subject, and an 8 oz. bottle of water.

The snack was served family style, in which the children served themselves and were able to portion out the amounts of food they thought they would eat. The children were allowed to eat as much or as little as they wanted during snack time. Students from lab were used to observe and time the subjects during snack time. They would record each piece of fruit or vegetable the subjects at their table took, and how many they actually ate.

Prior to the start of the study the children were weighed and their height was taken and measured. The same procedures were done after the study, along with preference testing with each subject using the 6 foods from the snack study. The preference testing was conducted with each child eating a sampling of the food one at a time according to random ordering previously set using a computer program. Once the child ate the food they were asked to place its cup on a placemat portraying a “yummy face”, “yucky face”, or “okay face”. Using these face placemats helped the kids tell us their preferences on the taste of the food and whether they liked or disliked it.

B. Participant Recruitment

The subjects used in the study were preschool aged children attending the Bennett Family Center at the University Park campus of The Pennsylvania State University. The study included four classrooms from the center that taught children ages 3-5. Participants for the study were recruited by distributing letters to the parents of the children. With written consent from the children’s parents, the subjects participated twice a week during snack time on Tuesdays and Thursdays. Children with allergies to any of the foods served during the snack and children not given permission to participate in the snack experiment were not included in the study or results.

The study included 61 children who ranged from ages 3 to 5 and whose characteristics are displayed in Table 1. The children were ethnically diverse with a population of 56% were white, 29% Asian, 11% black or African American, and 4% Pacific Islander. Heights and weights were measured for 56 children used in the study; 7 (13%) of the children had a sex-specific BMI-for-age percentile above the 85th percentile for national data (3). In order to improve participation rates for the study, no demographic information was collected from parents and guardians; however, most of the parents and guardians with children at the daycare center had a college degree and a household income above the national average

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 (<i>n</i> = 32) | | Boys (<i>n</i> = 29) | |
|--|------------------------|--------------|-----------------------|--------------|
| | Mean ± SD | Range | Mean ± SD | Range |
| Age (y) | 4.2 ± 0.7 | 3.1 - 5.4 | 4.6 ± 0.7* | 3.1 - 5.6 |
| Weight (kg) | 17.2 ± 2.2 | 12.0 - 21.7 | 18.9 ± 2.4* | 15.1 - 28.5 |
| Height (cm) | 105.0 ± 6.1 | 93.5 - 118.2 | 108.5 ± 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).

Each subject was identified during the study by a particular letter previously assigned to him or her. Each classroom was also assigned a particular color of stickers to help identify their individual water bottles, plates of pita bread, and bowls of fruit and vegetables.

C. Test Foods and Meal Manipulation

The study used a design that involved 8 different experimental conditions, 4 using vegetables and 4 using fruits. There were 6 conditions (3 fruit and 3 vegetable), which involved serving only one fruit or vegetable at a time. The other 2 conditions involved serving either a variety of three fruits or a variety of three vegetables to the children. The particular fruits and vegetables chosen for the study were selected because of the children's familiarity with them at the daycare center. Likewise they were chosen to present contrasting colors, textures, and tastes among the fruits and vegetables served.

The test foods for the snack study were 3 types of vegetables and 3 types of fruit. Specifically the foods used were canned peaches (Sysco), canned pineapple ring (Dole), prepackaged apple slices (Packer), cucumbers, grape tomatoes, yellow peppers, wheat pita bread (Toufayan), and water bottles (C. Geyer). All of the foods used in the study were cut and weighed prior to their distribution at the day care center. The six fruits and vegetables used in the study are displayed in Table 2 along with their compositions of energy, carbohydrate, sugar, fiber, and water.

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 slices | 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 wedges | 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

The order of conditions was arranged so that during each testing session that was completed, one of the two preschool classrooms would always have fruit on Tuesday and vegetables on Thursday, and that the other classroom would conversely always have vegetables on Tuesday and fruit on Thursday. The determination of what fruit or vegetable each room would have was based on a Latin square, so that all conditions were only seen once per class, and

occurred once every week. Similarly the variety condition for each classroom took place on different weeks.

Each condition was assigned a number for the counterbalancing process. In the fruits category: 1=apples, 2=peaches, 3=pineapples, 4=variety. In the vegetable category: 5=cucumbers, 6=peppers, 7=tomatoes, and 8=variety.

D. Procedures

Two times a week, for four weeks, subjects were served our provided snack during their regular snack time at the daycare center. Every Tuesday and Thursday of those eight weeks water bottles (8 oz.), pita bread slices ($\frac{1}{4}$ slice of a whole pita round), and slices of the fruits and vegetables (peaches, pineapple, apple, yellow pepper, tomato, and cucumber) were prepared before departure to the daycare center. In the kitchen of the food lab all of the fruits and vegetables were cut and individually weighed to between 8-12 grams per slice, with an average of 10g. Likewise the pita was cut evenly into 4 pieces, each of which weighed between 13-15 grams. All of the weighing and preparation of the food took place inside the kitchen of the Laboratory for the Study of Human Ingestive Behavior prior to distribution during snack time at the Bennett Daycare Center.

Plastic bowls provided by the daycare center were taken and labeled with colored, circular stickers and numbers that corresponded to each table in the assigned classrooms. Prior to each snack the bowls were weighed by themselves and then were weighed containing roughly 300g of the fruit or vegetables. Each classroom table was assigned 3 bowls during every snack containing 300g of one fruit or vegetable in each bowl, or containing 300g in each bowl of 1 of the 3 different fruits or vegetables offered in the variety conditions.

After weighing and recording each bowl, they were placed on a cart with the pita plates and water bottles and divided by classroom. Before the snack was placed on the tables, the snack tables were set with napkins, eating utensils, the plates of pita, water bottles, and the 3 assigned food bowls for each table. Following the table setup, children were called to sit down by their teachers and were instructed to begin eating with the permission to take as much or as little as they wanted of the available fruits or vegetables. Each table included about 4-6 children depending on absenteeism of the students.

During the single-type conditions all of the bowls on each table contained the same fruit or vegetable while during the variety conditions each of the 3 bowls per table contained 3 different fruits or vegetables. Children were asked to take as much or as little of the snack as they would like, but all children were required to sit down for snack time whether or not they chose to eat snack. Teachers and aides sat at the tables with the children but did not consume the snack so that they did not influence the children's intake. Teachers and aides were instead instructed to ask the children if they were interested in eating the particular snack and served the snack family style. If any of the bowls of fruits or vegetables were emptied during snack time they were immediately replaced with a bowl containing the same type and amount of food that was initially provided.

Every table in each of the 4 classrooms was assigned two students who recorded the type and amount of fruit or vegetable chosen and consumed by each student. The student observers also timed the children and the length of snack time for each student was recorded. The data collected by the observers served as the initial counts for the number of fruit and vegetable pieces selected and consumed by each student.

My specific role throughout the study was to help prepare, weigh, and label the foods and water bottles used during the snack study. I also assisted in monitoring 2 of the 4 classrooms studied during snack time, and ensuring each table in the classrooms was assigned student recorders, the correct number of food bowls, plates of pita bread, bottles of water, and eating utensils. While I assisted in the snack study conducted in my classroom, the other honors scholar working on the study embraced the same roles but for the other classroom observed during the 2 sessions of the study.

E. Assessments

The number of pieces of fruit or vegetable chosen by each child was recorded and timed with a stopwatch by two observers at each table in every classroom. After snack time, the numbers of uneaten pieces remaining on the plate were recorded to the nearest half of a piece, in addition to any pieces dropped on the table or floor during mealtime. After each snack time, uneaten pieces of food and water bottles were weighed using digital scales in order to determine consumption of the pita bread and water, as well as check for accuracy of recorded counts for fruit and vegetable pieces.

After the study was conducted in the 4 classrooms, the children participated in an assessment to see how they rated the consumed fruits and vegetables. They were presented with small samples of the six different foods used in the study one at a time and in a designated random order. During the time each child was given preference testing, they were instructed to taste the food and, depending on their liking of that particular food, point to one of three laminated cards that portrayed faces representing “yummy”, “okay”, or “yucky”. After each individual rating, the children were then instructed to rate all of the samples together, “1” being

their favorite and “6” being their least favorite of the given foods. Results were completed by 54 children from the study, and the remaining 7 children who were not used in the study were either absent or declined to participate in the rating assessment.

Body weight and height of the children was also measured before and after each classroom study. Body weight of the children was measured twice to the nearest 0.1 kg using a portable digital scale (Seca Onda model 843; Seca Corp., Hanover, MD) and height was measured twice to the nearest 0.1 cm using a portable stadiometer (model 214; Seca Corp., Hanover, MD).

F. Data Analysis

This particular study was conducted to assess and analyze the number of pieces of fruit and vegetable children selected and consumed during snack time. The number of pieces and type of food, fruit or vegetable, was also a measure of the study, along with the amounts selected and consumed during variety conditions versus the 6 single-type conditions. The data resulting from the fruit and vegetable study is typical of that for episodically consumed foods, including a large proportion of zero values from children who did not eat during the snack times, and a skewed dispersion with a few very high values. The data is not evenly distributed, therefore the results are skewed. Because the intake of fruits and vegetables was measured by counting pieces of food, the data is categorical rather than continuous. The data sets were analyzed using statistical methods that were appropriate for these characteristics, a non-linear mixed models to analyze the counts of pieces selected and consumed, and binary logistic regression was used to analyze the likelihood of selecting any pieces.

Chapter 3

RESULTS

A. Effects on Food Selection and Consumption

When comparing the conditions of offering a variety of fruits and vegetables to offering children a single fruit or vegetable, the variety condition increased the likelihood that children would select some pieces for snack rather than not selecting any pieces (Figure 1). Across all conditions children selected some pieces of fruit or vegetable 94% of the time during variety snack and 70% of the time during single-type snacks.

The effect of the variety condition on increasing the probability of selection did not show a significant difference when comparing fruit and vegetable intake to one another. The increases in selection between fruits and vegetables were not comparably different from one another, therefore when comparing increased selection of one group to the other provides no significant variation.

An interesting result independent of the variety effect was that the children were more likely to select a food item during the snack periods offering fruit than they were during the days vegetables were provided for snack. Overall some vegetable pieces were selected at 63% during the vegetable conditions, whereas fruit pieces were selected at 88% during the fruit conditions.

Although the variety condition increased the probability that children would choose fruits or vegetables during snack time, variety caused no further effects on the probability of eating the selected pieces of fruits or vegetables. Children however ate greater amounts of the fruit pieces

they selected as opposed to the vegetable pieces they selected. 82% of the vegetable pieces selected by the children were consumed while 97% of the fruit pieces they chose were consumed. When taking into consideration both selection and consumption of the fruits and vegetables, 52% of the children ate some vegetable pieces while 85% ate some fruit pieces, as shown in Figure 1.

Figure 1

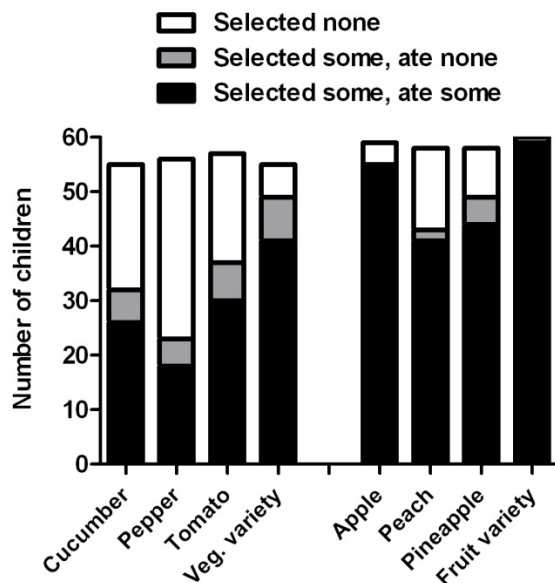


Figure 1. Number of preschool children who did and did not select and eat any pieces of vegetables or fruits at a snack, out of a total of 61 children enrolled in the study. On different occasions, the children were offered each of three single types of vegetables and a variety of all three types, and similarly for fruits. Children were more likely to select some vegetables or fruits in the two variety conditions than they were in the single-type conditions according to repeated measures logistic regression ($P < 0.0001$).

B. Effects on the Amount of Food Selected and Consumed

When the variety and single type conditions of the study were compared to one another, the variety condition increased both the amounts of fruits and vegetables selected and consumed by the preschool children. Throughout all vegetable and fruit snacks it was found that the children ate a mean of 7.7 ± 0.5 pieces at the variety condition snacks and 4.6 ± 0.2 pieces at the single-type condition studies. When a variety of types were served an average increase in intake of 3.1 pieces (67%) resulted.

The variety condition provided an increase in selection and intake of fruits and vegetables compared to the single type conditions, however the amount of increase did not differ between fruits and vegetables. The resulting increase was about 31g, which is roughly $\frac{1}{4}$ cup (60 ml) and equivalent to $\frac{1}{6}$ of the recommended daily intake of vegetables and fruits for most children. Figure 2 depicts the intake of fruits and vegetables in the variety and single conditions for each food group. Although it appears as though the fruit variety had a greater increase in consumption, the difference between fruit and vegetable consumption was not statistically significant because more children ate fruit as opposed to vegetables overall.

The difference found between the selection and consumption of fruits and vegetables was independent of the variety effect. Overall the children ate a mean of 2.2 ± 0.1 vegetable pieces, and 8.4 ± 0.3 fruit pieces, as displayed in Table 3. The individual single-type mean values that differ significantly from the variety mean values are marked with an *. Within the fruit conditions, apple, peach, and pineapple are greatly differed significantly from the variety mean for selection while only values for apple and pineapple differed from the variety mean value for

consumption. In the vegetable conditions both selection and consumption values for cucumber and yellow pepper differed significantly from the variety mean values.

Offering a variety of fruits and vegetables increased selection and consumption of the foods, however what was also discovered was that providing a variety also increased the number of pieces wasted, or uneaten pieces of fruits and vegetables that were left on plates after meal completion. Children left a mean of 1.84 ± 0.1 pieces of food in the variety condition and 0.57 ± 0.02 pieces in the single-type conditions, which calculates to be a difference of about 1.27 pieces of fruit or vegetable. When comparing the amounts of uneaten fruits and vegetables in the single-type and variety conditions, the mean difference between the two was 13.0 ± 1.0 g. The difference between uneaten pieces in the fruit conditions and vegetable conditions was a mean of 0.7 ± 0.1 pieces for vegetables and 1.1 ± 0.1 for fruits.

Figure 2

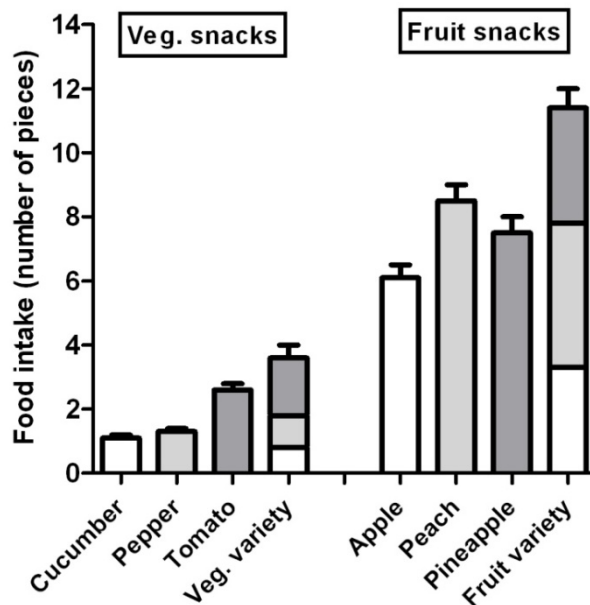


Figure 2. Mean (\pm SEM) number of pieces of vegetables and fruits consumed by 61 preschool children in a study that tested the effect of serving a variety of types on intake at an afternoon snack. On different occasions, the children were offered each of three single types of vegetables and a variety of all three types, and similarly for fruits. 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 were offered than when a single type was offered ($P = 0.0002$). Children also consumed a greater number of pieces of fruits than of vegetables ($P < 0.0001$). The mean weight per piece was 10 g.

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 |

¹ The mean weight per piece was 10 g.

² Mean 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 ($P < 0.05$).

C. Effects on the Variety of Food Type Selected and Consumed

Offering children a variety of vegetables proved to have no effect on the number of different types (cucumber, yellow pepper, and tomato) selected during snack time. When compared to one another, a similar number of types from among the single-type conditions were chosen during the variety condition. For example, as shown in Table, 4 during the single vegetable condition 11 of the 42 children (26%) chose all 3 types of vegetables while 12 of the 42 children (28.5%) chose all three types of vegetables during the variety condition. There is no significant difference in the data suggesting that offering a variety of vegetables to the children changed their selections of certain types of vegetables. However, it may be possible that variety could decrease the number of food types selected because children could choose to only select their favorite fruit or vegetable.

The fruit conditions provided results quite different from the results of the vegetable conditions when looking at selections and consumption of fruit types (apple, pineapple, peach). As displayed in Table 4, children selected fewer types of fruit during the variety conditions when compared to the single-type conditions. 35 of the 54 children (65%) involved in all four of the fruit conditions selected 3 types during the single-type conditions while 22 of 54 children (41%) selected 3 types during the variety condition.

Overall, when comparing the results of selection types between fruits and vegetables during single-type and variety conditions, variety did not affect the number of types of vegetables selected. However, the variety fruit condition led to a lowered selection of different types of fruits provided during snack time.

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.

D. Effects on the Liking and Preference of Fruit and Vegetables

Preference testing results are depicted in Table 5 for the 54 children who completed the ratings. The liking and preferences for the 6 different fruits and vegetables used for the snack study are shown in the table. Differences were found in the number of types of fruits and vegetables kids rated as yucky. For example, the table shows that for preference rankings, 11 (20%) of the children said their favorite food was a vegetable, while 43 (80%) said their favorite food was a fruit.

The children who ranked their favorite food as a vegetable did not differ in the effect of variety on the probability of selecting any pieces of snack, however it did affect selection and consumption of vegetables compared to fruits. Those who said their favorite food was a vegetable showed no difference in their selection (82% of snacks) and consumption (80% of snacks). Children who chose a fruit as their favorite food however were less likely to eat vegetables than fruits, and selected fruits at 89% of snacks and vegetables at 61% of snacks. These children ate the fruit they selected at 86% of the snacks and ate the vegetables they selected at only 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 |

Chapter 4

DISCUSSION

A. Summary of Findings

The effects of offering a variety of fruits and vegetables to children led to an increase in selection and intake in fruits and vegetable. These findings are similar to results reported in the 2008 Temple Study and 2008 adult variety vegetable study that found an increase in energy intake with variety (15, 17). Similarly offering a variety of fruits and vegetables increased consumption overall, and at the same time increased the amount of pieces uneaten by the children. The effect of variety in increasing consumption did not differ significantly for fruits when compared to vegetables.

When comparing fruits and vegetables to one another, fruits were chosen and consumed more often than the provided vegetables, which is consistent with the national averages of fruit and vegetable intake among children ages 2-5 as reported in the 2009 Lorson Study (7). Because vegetables were selected and consumed in lesser amounts than fruits, there were also fewer pieces of vegetables that were uneaten and counted as waste.

Overall the increase in selection and consumption of fruits and vegetables in the variety snack versus the single-type snack did not differ significantly. The effect of variety on fruits and vegetables was similar between fruits and vegetable; however the overall amounts of intake for fruits and vegetables did differ because fruits were consumed in greater amounts than vegetables.

B. Summary of Previous Research on Variety

A majority of the research that has been conducted in the past has concentrated on the effects of variety in the consumption of foods in adults and infants rather than children. Variety studies conducted on adults have provided results that are similar to the results found in this variety study. One of the main outcomes in many of the studies was an increase in consumption when offering participants a variety of foods compared to a single type of food (2, 12, 17).

The primary study of variety conducted in children was the Temple et al. study in 2008 (15). This study found that offering children a variety of foods compared to a single food decreased their habituation of dietary behaviors, which in turn helped increase their food consumption.

C. Variety in Children

The results found in offering a variety of fruits and vegetables to children in this study were similar to previous results found in a study that looked how dietary variety can affect habitual eating patterns in children (15). The study found that when children are offered a variety of foods habituation was disrupted and their consumption of foods increased. Similarly it was suggested that because variety was independent of energy density, offering a variety of low energy dense foods could increase their intake. The results of both studies showed that variety can lead to an increase in foods, and even more importantly increasing the variety of low energy dense foods can lead to an increase in their consumption.

The study conducted in the preschool classrooms during snack time extended previous work because it offered only fruits and vegetables to children rather than a variety of low and high-energy dense foods. The major objective of this study was to observe if offering a variety

would specifically increase consumption of fruits and vegetables. When compared to the Temple study, this study also differed because it concentrated on the age group of preschoolers rather than all numerous ages of children because it is around this age that eating habits and preferences are often created and shaped.

D. Effects of Offering a Variety

The beneficial effects of offering a variety include an increase in selection and consumption of fruits and vegetables when compared to offering children only a single type of fruit or vegetable. The importance of an increase in selection and consumption as a result of offering a variety is that variety can become a method of increasing fruit and vegetable intake in children. Children are not limited to consuming solely the vegetable or fruit provided if there is only a single choice. Variety provides a greater amount of options so that there is a larger likelihood that one or more of the options will be selected and consumed.

One of the less positive effects of offering a variety to children are that it reduced the number of types of fruits and vegetables selected and consumed when compared to serving them separately. It is possible that during the variety conditions children selected and consumed their favorite fruit or vegetable as opposed to a variety of the 3 being offered. Another less positive effect found in the variety conditions was increased food waste. Although the amount of waste was small compared to the amount of foods consumed, there was a noticeable increase in waste during the variety conditions. During the variety conditions there was a food waste mean of 1.84 ± 0.1 pieces of food while the single-type conditions resulted in a food waste mean 0.57 ± 0.02 pieces.

E. Influence of Food Characteristics and Preference

The increase in intake that was experienced during the study was independent on whether the food was a fruit or vegetable. Both intake of fruits and vegetables was increased during the variety conditions; however when comparing the amount of increase between fruits and vegetables, there was not a significant difference between the two. The preschoolers ate greater amounts of fruit in general and it looks as if fruit had a larger increase in the variety condition; however the increases for fruit and vegetable were somewhat comparable.

Overall intake was dependent on whether the food offered at snack time was a fruit or vegetable. According to the liking preferences of the children, 43 of the 54 children (80%) said their favorite food was a fruit while only 11 of the 54 (20%) said their favorite food was a vegetable. Children were more likely to choose fruit in both the single-type and variety conditions when compared to their selection of vegetables. The results showed that for both single-type and variety conditions 52% of the children ate some vegetable pieces while 85% ate some fruit pieces.

Using the results found in this study it is possible that introducing a variety of fruits and vegetables to children will increase their dietary intake. Because children ages 2-5 consume lesser amounts of vegetables compared to fruits (7), incorporating a variety of vegetables into mealtime would be beneficial, however increasing intake in both areas is important overall.

F. Strengths and Limitations of the Study

Strengths of the study include its results that provide data on the selection and intake of fruits and vegetables in preschool aged children rather than just their preference and liking of the foods. The portions of the fruits and vegetables offered were controlled so that portion size

would not be a confounding variable in the results. Within the methods of the study, allowing the children to serve themselves and take as much or as little as they wanted allowed the children to have more control over their intake. Likewise the data is more representative of the children's intake as related to preference and liking because they were free to eat or decline to eat the provided snack. Because the study was conducted only during snack time, this allowed for a greater concentration on fruits and vegetables without the concern of other foods and meals complicating the study's methods and procedures.

Limitations of the study could include the small sample size of children used. Although results of the study showed that offering a variety of fruits and vegetables to children can affect selection and intake, a larger sample size may have provided more significant results. Similarly, because of the variable schedules of the preschoolers it was sometimes difficult to ensure all of the children would be present at the various study conditions. Absenteeism was sometimes a problem if children were ill and could not attend the study, or if parents chose to pick up their children from daycare before snack time.

Another limitation of the study was the population of children involved in the study. A majority of the children are from middleclass households of well-educated parents who probably offer fruits and vegetables to their children more often than other populations. Because of this the children may have had previous exposure to the fruits and vegetables offered during snack time, which could have altered their amount of intake depending on whether the child liked or disliked the food. It is also possible that food selection and consumption could have been distorted due to children choosing their favorite fruit or vegetable during the variety conditions. By doing this, variety selection would decrease and would show a decreased effect on selection and consumption in the results.

G. Practical Implications of the Variety Effect

Child and adolescent dietary behaviors are strongly influenced by environmental factors, and from around the age of three children's eating behaviors are influenced by responses to environmental cues as well as family and social factors (1). Parents and schools are also major influences on the development and sustainability of nutritional behaviors in children and adolescents therefore should be involved in the implementation of methods to help increase fruit and vegetable intake in these age groups.

The findings from this study could be applied to help increase fruit and vegetable consumption among children and adolescents. The results of the study showed that offering a variety of fruits and vegetables to preschool aged children increased both their selection and intake. Because of this, it may be beneficial to apply this method to children of varying age groups to see if similar results are found. Locations where the variety method can be applied include schools, daycare establishments, and household settings. Providing a variety of fruits and vegetables is not a difficult change to make within the eating environment, and involves no manipulation of foods or meals.

In order to increase fruit and vegetable consumption in children, it may be helpful to combine various methods to help increase intake along with offering a variety of fruits and vegetables at snack and meal times. Studies such as Lakkakula et al. study have found that a cafeteria-based tasting program helped increase the liking of fruits and vegetables in 1st, 3rd, and 5th graders (6). Through repeated exposure and tasting intervals there were improved differences noticed in likings of the foods tested on the children (apricots, cantaloupes, peaches, pears, bell peppers, carrots, peas, and tomatoes). Combining variety conditions such as the one used in the

preschool study along with the method of repeated exposure and tasting intervals may help lead to a greater increase and fruit and vegetable consumption. By using both methods, whether in a household setting or school setting, not only will fruits and vegetables be the primary foods of the study, but children will also have opportunities to get accustomed to the foods being offered and develop likings of them.

Variety of foods offered at meal times has often been associated with an increase in food consumption, which regularly leads to overweight or obese individuals. There have been studies conducted that showed an increase in the variety of foods was associated with increased intake for all food groups (8). The results of the variety study in children help show that an increase in variety is correlated with an increase in selection and intake; however increased consumption of certain foods can be beneficial and may not always be associated with increased energy intake. Taking the understanding that variety helps increase consumption of foods and applying it to children and adolescents with limited fruit and vegetable intake can help increase their selection and consumption of the low-energy dense foods, therefore improving their overall dietary intake.

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