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BUILDING CHILDREN'S LIKING AND PREFERENCES FOR FRUITS AND VEGETABLES THROUGH SCHOOL-BASED INTERVENTIONS

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

In

The School of Human Ecology

By

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May 2011

DEDICATION

I would like to dedicate this work to my family and my major professor Dr. Tuuri.

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I would like to express my gratitude to many people who inspired and helped me during this project. My first thanks should go to my committee chair, Dr. Georgianna Tuuri for her mentoring and support throughout the period of my research. I would also like to thank my committee members, Dr. James Geaghan, Dr. Sarah Pierce and Dr. Michael Keenan for their constant guidance. My special thanks are due to Dr. Lisa Lundy for her valuable suggestions. My appreciation also extends to my colleagues, the Building Preferences research team, the Wellness Partnership research team and the Smart Bodies Research Program team.

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ABSTRACT

Children's food preferences play a major role in their food choices and consumption. The objectives of these studies were to examine the relationship between children's preferences for fruits and vegetables (FV) and their weight status and to increase children's liking of FV by offering repeated opportunities to taste less liked items. A representative sample of elementary school children (1st, 3rd, 4th, and 5th grades) were recruited in the three interventions. In the first study, 341 fourth- and fifth-grade children (43% boys; 68% 4th graders) were measured for height and weight and completed a survey which sought their preferences for 38 different FV. Children who reported a very low preference for FV were 5.5 times more likely to be categorized as at risk for overweight or overweight than were those who reported a high preference for FV. A total of 360 fourth and fifth graders (45% boys; 62% 4th graders) participated in the second study and were offered a taste of carrots, peas, tomatoes, and bell peppers once a week for 10 weeks. For children who began the program disliking the vegetables, repeated tasting improved liking scores for carrots, peas, and tomatoes but not for bell peppers. The number of children who reported liking for previously disliked vegetables was greater after eight or nine taste exposures. In the third study, a total of 379 first-, third-, and fifth-grade students (51% boys; 32% 1st graders and 32% 3rd graders) were offered a taste of four vegetables (bell peppers, carrots, peas and tomatoes) or four fruits (apricots, cantaloupe, peaches and pears) twice a week on alternate weeks for eight weeks and asked to record their liking for each item. An average of five tastes of vegetables and two tastes of fruits were required to observe a change in liking scores. For children who began the program disliking these FV, liking scores for all eight items tasted improved at the end of the intervention and were maintained at the later two follow-up assessments. Repeated taste exposure to less liked FV is a promising strategy to promote liking of these items by elementary school-age children.

CHAPTER 1

INTRODUCTION

Epidemiologic evidence suggests that intake of diets rich in fruits and vegetables (FV) offer significant protection against cancer and cardiovascular diseases (1-3), and childhood consumption of these foods is associated with reduced risk of cancer and stroke in adulthood (4,5). Children who prefer and consume diets high in FV are also less likely to be overweight or obese (6-8). However, only about 26% of United States (U.S) children aged 6 to 11 years of age eat two or more servings of fruits and three or more daily servings of vegetables each day (9).

In addition, these foods may be of particular importance for low-income and minority populations because they are at greater risk for obesity and obesity-related diseases such as diabetes (10,11). Although children from low-income households may lack access to FV at home, these foods are available through the U.S. National School Lunch Program; however, many children are not familiar with FV and choose not to eat them (12,13). Several school-based intervention programs have been developed with the intention of helping children increase their fruit and vegetable consumption. While many of these interventions successfully increased nutrition knowledge and improved attitudes towards eating these foods (14-17), exposure to an environment that encourages children to experience the taste of new foods may be necessary in order to maximize program impact (14-16).

The complex behavior of fruit and vegetable intake appears to be controlled by a combination of genetically determined taste preferences and environmental influences such as availability or accessibility of FV in the home and parent or family support (18-20). Although genetic variation accounts for a relatively small percentage of the variance in food preferences, the role of food environment appears to be very important (21). Children's food preferences are known to be key determinants of their food choice and consumption. A preference for sweet and salty foods is a normative neonatal characteristic and children of all ages tend to reject foods which are not familiar to them (22).

It has been proposed that disliking certain foods can be transformed into liking of those foods with the experience of repeated tasting or exposure (23). Frequent exposure to foods through sight, smell, and taste, is critical to achieving children's acceptance of the items (23, 24). Studies involving infants suggest that one exposure to a taste of a new food may increase liking of this food while up to 15 exposures may be needed to enhance preferences in older children (25-28). As few as three tastes may be sufficient to establish a preference for fruit, although vegetables may require greater numbers of exposures (27).

It is important to note that most of the research on changing food preferences has been conducted with infants and preschool-aged children living in the U.S and Western Europe. Investigations that address altering food preferences among children attending public elementary schools are very limited. In particular these studies are important in children from minority populations because having a low fruit and vegetable preference is associated with greater risk of overweight or obesity (8). Research studies that address improving preferences for and consumption of FV across high risk groups and different food environments are essential. Moreover intervention programs that demonstrate the effectiveness of exposure to foods in a naturalistic situation, such as a school cafeteria, are needed.

1.1 Justification

Obesity is a serious and growing problem for children in the U.S (29). Between 2001-2002 and 2003-2004 the prevalence of overweight among elementary school children grew by 2.5% and currently includes 33.3% of that population (29). The recent National Survey of Children's Health estimated that 15% of low-income children aged 2-5 years in Louisiana are obese and 35.9% of children aged 10-17 years of age are overweight or obese (30). The increase in the number of overweight children is thought to be related to environmental factors that favor greater energy intake combined with children's lower energy expenditure (31).

Consumption of energy-dense diets lacking in fiber and antioxidant-rich FV, has been reported as a risk factor for overweight in children (32-34). Even though the benefits of consuming FV are well established, only one-fourth of children aged 6 to 11 years of age eat the recommended amounts of fruit each day and only 27% of boys and 24% of girls eat the recommended amounts of vegetables each day (9). Moreover the current food environment does not encourage children to learn to like these nutrient-rich items (35). In addition, promotion of consumption of these foods in low-income and minority populations may be very important because of their increased risk for obesity and related diseases (10,11).

Most students attend schools where FV are available to them; therefore the school offers a place where children can develop preferences for energy-diluted, functionally-rich fruits and vegetables. Additionally, school programs aimed at children can also impact parents and families. School based programs have offered multiple tastings as a way to increase children's preferences for FV (24-28). In these studies the number of taste exposures has varied widely (3 to 20 tastings) as well as the children's ages (4-16 years). Therefore, studies need to explore the most effective age group to introduce such a program and determine the number of taste exposures required to attain and maintain liking for fruits and vegetables in low-income public elementary school children.

1.2 Objectives

- Examine if repeated taste exposures would increase and maintain liking of selected FV in elementary school children.
- Determine the number of food taste exposures that are necessary to increase liking of selected fruit and vegetable items by lower, middle, or upper elementary school children.

- Determine the most effective age (between lower, middle, or upper elementary school students) to improve children's liking of FV.
- Examine the association between children's self-reported fruit and vegetable preferences and their weight status.

1.3 Major Research Hypotheses

- At the conclusion of the fruit and vegetable tasting interventions:
    1. Children who participated in the food tasting interventions will have higher liking for the fruit or vegetable items tasted during the programs than reported at the baseline measurement and maintain their increased liking for one-year following the program;
    2. First-grade children will demonstrate a greater increase in liking scores for the fruits and vegetables tasted than will fifth-grade children;
- At baseline measurements, elementary school children with very low scores for fruit and vegetable preferences will be at greater risk for overweight or obesity.

1.4 Definitions

Body mass index (BMI): An anthropometric measure defined as one's weight in kilograms divided by the square of one's height in meters (36).

BMI-for-age percentile: In children and teens, body mass index is used to assess the status of being underweight, healthy weight, overweight, and obese. Children's body fatness changes over time, and girls and boys differ in their body fatness as they mature. The BMI for children, therefore, is referred to as "BMI-for-age percentile" and is gender and age specific (36).

BMI-for-age percentile categories (36):

Obese: A BMI- for-age greater than or equal to the 95th percentile.

Overweight: A BMI-for-age greater than or equal to the 85th percentile and less than the 95th percentile.

Healthy weight: A BMI-for-age above the 5th percentile and less than the 85th percentile.

Underweight: A BMI-for-age less than the 5th percentile.

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CHAPTER 2

LITERATURE REVIEW

2.1 Benefits of Fruit and Vegetable Consumption

The health benefits of adequate fruit and vegetable consumption are widely accepted. Higher intake of FV by adults is associated with a significant reduction in chronic diseases such as obesity, diabetes, cardiovascular diseases, and certain types of cancer (1-4). It has been estimated that increased fruit and vegetable intake could reduce the risk of ischemic heart disease by 31% and stroke by 19% (5). One additional serving of fruit or vegetable per day is associated with a 6% lower risk of ischemic stroke (6). It is estimated that the risk of stomach, esophageal, lung, and colorectal cancer could be reduced by 19%, 20%, 12%, and 2% respectively with increased consumption of FV (5).

Childhood consumption of these foods offers a significant protection against overweight and obesity as well as stroke and cancer in later adulthood (7-11). An observational study with 634 children aged 7 to 11 years showed that higher fruit and vegetable intake was associated with a lower risk of overweight in this age group (9). A clinical control study with a similar age group of children also showed that there is a negative relationship between children's BMI and their fruit and vegetable intake (10). In addition children who prefer diets high in FV are less likely to be overweight or obese (12). Fruit and vegetable consumption is particularly important for low-income and minority populations because they are at greater risk for obesity and obesity-related diseases such as diabetes (13, 14).

Even though the potential benefits of consuming FV have been suggested, a major percentage of the American population does not meet the daily recommendations for this food category (15). Recent Youth Risk Behavior Surveillance System data from high school children indicates that only 22.3% of students eat more than five servings of FV per day (16). Analysis of diets of children aged 6 to 11 years of age also showed that only about 26% of children consume two or more servings of fruits and three or more daily servings of vegetables each day (17).

Childhood food consumption is a strong predictor of adulthood food patterns, therefore increasing children's fruit and vegetable consumption is important to maintain overall good health later in life (18).

2.2 Improving Fruit and Vegetable Intake in Children

Schools have been identified as ideal settings to shape children's health behaviors (19). It is estimated that nearly 43 million children in the United States are enrolled in grades pre-K through eight in 2008. More than 30 million children are enrolled in the United States Department of Agriculture's National School Lunch Program and eat at least one meal at school (20, 21). It has been suggested that children from low-socio economic families with limited resources may lack accessibility to FV but these foods are available to children at school (22). Despite the fact that FV are provided with school lunch children may not choose to eat them perhaps due to a lack of familiarity (23).

2.3 Social Cognitive Theory

The Social Cognitive Theory (SCT) is one of the most frequently used health behavior theories (24). It incorporates reciprocal determinism of person, environment, and behavior which provides a strong framework for designing effective behavior change programs (24). This theory specifies a core set of concepts and the mechanism through which they work, and optimal ways of transforming this knowledge into effective health behavior (25). The key concepts of SCT include psychological determinants of behavior, observational learning, and environmental determinants of behavior (25). Outcome expectations are the results that an individual anticipates from taking actions (24). Self-efficacy is the person's confidence in performing a behavior and in overcoming barriers that influence the behavior (25). Self-efficacy is the most important personal factor in behavior change because it affects a behavior both directly and by its influence on the other constructs (24). The stronger the perceived self-efficacy, the higher the goals that people

set for themselves and the stronger their commitment to them (24). Environment refers to the factors that are physically external to the person; SCT hypothesizes that individual observational learning will not lead to behavior change unless the observer's environment provides the resources or the opportunities to support the new behavior (25).

2.4 School-based Interventions Aimed to Improve Children's Fruit and Vegetable Intake

Dietary behavior is a complex process and SCT suggests that a person's dietary behavior is influenced by personal and environmental factors (26). Several school based programs were designed and tested to encourage fruit and vegetable intake in children and these studies included a variety of SCT components such as nutrition education, role modeling, and changing the school lunch menus (26-29). "Eating Among Teens" was a large population-based study which explored fruit and vegetable intake among 3960 middle and high school students and identified specific correlates of intake within the domains of personal and socio-environmental factors (26). Participants' dietary intake was assessed by food frequency questionnaires and a 221 item psycho-social factors survey. The strongest correlates of fruit and vegetable intake were taste preferences (28% of variance) and home availability of FV (45% of variance). Taste preferences were influenced by health/nutrition attitudes whereas home availability of FV was associated with social support for healthy eating, family meal patterns, family food security, and socio-economic status (26).

The 5-a-Day Power Plus Program was a multi-component intervention that included two classroom curricula with ten 45-minute lessons. Each lesson included skill building, problem solving activities, preparation and taste testing of healthy snacks. The food service component of the program encouraged the selection and consumption of fruits and vegetables during the school lunch. The parental involvement component consisted of five information/activity/snack packets. Lunch room observations reported that the intervention resulted in an increased consumption of

fruits and vegetables (p=0.00), although increased fruit consumption (p=0.00), not vegetables (p=0.17), accounted for the majority of the observed change (27).

A similar study by Reynolds *et al.*, (2000) included components such as classroom activities with modeling, self-monitoring, problem solving reinforcement and taste testing, increased availability of fruits and vegetables in the school cafeterias, and parent encouragement at home to support the behavior change. The 24-h recall data indicated that children in the intervention group consumed more servings of fruits and vegetables combined at follow-up 1 (p=0.00) and 2 (p=0.00) when compared to control group children. However no differences were reported in the cafeteria observation data at either follow-up period (28).

"Gimme-5" was another multi-component intervention designed to impact fourth and fifth grade students' fruit and vegetable consumption and related psychosocial variables in 16 (8 intervention and 8 control) elementary schools (29). The intervention included a nutrition education curriculum, newsletters, and videotapes. Children's fruit and vegetable intake was assessed through 7-day food records at three study phases (Baseline, 1.5 years, and 3 years). The results showed increased fruit and vegetable consumption at lunchtime (p=0.07), and greater self-efficacy (p=0.05) and social norms (p=0.06) to consume FV in the intervention schools when compared to the control schools (29).

The "5-A-Day Cafeteria Power Plus Project" was one of the few programs that examined environmental strategies that increase fruit and vegetable consumption in elementary school children (30). It was a two-year randomized trial that emphasized the school cafeteria in 26 elementary schools (13 intervention and 13 delayed-program controls). During the intervention, food service staff increased the availability of FV at the regular school lunch (at least one additional serving of FV) and encouraged verbally children to choose and eat FV on a daily basis. Children who participated in the intervention had higher intake of FV without potatoes

(p=0.03), FV without potatoes and juice (p=0.02), fruits (p=0.01), and fruits without juice (p=0.00) compared to the control children. There were no differences reported for total fruit and vegetable servings with potatoes, juice, or vegetables (30).

A recent program called "Smart Bodies" also was a multi-component program aimed at improving the food environment in 14 (7 intervention and 7 control) public elementary schools (31). During the 12 week intervention period, teachers were asked to encourage children to taste a fruit/vegetable served by school lunch and show eight Smart Bodies videos which used cartoon characters to promote FV consumption. Children in the intervention group had higher nutrition knowledge (p=0.00) and self-efficacy to consume fruit/fruit juice, choose fruit instead of a dessert/cookie/candy, and eat the recommended number of fruit and vegetable servings daily (p=0.00) but their preferences for FV did not change (31).

The reported programs were successful in increasing knowledge, changing attitudes, and minimally increasing combined fruit and vegetable intake (27-31). The findings of these intervention programs suggest that children may need to be exposed to an environment that encourages them to experience the flavors and textures of new foods, in order to maximize the success of school interventions (26-31). An alternative approach that gives emphasis to changing dietary behaviors by providing opportunities to taste unfamiliar foods might be important.

2.5 Children's Food Preferences

Children's food preferences are strongly associated with their consumption patterns (32). Unfortunately, foods rich in fat and sugars are typically preferred while low-calorie, nutrient-rich fruits and vegetables are poorly liked (33). Children of all ages tend to reject foods that are unfamiliar or taste bitter while preference for sweet and salty foods is a normative neonatal characteristic (34). A study conducted with 3-4 year old children showed that preference for a particular food was explained by sweetness of food (50% of variance) and degree of familiarity

(60% of variance) (35). Another recent study supported these results and showed that foods that had been tried less often tended to be less liked (33). Therefore, studies addressing the factors that influence children's food preferences are critical to the development of effective intervention programs to improve children's diets.

The rejection of unfamiliar foods, referred to as neophobia, is highly associated with lower intake of vegetables by children (34). With repeated tasting or exposure, however, neophobia can be reduced and dislike of particular foods can be transformed into liking. Repeated opportunities to smell, see, or taste are critical to achieve acceptance of previously disliked foods by children (35, 36). Children are also likely to develop a preference for foods if they are encouraged by someone their own age or older to taste them, or if they are recommended by someone the child admires (32).

Repeated taste exposures and modeling of healthy behaviors have been found to be effective in improving food preferences (36-41). Several laboratory based studies with infants, children, and adults demonstrated that preferences for foods or flavors can be increased through repeated exposure to selected items (36 -38). A series of studies have also been conducted in school settings with preschoolers (37) and school-age children (40, 41). In one study conducted with primary school children 5-7 years of age in the United Kingdom, 10 daily taste exposures to an unfamiliar vegetable (raw red pepper) significantly increased children's liking and consumption of the vegetable (39). Another study with a younger population (2-6 years old) reported that 15 repeated taste exposures of disliked vegetables resulted in a greater increase in liking and intake compared to the control group (41).

Although one opportunity to taste a new food may increase liking in young children, up to 20 exposures may be needed to enhance preferences in those of school age (42, 43). Liem & deGraaf (2004) reported that eight exposures were sufficient to increase preferences for

sweetened orangeade in 8-11 year-old children (44), but another study showed that older children (9-12years) needed more exposures (up to 20) to increase their willingness to try new foods (45). Horne *et al*., (2004) proposed that as few as three tastes may be sufficient to establish a liking for fruits, but vegetables may require a greater numbers of exposures (40). However, a recent pilot study conducted with African American elementary school children reported that at least 6 taste exposures were required to observe a change in preferences for previously disliked vegetables (46).

Food preferences may be established as early as three years of age (47), and children are thought to grow more accepting of new foods as they become older (48). Very few studies have examined the age-related changes of children's food preferences. Cook & Wardle (33) reported that preference for fruits peaked at 8 to 11 years of age, but no differences across ages in preference for vegetables in a large sample of British children aged 4-16 years. The number of foods that were tried increased with age but the number of foods that were disliked also increased with age (33). Another longitudinal analysis with children 2-8 years of age also reported that foods introduced after the age of 4 years were more likely to be disliked or rejected than liked (47). However, other intervention programs intended to improve fruit and vegetable intake have demonstrated that children can increase their liking for fruits and vegetables throughout the elementary school years (29-31).

Studies exploring gender differences in food preferences across age groups have consistently reported that girls had greater liking and consumption of FV when compared to boys (33,49-51). A British study involving 4-5 year old children reported that girls liked vegetables more than boys but reported no gender differences for other food groups (49). Another study conducted with French children aged 9-11 years also found that boys were less likely to prefer and consume fruit and raw vegetables than girls (50). In a cross-sectional study of British school

children (4-16 years of age) Cooke and Wardle also reported that girls had higher liking for FV whereas boys gave higher ratings for energy dense foods such as fatty & sugary foods and meats (33). A recent study with African American children who attended public elementary school children in the southeastern U.S found similar findings and reported that girls were three times more likely to have a higher combined fruit and vegetable preference when compared to boys. When preferences for fruits or vegetables were examined separately, girls were 18 times more likely to prefer fruits than boys but no differences were observed for vegetable preferences (51).

2.6 Conclusion

Adequate consumption of FV is thought to provide significant protection against chronic diseases but children are not consuming the recommended amounts of these foods. This places them at risk of obesity and other chronic diseases. Even though healthy foods such as FV are offered at school, many children choose not to eat them. Several school based nutrition intervention programs have been conducted to improve children's dietary patterns, but have had limited impact on increasing children's fruit and vegetable intake. Children's food preferences are strong predictors of their consumption. Repeated taste exposures and modeling of healthy behaviors have been found to be effective in improving food preferences with infants and pre-school children; however, investigations examining the effect of repeated taste exposures in the public elementary school setting and ones which determine the most effective age to observe a change in preferences are very limited. It is important to demonstrate the effectiveness of food tasting in settings where children make food choices such as school cafeterias.

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CHAPTER 3

BLACK CHILDREN WITH HIGH PREFERENCES FOR FRUITS AND VEGETABLES ARE AT LESS RISK OF BEING AT RISK-OF-OVERWEIGHT OR OVERWEIGHT*

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3.1 Introduction

The health benefits of adequate fruit and vegetable consumption are widely accepted. Higher intake of fruits and vegetables by adults is associated with a significant reduction in various types of cancers and cardiovascular diseases (1- 3). Childhood consumption of these foods is related to a lower risk of cancer and stroke in adulthood (4, 5). Studies have also noted that greater intake of fruits and vegetables is associated with lower risk of overweight in children (6- 8). In addition, these foods may be of particular importance for low-income and minority populations because they are at greater risk for obesity-related diseases such as diabetes (9, 10). Despite the potential health benefits, only about 26% of children aged 6 to 11 years of age consume two or more servings of fruits and three or more daily servings of vegetables each day (11).

Children's food preferences are known to be key determinants of their consumption (12,13). The complex behavior of fruit and vegetable intake appears to be controlled by a combination of genetically determined taste preferences and environmental influences such as availability or accessibility of fruits and vegetables in the home and parent or family support (14-16). While it has been reported that intake of fruits and vegetables is associated with body mass index (BMI; calculated as kg/m^2) in children (8), to our knowledge no study has examined the relationship between children's preference for fruits and vegetables and their weight status. In addition, because of the greater risk for overweight among low-income and minority populations it is important to examine food preferences of children from these population groups. Therefore, the purpose of the present investigation was to examine the association between low-income Black children's preferences for fruits and vegetables and their risk of being categorized as at risk of overweight or overweight.

3.2 Methods

The present study includes baseline data from Black children enrolled in the fourth or fifth grade who participated in a 2-year randomized-controlled intervention trial called Smart Bodies (Silverman L, Zanovec M, Geaghan J, Murphy E, Solmon M, Roy H, Guarino A, Holston D, Tuuri G. Smart Bodies school-based intervention increased nutrition knowledge and willingness to consume more fruits and fruit juices. Manuscript submitted for publication). The program was conducted in low-income urban public elementary schools in southeast Louisiana where Black children comprised approximately 82% of the student population and the percentage of children eligible to receive free or reduced-price lunches ranged from 72.5% to 97.5% (mean = 87.7%) (17). Enrollment in a free or reduced-price lunch program was used as the surrogate measure of socioeconomic status (18). Parent consent and child assent were obtained prior to data collection. The race of the child was noted by the parents on the consent form. If missing from the parent consent form, race was determined from self-reported information provided by the child at the time of height and weight measurement. The Louisiana State University and the Louisiana State University Agricultural Center Institutional Review Boards approved the study.

Height and weight were measured by trained investigators using a standard protocol. Height was measured once without shoes to the nearest 0.1 cm using a portable stadiometer (Shorr Productions, Olney, MD). Body weight was measured once in light clothes to the nearest 0.1 kg using a digital scale (Seca 880, Seca Co., Hanover, MD). The scale was calibrated prior to each measurement session using two 5 kg standard weights. Children's heights in inches and weights in pounds were entered into a software program that calculated each child's BMI-for-age percentile (Student BMI Health Report, version 1.0, 2004, Louisiana State University, Baton Rouge, LA). The children were placed into one of the following four weight categories based

upon their BMI-for-age percentile: underweight (<5th percentile), healthy weight (5th-<85th percentile), at risk of overweight (≥85th - < 95th percentile) or overweight (≥95th percentile) (19).

The self-administered questionnaire seeking information about the child's preferences for fruits and vegetables had been designed and validated with a similar population group (20). Students described how much they liked or disliked each of 38 different fruits and vegetables. The Likert-type response scale included the following: 1=I don't like this, 2= I like this, 3=I like this a lot, 4=I don't know what this is.

3.2.1 Data Analysis

Surveys were scanned and coded using Remark Office OMR (version 6, 2005, Gravic, Inc, Malvern, PA), and statistical analysis was conducted using the Statistical Analysis Software (version 9.1.3, 2007, SAS Institute, Inc, Cary, NC). After scanning, all surveys were manually checked for any unreadable data. Descriptive statistics regarding gender, grade and weight status were computed. The internal reliability of the fruit and vegetable preference survey was examined using the Cronbach's α test. χ^2 assessments examined if children's lack of fruits and vegetables familiarity (question response no. 4: I don't know what this is) differed according to their weight status, and Spearman rank correlation examined the direction and strength of the association between fruit and vegetable preferences (Question responses nos. 1-3) and BMI-for-age percentiles. A multinomial logistic regression model was used to evaluate the association between FV preferences and weight categories. The probability value was set at $p < 0.05$.

3.3 Results and Discussion

3.3.1 Demographics

Of the 341 children included in this analysis, 43% were boys (*n*=147) and 68% were in 4th grade (*n*=231). From the calculated BMI-for-age percentiles, only a small proportion of the participants were underweight (3%; *n*=10), more than half were at a healthy weight (60%;

n=205), 17% (*n*=58) were at risk of overweight, and 20% (*n*=68) were overweight. The underweight children were excluded from the analysis.

3.3.2 Fruit and Vegetable Preferences

A Cronbach's α test for the fruit and vegetable preferences questionnaire indicated an acceptable reliability score ($\alpha = 0.94$). The apple was the most familiar fruit followed by oranges, bananas and grapes. Avocados, papayas and apricots were the least familiar fruits. In the vegetable group, carrots were the most well known followed by corn and green beans, whereas cauliflower and cucumbers were the least familiar vegetables. As shown in Table 3.1, grapes were the most liked fruit and avocados were the least liked. Nearly 70% of children had high preferences for all fruits except tangerines, cantaloupe, mangos, apricots, papayas, and avocados. French-fries, corn and lettuce salad were the children's most favorite items in the vegetable group, and garlic, onions, coleslaw, and cauliflower were the least liked.

Forty-eight percent of the children were familiar with all but three of the fruits and vegetables listed in the survey (35 of 38). In order to examine the relationship between familiarity with fruits and vegetables and weight status, children were divided into two groups based on their response of 'I don't know' (no. 4) for each fruit and vegetable item. Children with less than or equal to three 'I don't know' answers were compared to children with more than four 'I don't know' responses. Between these two groups the children's familiarity with fruits and vegetables was not found to be associated with their weight status ($\chi^2 = 0.27$, 1 degree of freedom).

The relationship between fruit and vegetable preferences and weight status was evaluated by calculating a mean score for fruit and vegetable preferences after removing all responses of "I don't know" (no. 4). A negative association was observed between a child's fruit and vegetable preferences and his or her BMI-for-age percentile value ($r = -0.26$, $p = 0.01$). For the regression

Table 3.1 Elementary school aged children's self-reported preferences for fruits and vegetables (*n* = 331)

Fruits and vegetables	Most liked (>60%)	Somewhat liked (30 -60%)	Least liked (<30%)
Fruits	Grapes (92%)	Tangerines (57%)	Apricots (22%)
	Apple (91%)	Cantaloupe (47%)	Papaya (14%)
	Oranges (89%)	Mango (38%)	Avocado (9%)
	Strawberry (87%)		
	Watermelon (84%)		
	Pineapple (83%)		
	Peaches (81%)		
	Pears (80%)		
	Banana (78%)		
	Plums (76%)		
	Kiwi (68%)		
Vegetables	French-fries (90%)	Cabbage (59%)	Garlic (25%)
	Corn (87%)	Broccoli (55%)	Onion (21%)
	Lettuce salad (72%)	Peas (49%)	Coleslaw (16%)
	Sweet potato (71%)	Tomatoes (47%)	Cauliflower (14%)
	Baked potato (67%)	Cucumber (46%)	
	Potato salad (62%)	Celery (45%)	
	Carrots (62%)	Spinach (43%)	
	Green Beans (61%)	Bell pepper (35%)	
	Greens (61%)		

model, children were placed into one of the following two weight groups: healthy weight (BMI-for-age 5^{th}-<85^{th} percentile) and at risk of overweight/overweight (BMI-for-age ≥ 85^{th} percentile). They were divided into four groups based upon the following fruit and vegetable preferences scores: very low (1-1.5), low (1.6-2.0), moderate (2.1-2.5) and high (2.6-3.0). Children who had very low preferences for fruits and vegetables were 5.5 times more likely to be at risk of overweight or overweight when compared to children who reported high preferences for these foods (Table 3.2). No such differences were observed between the low & high and moderate & high preferences groups (Table 3.2). When preference scores for fruits only or

vegetables only were examined, no associations were observed between preferences and risk of or overweight status ($p = 0.13$ & $p = 0.70$ for fruits and vegetables respectively).

Table 3.2. Odds of children being at risk of overweight/overweight[a] based on differences in mean group preference scores for fruits and vegetables[bc]

Variable	Odds Ratio	95% Confidence Intervals	*p* value
Very low Vs High	5.52	1.97 – 15.44	0.002
Low Vs High	2.01	0.90 – 4.48	0.72
Moderate Vs High	1.94	0.88 – 4.28	0.59

[a]At risk of overweight and overweight children were combined into one group (n = 126) and compared to healthy weight children (n = 205).
[b]Fruit and vegetable preference mean group score were as follows: very low (1-1.5), low (1.6-2.0), moderate (2.1-2.5) and high (2.6-3.0).
[c]The at risk of overweight/overweight group and the high mean fruit and vegetable preference group were used as the reference groups.

The present study suggests that children are more likely to prefer fruits as compared to vegetables. This might be explained by a preference for sweet flavored foods (21). Children's food preferences are often guided by taste alone (22). It has been proposed that children prefer sweeter vegetables and fruits rather than bitter ones (23). Individual differences in taste perception and preferences appear to be genetically influenced. Studies suggest that the inherited ability to taste bitter thiourea compounds such as 6-n-propylthiouracil, may be a marker of these differences (24). Propylthiouracil tasters show lower acceptance of cruciferous and other bitter vegetables and fruits (25).

The accessibility of fruits and vegetables to the child or availability in the home or at school may be important factors influencing a child’s preference and intake (26-29). Bere & Klepp (29) noted that children who were given high accessibility to FV demonstrated a greater change in preferences than those allowed only low accessibility. Preferences were positively

related to intake in children who were given frequent opportunities to select fruits and vegetables (27). With limited accessibility to fruits and vegetables, children's preferences were not related to intake (27). Similarly, Cullen and collegues (28) found that for children with high preferences the association with fruit and vegetable availability was substantial. However, those with lower preferences needed higher access to fruit and vegetables in order to begin eating sufficient amounts of these foods (28).

Children may also prefer foods with which they are familiar. Research suggests that dislike of foods can be transformed into liking with repeated tasting or "exposure" to these dietary items (22). Children's preference for and consumption of disliked vegetables can also be enhanced through opportunities to observe their peers selecting and eating these foods (30). Moreover, preferences for and increased consumption of fruits and vegetables by youth has been shown to be positively associated with authoritative parenting style and parent support for eating fruits and vegetables (31,32).

Food preferences may be established as early as three years of age (33), and children are thought to grow more accepting of new foods as they become older (34). Cook & Wardle (35), in a large sample of British children aged 4-16 years, examined age-related changes in liking for a variety of foods (35). These researchers reported that preference for fruits peaked at 8 to 11 years of age, but observed no difference across ages in preference for vegetables (35). Intervention programs intended to improve fruit and vegetable intake have demonstrated that children can increase their liking for fruits and vegetables throughout the elementary school years (37-39).

This study reports cross-sectional, self-reported data from a sample of fourth- and fifth-grade black children attending public schools in the southeastern United States. The child's

socioeconomic status was not directly assessed and school data regarding the percentage of children eligible to receive free or reduced price lunch was used as a surrogate measure to classify income status of the students. Therefore, the results should not be generalized to children of other races or ethnicities, socioeconomic groups, or ages, and indicate a need to further study and validate the findings with other groups.

3.4 Conclusions

Children who have low preferences for fruits and vegetables are at greater risk of being categorized as at risk of overweight or overweight when compared to those with high preferences. Children's preferences for fruits and vegetables are known to be positively related to their consumption of these foods; therefore it is important to help children develop preferences for fruits and vegetables at an early age. Nutritionists and other health care providers working with children and families should promote food environments that increase children's acceptance of fruits and vegetables as a measure to reduce the prevalence of overweight in children.

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CHAPTER 4

REPEATED TASTE EXPOSURE INCREASES LIKING FOR VEGETABLES BY LOW-INCOME ELEMENTARY SCHOOL CHILDREN*

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4.1 Introduction

Obesity is a serious and growing problem for children in the United States (1). Between 2001-2002 and 2003-2004 the prevalence of overweight elementary school children grew by an estimated 2.5% and currently includes 35.5% of that population (1,2). The increase in the number of overweight children is thought to be related to environmental factors favoring greater energy intake combined with lower energy expenditure (3). The consumption of energy-dense foods that lack fiber and antioxidant-rich fruits and vegetables has been reported as a risk factor for overweight in children (4-6). Despite the noted benefits of consuming these healthy foods, only 26% percent of children 6 to 11 years of age eat two or more servings of fruit each day and only 27% of boys and 24% of girls eat three servings of vegetables each day (7). Under-consumption of fruits and vegetables may be more common among children from low-income households due to several factors, including their cost (8), lack of access at home, and familiarity with these foods (9-11). Although many children may not be familiar with fruits and vegetables and therefore may choose not to eat them, these foods are available through the National School Lunch Program (8,12).

Several school-based intervention programs have been developed with the intention of improving the food environment and helping children increase their fruit and vegetable consumption yet few have successfully increased intake of these items by children (13-16). The 5-a-Day Power Plus Program (14) was a multi-component intervention that included two classroom curricula with ten 45-minute lessons that included skill building, problem solving activities, preparation and taste testing of healthy snacks, and a food service component that encouraged the selection and consumption of fruits and vegetables during the school lunch. Lunch room observations reported that the intervention resulted in an increased consumption of fruits and vegetables, although increased fruit consumption, not vegetables, accounted for the

majority of the observed change (14). A similar study (15) included components such as classroom activities with modeling, problem solving, reinforcement and taste testing, increased availability of fruits and vegetables in the school cafeterias, and parent encouragement at home to support the behavior change. Children in the intervention group consumed more servings of fruits and vegetables at follow-up 1 and 2 as indicated by the 24-h recall, but no differences were reported in the cafeteria observation data (15). The Cafeteria Power Plus project was another program that focused on environmental changes in school cafeterias (13). During the intervention, food service staff increased the availability of fruits and vegetables during the regular school lunch (at least one additional serving of fruits and vegetables) and verbally encouraged children to choose and eat fruits and vegetables on a daily basis. Taste tests of unfamiliar fruits and vegetables that can easily be incorporated into the regular school lunch menu were conducted monthly with the help of parent volunteers and student helpers. The intervention resulted in an increased intake of fruits and vegetables (without potatoes) and fruit juice but not vegetable consumption (13). Therefore, it is important to develop interventions that promote increased vegetable intake among elementary children because vegetables are poorly liked foods and are less likely to be chosen during school lunch (12,17).

Children's food preferences are known to be key determinants of their consumption (18). Foods that are rich in fat and sugars are typically preferred; low-calorie, nutrient-rich fruits and vegetables are poorly liked (19). Children of all ages tend to reject foods that are unfamiliar or taste bitter while preference for sweet and salty foods is a normative neonatal characteristic (18). The rejection of unfamiliar foods, referred to as neophobia, is highly associated with lower intake of vegetables by children (18,20).

It has been proposed that disliking particular foods can be transformed into liking through repeated tastings or exposures. Frequent experience with foods through sight, smell, and taste is

critical to achieving acceptance of these items by children (21,22). Repeated taste exposures and modeling of healthy behaviors have been found to be effective in increasing preferences and acceptance of the foods with infants (23), preschoolers (24-26), and school-age children (25-27), although the data on the number of necessary exposures have been inconsistent, with substantial variability observed by age group. One opportunity to taste a new food may increase liking in young children, whereas up to 15 exposures may be needed to enhance preferences in those of school age (23, 25-27). In addition, the number of necessary tastes depends on the type of the food offered. As few as three tastes may be sufficient to establish a liking for fruits, whereas vegetables may require a greater numbers of exposures (27).

Studies that examine the impact of repeated tastings of initially disliked vegetables in elementary school children are limited, yet this information has practical importance for schools and parents. It is also important to evaluate the effectiveness of food tasting programs in real-life settings where children make food choices such as school cafeterias. Such nutrition interventions may be particularly helpful for children from low-income households. Therefore, the purpose of the present investigation was to examine if repeated tastings of selected vegetables in an elementary school setting would increase children's liking for these items. An additional objective was to determine the number of tastings at which the maximum number of children reported a change in opinion from disliking to either liking or liking a lot.

4.2 Methods

Fourth- and fifth-grade students enrolled in four low-income public elementary schools in southeast Louisiana volunteered to participate in a pilot project called the "Wellness Partnership for Kids." The program consisted of a cafeteria-based vegetable tasting program that was combined with a school wellness curriculum called Smart Bodies that promoted healthy eating and physical activity (16). All the children attending the schools participated in the program, but

only data from the fourth- and fifth-grade children with parent consent and who provided written assent were included in the analyses. The study was approved by the Louisiana State University Agricultural Center Institutional Review Board.

The program began in the spring of 2008 with children receiving four freshly prepared vegetables in the cafeteria with the regular school lunch. The cold vegetables included one baby carrot, a small piece of tomato (1/32 of a medium sized tomato), and one-half tablespoon of diced green bell pepper. The hot vegetable included a one-half tablespoon serving of cooked canned green peas without any seasoning. The hot and cold vegetables were served in separate containers. The rationale for the selection of these specific vegetables was that children who had participated in a previous study (28) scored them as low- to medium-liked from a list of 38 vegetables. The researchers directed the children to taste the vegetables using a standard script as follows: "You were given two cups that contain four different vegetables. One at a time, please taste each of the four vegetables. You do not have to swallow them; you may spit them into your napkin after tasting. Please make sure that you taste each vegetable one at a time. There are some questions on the paper about each vegetable. Please read them carefully and answer them honestly."

The children completed the one-page survey, developed for the program, as they tasted each vegetable. The survey was composed of a table with four rows and seven columns. Each row contained a picture of a vegetable in the following order: bell peppers, carrots, peas, and tomatoes. The first three columns included the following: a picture of a napkin with the words "I spit it into the napkin," a picture of a mouth with the words "I swallowed it," and the words "I did not put in my mouth." The remaining four columns included cartoon faces and words: a frown face with the words "I did not like it," a smile face with words "I like it," a broadly smiling face with the words "I like it a lot," and the words "I do not know what it is" without a

face. Children were asked to indicate whether they spit each vegetable into the napkin, swallowed it, or did not put it in their mouth. They reported their liking of each vegetable using the faces scale (scored 1=I don't like this, 2= I like this, 3=I like this a lot, 4=I don't know what this is). The survey was developed and reviewed for content accuracy and readability by a panel of experts in the field of nutrition and child development prior to use. The faces scale used for the survey was an adaptation of a previously validated questionnaire by Cullen et al., (29).

The children who were willing to taste the vegetables were divided into two groups based upon their first response: Group 1 included those children who indicated that they "did not like" a particular vegetable (liking score of 1) and group 2 included those children who reported an opinion of either "liked" or "liked a lot" for the particular vegetable (liking score of either 2 or 3). The children's liking scores in the two groups were followed over the 10 tasting sessions for each vegetable. If a child refused to taste any of the four vegetables, he/she did not receive a score for that vegetable for that particular day of tasting. The children's liking score for each vegetable was scored separately.

The tasting component of the study was halted after the fourth tasting for three weeks due to school vacations and scheduled standardized testing, and was concluded with six additional weeks of tasting. The school food service personnel ordered and prepared the food for the tastings and the researchers filled the containers prior to the children's tasting. Three grandparents assisted the researchers in distributing the vegetable cups and encouraged the children to taste the vegetable items. The volunteers were not related to the fourth or fifth graders who participated in the taste testing.

4.2.1 Data Analysis

The surveys were scanned and coded using Remark Office OMR (version 6, 2005, Gravic, Inc, Malvern, PA), and the statistical analysis was conducted using the Statistical

Analysis Software (version 9.1.3, 2007, SAS Institute, Inc, Cary, NC). All the surveys were manually checked for unreadable data after scanning. Descriptive statistics for gender, grade, and ethnicity were computed. Generalized linear mixed model analyses (PROC GLIMMIX) were used to examine changes in the children's liking scores for each of the four vegetables over the 10 tastings. The Tukey Kramer adjustment of least square means (LSM) was used for *post hoc* analyses. The probability value was set at $p < 0.05$.

4.3 Results

Of the 550 fourth- and fifth-grade students who were invited to participate in the study, 360 (67%) returned parent consent forms and gave their assent to participate in the program. Fifty-five percent of the participants (n=360) were girls, 62% were fourth graders, and 83% were Black followed by 8% White, 2% Hispanic, 3% Asian, and 4% Others. Three hundred and forty children participated in the first vegetable tasting session (T1). The 20 children who either missed the first tasting session or reported "did not taste" for the targeted vegetables at the first tasting session were given an additional opportunity to taste and to be placed into one of the two groups. Three hundred forty-eight children tasted at least one vegetable during the first or second opportunity to taste (Table 4.1). No child reported "I do not know what it is" for any of the vegetables tasted at the any of the tasting sessions. The children who participated in at least eight of the 10 tastings for a particular vegetable (46.5% for group 1 and 68.5% for group 2) were included in the analyses for that item (Table 4.2). Among all the participants (n=348), the percentage of children who tasted at least eight times for each vegetable was 43% for bell peppers, 59% for carrots, 47% for peas, and 48% for tomatoes.

Changes in the liking scores over the tastings varied across the vegetables, between the groups, and between the genders (Table 4.3). In group 1 (the children who began the program with disliking the targeted vegetables), the liking scores improved for carrots, peas, and tomatoes

Table 4.1 Children's response to the four targeted vegetables at the first tasting based on their reported liking scores (*n*=348).

	Group 1[a]		Group 2[b]		Did not taste[c]
Vegetable	Swallowed	Spit it in the napkin	Swallowed	Spit it in the napkin	
Bell Peppers	32	129	103	15	69
Carrots	16	48	216	22	46
Peas	27	79	164	16	62
Tomatoes	25	89	144	17	73

[a]Children who reported dislike (score = 1) at the first tasting.

[b]Children who reported like/like a lot (score = 2 or 3) at the first tasting.

[c]Children who missed the first opportunity to taste or refused to taste at the first session were given a second opportunity to taste.

Table 4.2 Number of children that participated[a] in at least 8 of 10 tastings by group and gender (*n*=204).

	Group 1[b]		Group 2[c]	
Vegetable	Boys	Girls	Boys	Girls
Bell Peppers	24	46	33	47
Carrots	11	19	65	109
Peas	15	33	52	65
Tomatoes	16	41	46	63

[a]Children who reported either tasting (swallowed) or spitting the vegetable into a napkin were considered as participating.

[b]Children who reported dislike at their first tasting.

[c]Children who reported like/like a lot at the first tasting.

Table 4.3 Odds of liking select vegetables after ten tastings among children that reported not liking at their first tasting and children that reported liking/liking a lot at their first tasting[a].

	Group 1[b]			Group 2[c]		
Vegetables	Odds Ratio	95% CI	*P* value	Odds Ratio	95% CI	*P* value
Bell Peppers	0.43	0.18 - 1.01	0.46	1.20	0.51 - 2.84	0.86
Carrots	5.12	1.41 - 18.51	0.04	1.54	0.63 - 3.76	0.39
Peas	5.60	1.97 - 16.40	0.05	1.90	0.52 - 6.86	0.75
Tomatoes	2.75	1.11 - 6.80	0.00	0.31	0.13 - 1.21	0.11

[a]Children's liking scores at the tenth taste were compared to the first taste.

[b]Children who reported dislike at their first tasting: Bell peppers (*n*=70), Carrots (*n*=30), Peas (*n*=48) and Tomatoes (*n*=57).

[c]Children who reported like/like a lot at their first tasting: Bell peppers (*n*=80), Carrots (*n*=174), Peas (*n*=117) and Tomatoes (*n*=109).

(Figure 4.1). There was no change in liking scores for bell peppers. The children reported 5.5 times higher liking scores for carrots, 5.6 times higher liking scores for peas, and 2.8 times higher liking scores for tomatoes at T10 (tenth tasting) when compared to their liking score at T1 (Table 4.3). Boys reported a 1.6 times higher liking for tomatoes (OR 1.78, CI: 1.06 - 3.02, p=0.03) and a trend was observed that boys liked bell peppers (OR 1.55, CI: 0.94 – 2.56, p=0.08) and peas (OR 1.52, CI: 0.80 – 2.89, p=0.08) better when compared to girls. In the case of the children who began the intervention liking the targeted vegetables (Group 2), no change in the liking scores were observed for bell peppers, carrots, peas, and tomatoes when compared to the T1 scores (Table 3). No gender differences were noted for carrots (p=0.15), peas (p=0.14), or tomatoes (p= 0.77); however, a trend was observed that boys liked bell peppers more when compared to girls (OR 1.79, CI: 0.93 - 3.44, p=0.08).

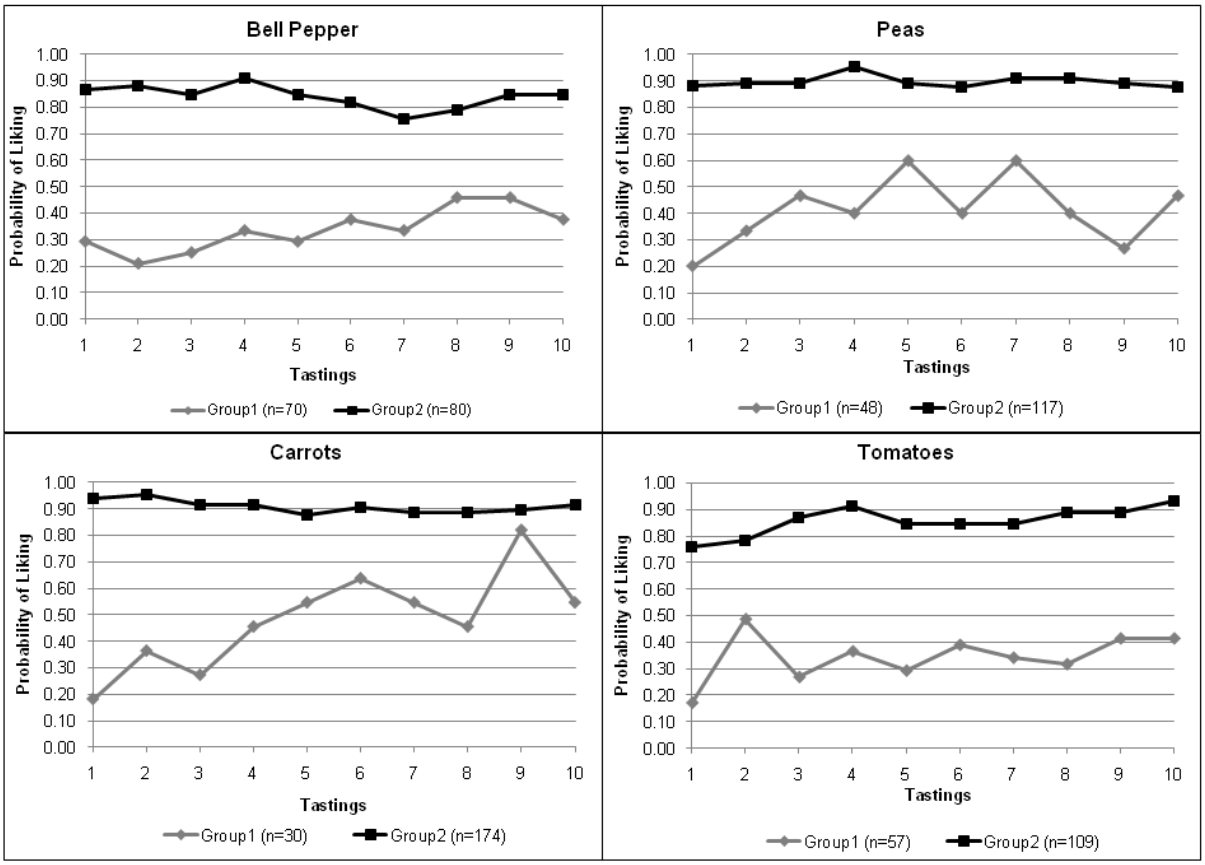

Figure 4.1 Change in liking scores among fourth and fifth grade children over 10 tastings
Note. Numbers on the horizontal axes correspond to the number of tastings.
Group 1: "Dislikers" at the first tasting (liking score = 1).
Group 2: "Likers" at the first tasting (liking score = 2 or 3).

In order to address the second objective of the study, the liking scores of the group 1 children were examined at each tasting (Table 4). The greatest percentage of children reported a change in opinion to liking or liking a lot by the eighth tasting for bell peppers (31%) and tomatoes (37%) and by the ninth tasting for carrots (77%) and peas (42%).

4.4 Discussion

The results of the present study suggested that participation in a school cafeteria-based vegetable tasting program is an effective way to increase children's liking for previously

Table 4.4 Children in Group 1[a] who reported like or like a lot (a score of 2 or 3) of targeted vegetables

	% of children									
Vegetable	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
Bell Peppers (*n*=70)	0	10	14	23	23	19	23	31	30	27
Carrots (*n*=30)	0	20	23	33	43	40	47	47	77*	60*
Tomatoes (*n*=57)	0	28	25	32	23	30	32	37*	37*	35*
Peas (*n*=48)	0	13	27	31	33	29	31	38	42*	40*

[a]Children who reported dislike (a score of 1) of targeted vegetables at the first tasting and completed eight of 10 tastings.

Note. T1-T10 refers to the tastings.

*$p \leq 0.05$, significance based on children's liking scores at each tasting compared to T1 scores.

disliked foods. Children who started the intervention program disliking the targeted vegetables and who tasted at least eight times during the 10-week program reported an improved liking of the foods. At the same time, children who began the program with a high liking of the targeted vegetables and were willing to complete the tasting program maintained their liking for the items. Several previous investigations conducted with infants and preschool children have

reported similar results (21, 23-27). To our knowledge, this is the first information reported about the effectiveness of a multiple-week school-based vegetable tasting program implemented in low-income public elementary schools.

The present investigation found that after eight to nine taste exposures the greatest percentage of children reported an improved liking score for previously disliked vegetables. This number of taste exposures was fewer than the 15-20 exposures that had been previously reported (21, 23,24,27). This might be explained by the fact that the previous studies involved younger children who were less familiar with the foods tasted. The children in the present study were older, had been exposed to the targeted vegetables through the school lunch program, and may have already established an opinion of them. This positive finding of fewer required taste exposures is significant because it makes tasting interventions more acceptable to schools and to parents.

Repeated taste exposures increased children's liking scores for carrots, peas, and tomatoes, but not for bell peppers. This might be explained by the fact that carrots and peas are sweeter in taste and children of all ages tend to prefer sweeter foods (31); certain vegetables (carrots, peas, cucumber, etc) are generally more liked than others (bell peppers, celery, etc); and children's individual differences, such as tolerance for bitter tasting foods, need to be taken into consideration (28,31).

4.4.1 Strengths of the Program

The "Wellness Partnership for Kids" program was unique because it tested the effectiveness of a cafeteria-based tasting program promoting multiple exposures to the taste of selected items in low-income public elementary school children. It was designed to be easily implemented in a school setting using available resources and personnel including cafeteria staff,

teachers, and parent volunteers. When used in conjunction with a school wellness plan, it offers a distinctive way to promote consumption of vegetables.

4.4.2 Suggestions for Future Research

Although the present study effectively increased children's liking of less liked vegetables, the low rate of participation needs to be addressed. The participants in the present study included fourth and fifth graders and it might have been better received by younger children. In addition, it is not known if the observed increases in liking are associated with an increase in consumption. Randomized controlled studies are needed to determine the most effective age to achieve an increase in liking and intake of vegetables and to maintain these positive behavioral changes.

4.4.3 Limitations

The results of this study were based on self-reported data from a sample of fourth and fifth grade children attending low-income public elementary schools in the southeastern United States where more than 80% of the children were Black. Therefore, the results should not be generalized to children of other races or ethnicities, socioeconomic groups, or ages. Additionally, the results were dependent upon children's truthfulness when completing the questionnaire and may have been subject to bias due to social desirability.

The present study was a pilot intervention without a control group. The purpose was to examine the effect of repeated exposure to specific vegetables on liking and no attempt was made to measure actual consumption. In addition, it was not possible to separate the individual effectiveness of the tasting program and the Smart Bodies wellness program on liking of selected vegetables. However, Smart Bodies was previously tested in a similar school setting and participation in the program resulted in increased nutrition knowledge and self-efficacy to consume fruit instead of a favorite dessert, drink fruit juice, and consume the recommended

amount of fruits and vegetables each day but did not increase preferences for fruits and vegetables (16).

In the present study, approximately half of the children who began the program failed to complete at least eight tasting sessions. A lower percentage of children who began the program disliking the vegetables (group 1) completed at least eight tastes than was observed for the children who began liking the items (group 2). This unequal participation limits the comparison between the groups. For those children willing to participate, the intervention successfully improved liking of three of four vegetables. However future interventions should include strategies which increase participation rate particularly among children who do not like vegetables.

The study had other limitations. The 3-point Likert scale may not have been sensitive enough to represent accurate liking/disliking of a particular vegetable. Furthermore, the selected vegetables were not excluded from the school lunch menus during this period. Baby carrots and seasoned cooked peas were offered three times, and tomatoes were offered nine times as a part of lettuce salad during the study period. Fresh bell peppers were not served but they were used in small amounts as seasoning in pasta sauce (three times), jambalaya (three times), and gumbo (eight times). While these vegetable items were available to children it is not known if they selected or refused them when offered with the regular school lunch during the study period. Finally, the short duration of the program and the three week break between the fourth and fifth tastings may have influenced the children's liking.

4.5 Conclusions

The "Wellness Partnership for Kids" vegetable tasting program demonstrated that repeated taste exposures to poorly liked vegetables increased liking for most of these items (three of four vegetables tasted) by those elementary school children willing to taste. Eight to nine

tastings may be necessary to impact the maximum number of children. The study procedure can be easily adopted by elementary schools and parents as a means to increase children's liking and acceptance of vegetables. Future research should be directed towards examining ways to increase participation, the most effective age for intervention, and the impact of greater liking on vegetable consumption.

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CHAPTER 5

A CAFETERIA-BASED TASTING PROGRAM INCREASED LIKING OF FRUITS AND VEGETABLES BY LOWER, MIDDLE AND UPPER ELEMENTARY SCHOOL-AGE CHILDREN

5.1 Introduction

Children's food preferences are known to be key determinants of their consumption (1, 2). Preferences are influenced by a variety of factors including a genetic predisposition to prefer sweet tasting foods and avoidance of unfamiliar or new foods (3). The tendency to reject new foods is referred to as neophobia, and it is suggested that children between two and six years of age express higher neophobia and that it decreases gradually after this time (4,5).

Food preferences may be established as early as three years of age (6), and children are thought to grow more accepting of new foods as they become older (7). Very few studies have examined the age- related changes in children's food preferences. Cook & Wardle (8) reported that preferences for fruits peaked between 8 and 11 years of age, but they saw no difference across ages in preference for vegetables in a large sample of British children aged 4-16 years. The number of foods tried increased with age but the number of foods disliked also increased with age (8). Another longitudinal study with children 2-8 years of age reported that foods introduced after the age of 4 years were more likely to be disliked or rejected than liked (6). However, intervention programs intended to improve fruit and vegetable intake have demonstrated that children can increase their liking for fruits and vegetables throughout the elementary school years (9-11).

It has been proposed that disliking of particular foods can be transformed into liking through repeated tastings or exposures. Frequent experience with foods through sight, smell, and taste is critical to achieving acceptance of these items by children (12,13). Repeated taste exposures have been found to be effective in increasing preferences and acceptance of foods with infants, preschoolers and elementary school-age children (14-19). However, investigations examining the effect of repeated taste exposure offered to the children in a public elementary school setting such as the school cafeteria are very limited. It is important to demonstrate the

effectiveness of food tasting in locations where children make food choices and to establish the age most effective for intervention. Therefore, the purpose of the present investigation was to examine the impact of multiple tastes of selected fruits and vegetables on first, third and fifth grade children's liking of these foods in the elementary school setting.

5.2 Methods

The participants were first-, third- and fifth-grade students from two low-income urban public elementary schools in southeastern Louisiana. The schools agreed to participate in a two-year intervention program. The "Building Preferences for Fruits and Vegetables" program began with eight weeks of cafeteria-based fruit and vegetable tasting followed by two additional weeks of tasting four and 10 months later. Parent consent and child assent were obtained. The study was approved by the Louisiana State University Agricultural Center Institutional Review Board.

The tasting intervention began in the fall of 2009 with vegetable tasting and was followed by fruit tasting a week later. This continued twice a week with fruits and vegetables offered on alternate weeks for eight weeks. Four and 10 months after the eight-week program children tasted vegetables twice during the first week and fruit two times during the following week. Small samples of four vegetables and four fruits were offered in the cafeteria during the regular lunch period. The vegetables served consisted of small pieces of a raw baby carrot, a piece of fresh tomato, one-half teaspoon of fresh diced green bell peppers, and one-half teaspoon of cooked canned green peas without any seasoning. Fruits included small pieces of fresh cantaloupe and canned apricots, peaches and pears. Vegetables and fruits were served in separate 1oz cups. The rationale for the selection of these specific fruits and vegetables was that children in a previous study had scored them as low- to medium- liked from a list of 38 fruits and vegetables (20).

Researchers guided the children to taste the vegetables and fruits during respective tasting

sessions using a standard script (19). Children were asked to complete a one-page survey immediately following the tasting of the four items. Each survey was composed of a table with four rows and six columns. Each row contained a picture of a vegetable/fruit in the order as follows: for vegetable tasting-bell peppers, carrots, peas and tomatoes; for fruit tasting-apricots, cantaloupe, peaches and pears. The first three columns included each of the following: a picture of a green circle-shaped cartoon face with an open mouth with the words "I chewed it and swallowed it," a picture of a napkin dispenser with the words "I spit it into the napkin," and a picture of a mouth with the words "I did not try it." The last three columns included the following cartoon faces and words: a broadly smiling face with words "I like it a lot," a smile face with words "I like it," and a frown face with the words "I did not like it." Children were asked to indicate whether they chewed and swallowed each vegetable/fruit, spit it into the napkin, or did not try it. They reported their liking of each vegetable/fruit using the faces scale (scored 3=I like it a lot, 2= I like it, 1 =I did not like it). The survey was developed and reviewed for content accuracy and readability by a panel of experts in the field of nutrition and child development prior to use and was pilot tested with a similar group of children in the same school district.

The children were divided into two groups based upon their response at their first tasting: Group 1 included those children who indicated that they "did not like" a particular vegetable/fruit (liking score of 1) and group 2 included those children who indicated either "like it" or "like it a lot" for the particular vegetable/fruit (liking score of either 2 or 3). The children's liking scores in the two groups were followed over the eight tasting sessions for each vegetable/fruit. If a child refused to taste any of the four vegetables/four fruits, he/she did not receive a score for that vegetable/fruit for that particular day of tasting. The children's liking score for each vegetable/fruit was scored separately. The same procedure was followed for the

two vegetable- and two fruit- tasting sessions which took place four months and 10 months after the eight week tasting program. All three grades were followed until end of the school year (four months follow-up) and first and third graders were followed into the next school year (10 months follow-up).

5.2.1 Data Analysis

Surveys were scanned and coded using Remark Office OMR (version 6, 2005, Gravic, Inc, Malvern, PA), and statistical analyses were conducted using the Statistical Analysis Software (version 9.1.3, 2007, SAS Institute, Inc, Cary, NC). All surveys were manually checked for any unreadable data after scanning. Descriptive statistics were computed for gender, grade and ethnicity. Generalized linear mixed model analyses (PROC GLIMMIX) were used to examine change in the children's liking scores for each of the four vegetables and four fruits over the 12 tastings. The Tukey Kramer adjustment of least square means (LSM) was used for *post hoc* analyses. The probability value was set at $p < 0.05$.

5.3 Results and Discussion

A total of 379 children were recruited to participate in the 18-month intervention. Fifty-one percent were boys (n=195), 32% (n=120) were in first-grade and 34% (n=130) were in third-grade. Approximately 59% of the participants were White (n=223), 38% were Black (n=146), 2% were Hispanic (n=8) and 1% (n=2) of children reported a race/ethnicity of Other. Of the total group of children, 283 children were present at the first tasting session. One additional opportunity was given to the children who either missed the first tasting session or reported "did not taste" for the targeted vegetables/fruits at the first tasting session to be placed into one of the two groups. The children (n=307) who tasted at least one vegetable or fruit during the first or second opportunity to taste and participated in at least six of eight tastings for a particular vegetable or fruit were included in the analyses for that item.

Table 5.1 Odds of liking select fruits and vegetables after 12 tastings among children that reported not liking at their first tasting[a].

	8 week intervention			4 month Follow-up			10 month Follow-up[c]		
FV[b]	Odds Ratio	95% CI	*P* value	Odds Ratio	95% CI	*P* value	Odds Ratio	95% CI	*P* value
Bell Peppers	5.0	1.14-22.22	0.04	7.6	3.62-16.12	0.00	12.04	4.69-30.30	0.00
Carrots	5.0	1.10-25	0.04	20.8	4.20-50	0.00	25	3.11-80	0.00
Peas	5.2	1.69-16.12	0.01	5.49	1.90-15.62	0.01	5.49	1.55-19.60	0.01
Tomatoes	4.6	1.89-11.23	0.00	4.06	1.74-9.52	0.00	11.76	11.76-50	0.00
Apricots	32.2	8.0-62.5	0.00	26.3	6.25-50	0.00	34.4	16.66-100	0.00
Cantaloupe	9.4	2.42-37.03	0.00	25	6.25-50	0.00	16.94	2.39-33.33	0.01
Peaches	62.5	8.40-500	0.00	66.6	8.92-500	0.00	95.23	66.5->500	0.00
Pears	12.5	1.25-41.66	0.00	13.6	3.47-52.63	0.00	32.25	4.6-90.9	0.00

[a]Children's liking scores at the eighth, tenth and 12th taste were compared to the first taste.

[b]Children who reported "did not like it" at their first tasting: Bell peppers (*n*=79), Carrots (*n*=25), Peas (*n*=38), Tomatoes (*n*=53), Apricots (*n*=34), Cantaloupe (*n*=32), Peaches (*n*=20) and Pears (*n*=29).

[c]Fifth grade children were not included in the 10 month follow-up assessment.

Changes in liking scores over the tastings varied across the fruits/vegetables and between the groups, grades, genders and time of the assessments. For group 1 (children who began the program disliking the targeted vegetables/fruits), the liking scores improved for all four vegetables and four fruits by the end of the 8-week intervention and at the two later follow-up assessments (Figure 5.1 and 5.2, Table 5.1). Vegetables required an average of five tastes whereas fruits needed only two tastes to observe a change in liking scores. At the end of the 8-week intervention, fifth graders liked bell peppers better than first (p=0.00) and third graders

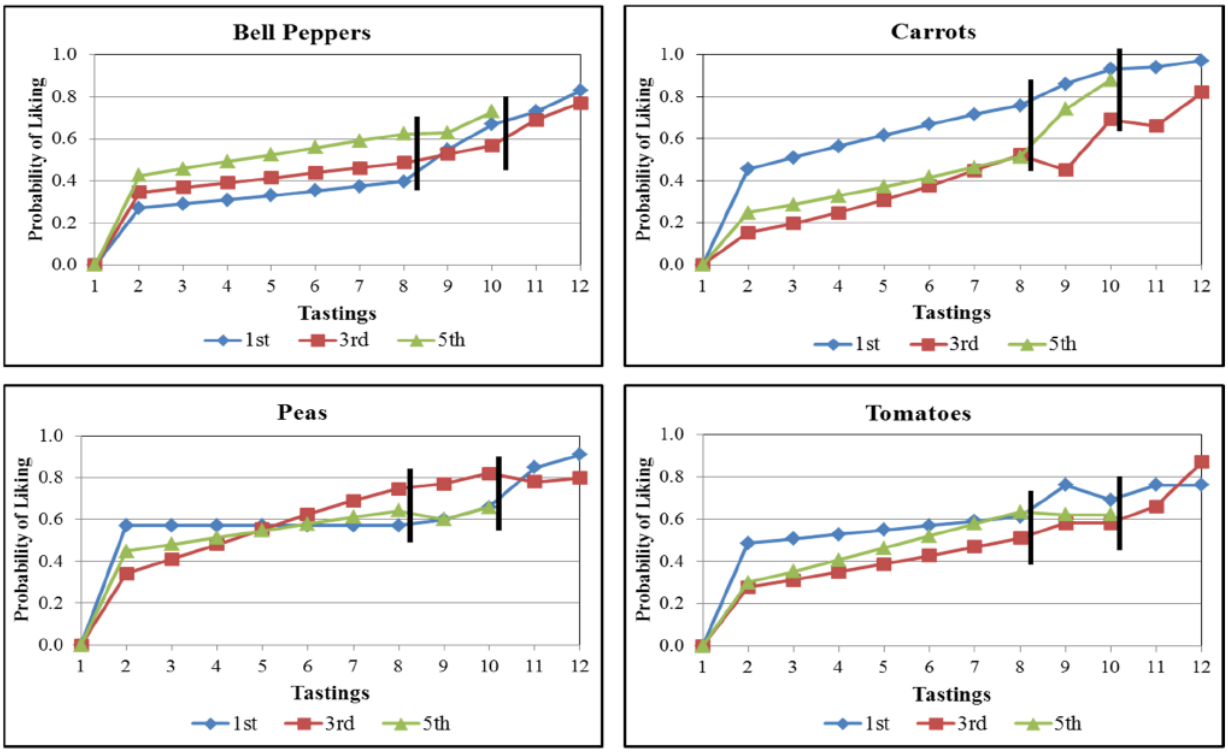

Figure 5.1 Change in liking scores among first-, third- and fifth-grade children who began the intervention disliking selected vegetables over 12 tastings.
Note. Numbers on the horizontal axes correspond to the number of tastings
The solid lines after the eighth and10th tastings represent the time gap between tastings (2weeks of follow-up after 4months and 10 months of the 8-week intervention)

(p=0.00), but no difference was observed between first and third graders (p=0.36). First graders liked carrots (p=0.04) and all four fruits better than third- (all fruits p<0.05) and fifth-grade children (all fruits p<0.05). No difference was observed for liking of peas (p=0.96) and tomatoes (p= 0.12) between grades. Girls reported higher liking for bell peppers (p=0.01), carrots (p=0.01), peaches (p=0.02), and pears (p=0.03) when compared to boys whereas boys reported higher liking for apricots (p=0.01) when compared to girls. No differences between the genders were observed for peas, tomatoes, and cantaloupe. In the case of children who began the intervention liking the targeted vegetables and fruits (Table 5.2), no change in liking scores were observed for any of the items tasted and no gender or grade differences were observed.

Children's liking scores for the eight vegetables and fruits in group 1 were maintained at both follow-up assessments (Table 5.1 and Figure 5.1 and 5.2). At the four month follow-up assessment, fifth graders liked carrots (p=0.04), cantaloupe (p=0.03) and peaches (p=0.00) better than third graders; third graders liked peas better than first (p=0.02) and fifth graders (p=0.05). First graders liked carrots (p=0.01), cantaloupe (p=0.00), peaches (p=0.00) and pears (p=0.00) better than third graders, but no differences were observed between first and fifth graders for these items. No such grade differences were observed for liking of bell peppers, tomatoes and apricots. Girls reported higher liking for carrots (p=0.04) than boys, but no differences were reported for liking of the remaining items. Only first- and third-grade children were assessed at the end of the 10 months follow-up. First graders liked carrots and all fruits better than third graders ($p\leq$0.01) and no differences in liking of bell peppers, peas, or tomatoes were reported between grades (Figure 5.1 and 5.2). No genders differences were observed for any of the items. In the case of the children in group 2, no change in liking scores were observed for any of the vegetables or fruits tasted over time or gender or grade at the four months and 10 months follow-up assessments (Table 5.2).

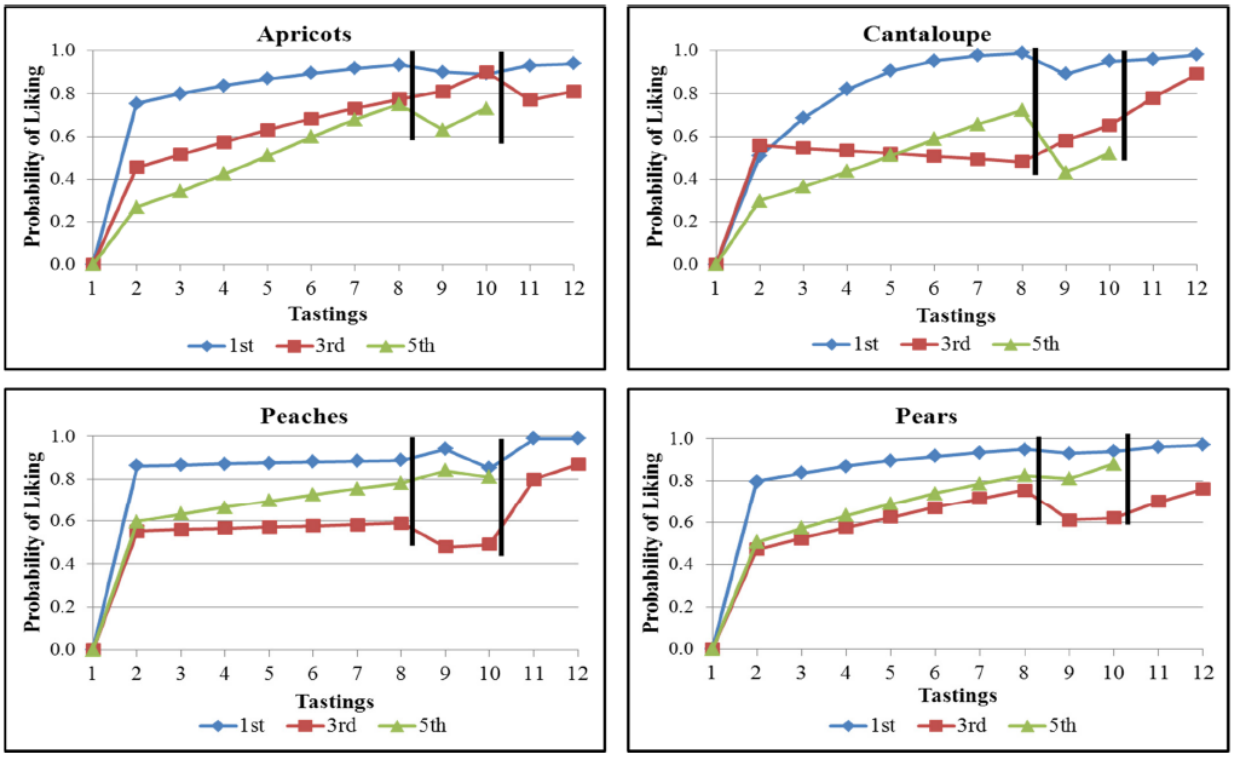

Figure 5.2 Change in liking scores among first-, third- and fifth-grade children who began the intervention disliking selected fruits over 12 tastings.
Note. Numbers on the horizontal axes correspond to the number of tastings
The solid lines after the eighth and10th tastings represent the time gap between tastings (2weeks of follow-up after 4 months and 10 months of the 8-week intervention)

Table 5.2 Odds of liking select fruits and vegetables after 12 tastings among children that reported like or like a lot at their first tasting[a].

	8 week intervention			4 month Follow-up			10 month Follow-up[c]		
FV[b]	Odds Ratio	95% CI	*P* value	Odds Ratio	95% CI	*P* value	Odds Ratio	95% CI	*P* value
Bell Peppers	0.83	0.31-1.95	0.62	1.65	0.58-4.71	0.61	0.71	0.26-2.04	0.41
Carrots	0.48	0.17-1.36	0.69	1.68	0.47-6.02	0.25	0.41	0.11-1.49	0.34
Peas	0.57	0.29-2.43	0.92	3.07	0.83-12.5	0.41	0.65	0.20-2.12	0.79
Tomatoes	0.84	0.30-2.39	0.96	1.00	0.37-2.64	0.96	1.21	0.39-3.71	0.98
Apricots	1.96	0.88-4.36	0.71	1.52	0.59-3.93	0.96	1.87	0.31-7.3	0.86
Cantaloupe	2.48	0.91-6.71	0.65	1.75	0.74-4.10	0.31	4.08	0.54-30.3	0.14
Peaches	0.21	0.02-2.24	0.87	0.33	0.04-2.48	0.39	1.50	0.36-7.46	0.99
Pears	1.34	0.33-5.31	0.88	1.00	0.28-3.53	0.85	1.51	0.30-7.13	0.86

[a]Children's liking scores at the eighth, tenth and 12th taste were compared to the first taste.

[b]Children who reported "like" or "like a lot" at their first tasting: Bell peppers (*n*=126), Carrots (*n*=246), Peas (*n*=196), Tomatoes (*n*=140), Apricots (*n*=263), Cantaloupe (*n*=255), Peaches (*n*=286) and Pears (*n*=278).

[c]First and third grade children only included in the 10 month follow-up assessment.

A cafeteria-based tasting program successfully increased liking of all vegetables and fruits tasted and the increased liking was maintained at two later follow-up assessments. Lower, middle and upper elementary school children who began the program disliking the targeted vegetables and fruits reported greater liking of these items and this improvement was maintained four months and 10 months following the program. At the same time, children who began the program liking the targeted items maintained their liking for these foods at each phase of

assessment. Several previous studies conducted with infants, preschool and elementary school children reported similar results (13-18) but none was conducted in the school cafeteria.

The present study found that an average of five tastes of vegetables and two tastes of fruits were required to observe a change in liking scores for children who began the program disliking the items. This number of taste exposures was fewer than the previously reported 8-20 exposures (13-15,19). This difference in number of tastings might be explained by the fact that some of these studies included unfamiliar food items whereas the present study included items that were familiar to the children and regularly served at school lunch. It has been reported that children are born with innate preferences for sweeter foods when compared to bitter foods (21) and this might be another reason why fruits required only two tastes to achieve a difference in liking whereas vegetables needed a greater number of tastes.

There were some age-related differences in liking of fruits and vegetables observed in the present study but they were different at each time point of assessment. All three age groups improved their liking for fruits and vegetables tasted and maintained their liking throughout the program. First graders liked carrots and fruits better than third and fifth graders at the end of the eight week intervention but these differences were not upheld at the four months follow-up. Fifth graders reported higher liking for some of these items at the four months follow-up than did first graders. Finally, at the end of the program first graders liked all fruits and carrots better than third graders. Fifth graders were not followed into the next school year therefore it is unknown if they maintained an increased liking of these items or not.

The results of this study were based on self-reported data from a sample of first, third and fifth grade children attending low-income public elementary schools in the southeastern United States. Therefore, the results should not be generalized to children of other ages, socioeconomic groups or geographical locations. The results were dependent upon children's truthfulness when

completing the questionnaires and may have been subject to bias due to social desirability. The responses of the children in the cafeteria-based tasting program were not compared to those of a control group. A true control may not have been possible for this type of study because studies have suggested that after only two tastes of some vegetables/fruits in the form of a pre- post-test evaluations, children experience a significant increase in liking scores (17). Age related changes in liking of specific fruits and vegetables over one year of time was measured but actual fruit and vegetable consumption was not measured. Furthermore, the selected vegetables and fruits were not excluded from the regular school lunch menus during the study period and it is not known if students selected or refused to eat them when offered.

The program had several strengths. This study offered a cost-effective, easily implemented method to help a racially/ethnically diverse group of elementary school-age children improve their liking for a variety of fruits and vegetables. To our knowledge this is the only cafeteria-based tasting program that included lower, middle and upper elementary school-aged children. The program was simple, well-accepted, and easily implemented in the school cafeteria setting using a minimum amount of available resources including cafeteria staff, teachers, and parent volunteers. This study did not force the children to taste or use reward as a method to encourage the children to consume these items. Instead this program simply asked children to provide their personal opinion of each fruit or vegetable tasted.

It is unknown if children who learn to like one fruit or vegetable will be more likely to prefer similar types of fruits or vegetables. Future studies need to examine if cafeteria-based tasting of some fruits and vegetables will result in overall increase in liking for a variety of these foods. In addition children's food preferences are strong predictors of their consumption, so future studies need to examine if the reported increases in liking achieved with school-based

tasting programs are accompanied by greater consumption of these foods. Also, studies involving longitudinal follow-up are needed to examine that the established liking for these foods will be carried into the later years.

5.4 Conclusions

This cafeteria based fruit and vegetable tasting program demonstrated that repeated taste exposures to poorly liked fruits and vegetables increased liking for these items by lower, middle and upper elementary school children and that liking was maintained up to one year following the intervention. An average of five tastes of vegetables and two tastes of fruits were required to observe a change in liking scores. The study procedure is simple and can be easily implemented in schools by using parents or other volunteers. Future studies should address whether this increased liking of the tasted items translates into liking and consumption of a wide variety of fruits and vegetables.

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CHAPTER 6

CONCLUSIONS

The work in this dissertation primarily focused on improving elementary school children's liking and preferences for less liked FV. Children were offered repeated opportunities to taste four vegetables and four fruits. We showed that repeated tasting of less liked FV successfully increased their liking for these items in low-income elementary school children.

Our study showed that children preferred fruits more than vegetables and among Black children there was a negative association between children's mean fruit and vegetable preference score and their body mass index-for-age percentile. Children who reported very low FV preferences were 5.5 times more likely to be categorized as overweight or obese when compared to those who reported high FV preferences.

We further showed that cafeteria-based food tasting interventions improved liking scores for poorly liked FV in elementary school-age children and increased liking was maintained one-year after the intervention. Fruits required two tastes and vegetables needed an average of five tastes to observe a change in liking scores for children who began the program disliking these items. Children who began the program liking the targeted FV maintained their liking for the tasted foods throughout the period of interventions.

Repeated tasting of less-liked FV by children is a promising strategy to promote liking of these items by lower, middle and upper elementary school children. Our study procedures are simple, cost-effective, and can be easily adopted by schools and parents using a minimum amount of available resources or personnel.

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VITA

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