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The Role of Flavor-Flavor Conditioning and Sensory-Based, Vegetable-Themed Education in Increasing Vegetable Consumption in Elementary School-Aged Children

Meagan Roxanne Latimer
Utah State University

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THE ROLE OF FLAVOR-FLAVOR CONDITIONING AND SENSORY-BASED, VEGETABLE-THEMED EDUCATION IN INCREASING VEGETABLE CONSUMPTION IN ELEMENTARY SCHOOL-AGED CHILDREN

by

Meagan Roxanne Latimer

A thesis submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in

Nutrition and Food Sciences

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UTAH STATE UNIVERSITY
Logan, Utah

2009
ABSTRACT

The Role of Flavor-Flavor Conditioning and Sensory-Based, Vegetable-Themed Education in Increasing Vegetable Consumption in Elementary School-Aged Children

by

Meagan Roxanne Latimer, Master of Science
Utah State University, 2009

Major Professor: Dr. Heidi J. Wengreen
Department: Nutrition and Food Sciences

This study aimed to increase vegetable consumption and preference in elementary school-aged children using two interventions: 1) flavor-flavor conditioning; and 2) sensory-based, vegetable-themed education. In both interventions, increase in consumption was measured by visual observation of how many vegetables children took and consumed from a vegetable buffet. Preferences were measured with a self-administered survey.

In the flavor-flavor intervention, children ages 5 to 11 (n=59) were exposed to sweetened and nonsweetened vegetable purees. Preferences were assessed prior to intervention using a rating and ranking system. Nine paired tastings were presented. Children received a posttest immediately after the final conditioning (n=27) and again 2 to 3 weeks after the final conditioning (n=24). A repeated measures ANOVA was used to examine the effect of conditioning (sweetened vegetable purees) on flavor preference. The change in attitudes and behaviors related to vegetables was evaluated using
independent samples t-tests. Pre- and post-flavor conditioning change in whole vegetable consumption was assessed using paired t-tests. Flavor-flavor conditioning is not an effective strategy to increase whole vegetable consumption or preference for vegetables in elementary school-aged children.

The vegetable-themed curriculum focused on four vegetables (carrots, peas, cauliflower, broccoli) and included three 30-minute lessons on each vegetable. Lessons included information on how the vegetable tastes, where it grows, and what it looks, feels, sounds, and smells like. Lessons were taught once per week for 3 weeks each month over four months. Children ages 5-11 enrolled in an after-school program at one elementary school were invited to participate (n=27). The amount of vegetables consumed by participants during a vegetable buffet was observed pre- and post-intervention (n = 20, 12 respectively). Differences in these amounts were assessed using independent samples t-tests. The education intervention was associated with increased consumption of carrots (p-value =0.001) and peas (p-value=0.003) but not cauliflower or broccoli. There was no change in vegetable-related attitudes/behaviors post-intervention. The results support the use of sensory-based, vegetable-themed education to increase vegetable consumption among children. Future studies should involve a larger sample size and should consider in-school rather than after-school education.

(229 pages)
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Meagan Roxanne Latimer
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CHAPTER 1
INTRODUCTION AND BACKGROUND

Abstract

Insufficient vegetable consumption in both adult and child populations in the United States is a health concern. Vegetables play a vital role in overall health, both in the promotion of wellness and the prevention of disease. It is critical to understand why vegetables are an important part of a healthy diet in addition to the components of food preference in order to formulate an effective intervention aimed at increasing vegetable consumption. Interventions to increase vegetable consumption among children are imperative as eating habits are learned early and not easily changed. Diet influences the risk of many diseases, cardiovascular disease in particular, and several have their roots in childhood. This study implemented and tested the effectiveness of flavor-flavor conditioning and sensory-based, vegetable-themed education in increasing vegetable consumption among elementary school-aged children. Intake levels were measured by means of plate waste data collection; attitudes and behaviors were assessed using hedonic surveys. Background, hypotheses, methods, and statistical procedures are included. This work was funded by the Carol M. White Physical Education Grant awarded to the Cache County School District (2007-2009).

Introduction

Health problems in the United States abound and many of the most prevalent diseases are affected by dietary behaviors. Vegetables play a critical role in the prevention of obesity by promoting a feeling of fullness on few calories and replacing
less healthy foods in the diet. Numerous studies indicate a critical role of vegetables in disease prevention by mediating obesity, considered by many doctors to be the leading cause of death in the United States as a precursor to many chronic diseases.

The objective of the research presented in this thesis project was to assess the effectiveness of two interventions aimed at increasing consumption of and preference for vegetables. The interventions were: 1) flavor-flavor conditioning using vegetable purees with preferences measured immediately post-conditioning and no more than three weeks after conditioning, and 2) providing sensory-based, vegetable-themed education in the after-school program. This project was supported by the Carol M. White Physical Education (PE) Grant awarded to the Cache County School District (CCSD), which is comprised of 22 schools including 12 elementary schools in northern Utah.

Collaboration between the CCSD and Utah State University Dietetics program faculty and students was developed to accomplish the nutritional objectives of this grant, which were broadly to enhance the nutritional environment for children in Cache schools. The Carol M. White PE Grant program was developed to help alleviate the burden of overweight and obesity in children in the U.S. The CCSD secured funds from this program to promote physical activity and proper nutrition among students attending Cache Schools. Many administrators and teachers in the CCSD agree that childhood is an appropriate time for health-based interventions in order to prevent disease in the children in the district. However, many professionals lack the resources for nutrition education development and or dissemination and purchasing of physical education equipment; the PE Grant helps provide for both of these needs.
Background

The evidence for increased vegetable consumption is reflected in the 2005 Dietary Guidelines for Americans (hereafter referred to as the “Guidelines”). The Guidelines are based on scientific evidence to promote health and reduce risk for chronic disease through diet and physical activity. As the most recent version of this federal document, the 2005 Guidelines advise individuals to consume between 9 and 13 servings or an average of four and one-half cups of fruits and vegetables daily, an increase from the previous 2000 Guidelines recommendation to consume 5 to 9 servings daily. Previous recommendations were not standardized to cup measurements (1).

Vegetables are a targeted and emphasized food group in the Guidelines with a focus on consumption of vegetables from all five vegetable subgroups that include dark green, orange, legumes, starchy vegetables, and other vegetables (1). A diet rich in vegetables would not only provide the deficient nutrients but would also help Americans meet the goal to consume fewer calories and other overconsumed nutrients including fat, sodium, and added sugar (1, 2).

Vegetable intake remains less than recommended and Americans are eating fewer vegetables now than was reported just five and ten years ago. Current habits as measured by the National Health and Nutrition Education Survey (NHANES) 2001-2002 data indicate that Americans generally need to increase vegetable consumption by 0.9 cups per day, with an increase needed in all vegetable subgroups with the exception of starchy vegetables among women (1). NHANES studies including 14,997 adults over the age of 18 from 1988-1994 and an additional 8910 adults from 1999-2002 for a total of 23,907 subjects demonstrated a slight decrease in the proportion of individuals meeting the
recommended level of vegetable consumption at three or more servings of vegetables daily.

Further data from the Behavioral Risk Factor Surveillance System (BRFSS) confirms low intake when compared with the current Dietary Guidelines, demonstrating that Americans are consuming far below that which is optimal (1, 3). BRFSS (1988-1994) data indicates that 35% of individuals met the recommendations for vegetable consumption. This fell to 32.5% of individuals meeting recommendations for vegetable consumption in the 1999-2002 survey (p = 0.026). The percentage of individuals in both surveys who reported no daily vegetable consumption was 25%. When excluding fried potatoes from consumption totals, both surveys decreased in percentage of people meeting vegetable consumption recommendations. In 1988-1994 consumption decreasing from 35% to 29.9% and in 1999-2002 consumption decreasing from 32.5% to 27.4% (p = .020) (4).

Both surveys provided evidence that older adults (aged more than 40 years in 1988-1994 and more than 50 years in 1999-2002) were more likely to meet or exceed recommendations for fruit and vegetable guidelines (p-value =<0.05) than their younger counterparts. According to the NHANES (1988-1994, 1999-2002) surveys, approximately 89% of Americans do not meet the USDA prescribed dietary guidelines for fruit and vegetable intake. Most individuals indicated a static consumption of the same vegetables rather than the recommended varied diet and there is currently no indication of improvement in vegetable consumption based on the NHANES surveys (1,4,5).
Children persist in the same low vegetable consumption pattern as adults. In the USDA Center for Nutrition Policy and Promotion’s Report Card on the Diet Quality of Children Ages 2-9, it is estimated that only 22% of children ages seven to nine eat three servings per day; only 19% of children ages four to six and 35% of children ages two to three meet this guideline, respectively (6). It is notable that vegetable consumption decreases with age within childhood and may be correlated with increased consumption of snack foods (6). Overall, the dietary quality of children ages two to nine is less than optimal. Poor eating habits in childhood lay a poor foundation for adult eating habits and may impair general growth and development in children (6).

Galloway et al. (7) found a modest negative significant relationship between food neophobia and vegetable consumption. Findings indicate that girls with neophobia ate fewer servings of vegetables compared with girls without food neophobia (7). They further determined that vegetable consumption among girls was well below the USDA recommendations and below the 2.2 servings a day that Krebs-Smith et al. reported in their study which examined three days of dietary records from 3148 children ages 2-18 (8).

The decreasing trend of both childhood and adulthood vegetable consumption may suggest that vegetable intake habits continue into adulthood. The Cardiovascular Risk in Young Finns Study indicated that there was some degree of dietary tracking, or stability of food choices, over a 21-year period that was stronger in older individuals (9). This study suggests that as individuals age, food choices become more predictable, validating the early intervention approach to dietary change. Patterns of fruit and vegetable consumption adopted in childhood persist into adulthood; intervention efforts
are appropriately directed to children (10). Early intervention is likely to maximize health benefits (11). Repeated food choices create momentum for similar food selections in the future (12).

**Causes of decreasing vegetable consumption**

The causes of decreasing vegetable consumption are many and include both inherent genetic factors and environmental factors. Isolating causes aids in directing the intervention approach. Poverty continues to be a barrier in purchasing and consuming fruits and vegetables (5). Findings using NHANES data indicated that individuals with average to high incomes were more likely to meet recommendations for fruit and vegetable consumption than were individuals with lower incomes (5). In her book *Food Politics*, Marion Nestle explains that barriers to fruit and vegetable consumption exist because of the competitive availability of inexpensive energy-dense food. Fruits and vegetables entail costs in fresh food distribution whereas the other energy-dense foods are manufactured based on government-subsidized crops. This makes energy-dense foods cheaper for manufacturers and therefore consumers (13). In his study on low-income mothers, Quan et al. (14) notes that research shows that those with limited income have lower total fruit and vegetable consumption than more affluent individuals. Quan suggests that educational methods that reduce barriers to the aforementioned behaviors should be pursued and would be helpful for this cohort in particular (14).

There is confusion as to how to implement the new dietary guidelines (15). Wardle et al. (16) determined that nutrition knowledge and vegetable consumption are positively correlated. Those in the higher knowledge groups reported eating more fruits and vegetables and less fat than those participants in lower knowledge groups. Without
nutrition knowledge in the statistical model, socio-economic (SES) status and occupational status are also significant determinants of fruit and vegetable consumption. When nutrition knowledge is added, SES and occupational status decrease to non-significance in regards to fruit and vegetable consumption. Nutrition knowledge therefore “mediates some of the SES variation in intake, especially for fruit and vegetables” (16). People in the highest nutrition knowledge category were nearly 25 times more likely than those in the lowest category to consume a healthy diet as defined by the survey. The results of the study provide evidence that nutrition knowledge is a significant component of fruit and vegetable consumption. Nutrition knowledge in this study explains 4-22% of the variation in intake of fruits and vegetables (16).

A review conducted by Eertmans et al. assessed the roots of liking or disliking foods in general (17). Personal preference is believed to play a major role of human food choice and intake in the absence of other potentially limiting factors like economics or ability to obtain food (17). For example, questionnaire data was obtained about women’s intended and reported consumption of four foods (milk, cheese, ice cream, chocolate and ‘high-fat’ foods—a generic category), showing that liking was a stronger predictor of consumption than health beliefs and evaluations although weight concern was a significant countering factor (17).

Food neophobia is a prevalent barrier to vegetable consumption, notably in children. Neophobia is different than pickiness in that neophobia is an unwillingness to eat unfamiliar foods; pickiness is an unwillingness to eat many familiar foods (7). It follows that children with food neophobia also maintain lack of variety in their diets (18). Infants exposed to a variety of vegetables during the weaning period are more likely to
accept new vegetables than those infants who are only exposed to one type of vegetable (19). Pelchat and Pliner concluded that there is a negative correlation between food neophobia and variety in the diet between the ages of 2 to 7 years (20), suggesting that early exposure to vegetables may ameliorate vegetable neophobia specifically. While parents are often charged with serving enough vegetables at home, Baranowski et al. concluded that most vegetables eaten by children are part of school lunches consumed on weekdays, not in the home. Therefore, school-based interventions should be of interest (21).

The focus on vegetables as a tool for weight management

Among all the dietary advice to consider, increasing fruit and vegetable intake may reverse current disease trends more so than any other change (22). It is stated best when Bazzano summarizes that an increased intake of fruits and vegetables is associated with a decreased incidence and mortality from the following diseases: cardiovascular diseases, stroke, hypertension, diabetes, obesity, and certain types of cancer (1, 2, 22, 23). The inherent properties of vegetables, including low energy density, low fat content, and high water and fiber contents can contribute to increased satiety and reduced food intake, leading to enhanced weight management (24, 25). These and other properties unique to vegetables provide for decreased prevalence of chronic disease among those who regularly consume generous amounts of vegetables. There are several observational reports that find a benefit for fruits and vegetables when assessed together, but when broken out, benefits were only observed for vegetable intake and not fruit (26, 27).

People do not stop eating based on calorie intake alone, but based on a feeling of satiety (24, 28). Short-term studies show that the volume of food eaten at a meal imparts
a feeling of fullness and causes a person to stop eating regardless of the calorie content of the meal (24,28). Foods that provide relatively few calories in a greater volume include foods with a high fiber and water content, such as vegetables. When holding calorie consumption constant, these foods allow a greater volume of food to be consumed in comparison to high energy-dense foods (24, 25, 28). This property may help people feel fuller faster and longer on fewer calories and thus be a helpful weight management strategy.

As an isolated factor, severe obesity affects most organ systems, making it obvious that obesity is an extensive health problem (29). Consumption of vegetables is a critical part of a nutrient-dense, low-calorie diet as part of preventing obesity or losing weight. Overweight and obese women on a hypocaloric, high vegetable diet decreased their weight, Body Mass Index (BMI), and fat mass (30). An increased consumption of vegetables is associated with a healthier dietary intake overall in both adults and children (31). More specifically, vegetables and fruit may replace the fatty foods consumed by children to help them maintain a healthy weight (32).

Higher vegetable diets for children are beneficial as weight and dietary trajectories persist from childhood to adulthood. Weight in early childhood may be indicative of weight in later childhood years. Guo and Chumlea (33) concluded that BMI values during adulthood are not related to BMI during infancy but they are related to BMI patterns by six years of age. The odds ratios of overweight for males at 35 years of age with childhood BMI values at the 95th percentile compared to those with BMI values at the 75th percentile doubled after about ten years of age (33). The same odds ratios doubled in girls after eight years of age. The odds of overweight at age 35 of those
individuals at the 75th percentile between the ages of eight and 18 were at least double of those participants at the 50th percentile for weight (33). The odds of overweight in adulthood for those with childhood BMI values at 95th percentile were 1.3 to 6.1 and 1.4 to 4.9 times as great for those with BMI values at the 75th percentile for males and females, respectively (33). A later, similar study focused on analysis of only the Fels sample, a longitudinal study of 166 males and 181 females from childhood to age 35, had similar findings (34). The Bogalusa (Louisiana) Heart Study is a community-based study of the natural history of cardiovascular disease risk factors beginning early in life, following children who matured to adults during the study (35). Of those who participated in the study, a subset of 841 participants was recruited to look at weight change and overweight status specifically. At baseline 24.7% of the nine to eleven year-old participants were overweight; at follow-up, when participants were 19-35 years of age 57.7% of participants were overweight. Nearly two-thirds of the participants that were in the highest BMI quartile in childhood were in the highest BMI quartile in adulthood; more than half of those individuals in the lowest quartile in childhood were still in the lowest quartile in adulthood. Less than 15% of the individuals who were in the highest quartile in childhood moved to the lowest quartile in adulthood. These findings indicate that childhood obesity tracks into adulthood and that children who are overweight are more likely to become adults who are overweight or obese (35). These results support the urgent need for obesity prevention efforts aimed at children and young adults. Obesity is considered by many experts to be the leading precursor to premature death in the United States (36, 37).
McCrory et al. (38), in a short-term study of 71 healthy men and women aged 20 to 80 years, concluded that there was a negative association between the variety of vegetables consumed (excluding potatoes) and body fatness. Comparatively, all other food groups were positively associated with body fatness (38). Adults tend to consume a consistent weight of food, so if low energy-dense vegetables are substituted for higher energy-dense foods, prompted by an increased variety, a lower BMI and caloric intake results (38). Consumption of a variety of vegetables increases absolute consumption of vegetables and decreases absolute consumption of other foods potentially higher in energy density. Decreased total calorie intake due to shifts in consumption of nutrient dense versus energy dense foods may contribute to decreases in body fatness. This relationship may be associated with the prevalence of obesity in the United States (38).

The etiology of obesity is complex and includes overconsumption of energy-dense foods, underconsumption of nutrient-dense food, physical inactivity and genetic predisposition; the challenge for effective intervention is real. There is some evidence that increasing fruit and vegetable intake among adolescents effectively decreases BMI (9). How fruits and vegetables fit into an overall healthy diet for that population yet remains a question.

**Vegetable intake and chronic disease**

Frazao (39) estimates that healthier diets including vegetables may decrease financial burden on the United States by $71 billion in costs related to CHD, cancer, stroke, and diabetes. This includes diet-related medical costs, diet-related productivity losses from disability, and the economic value of diet-related premature deaths (39). Avoidance of chronic disease not only allows for longer life but better quality of life.
Diet plays a major role in the development and prevention of many of the leading causes of death as listed by the CDC (39).

Hung et al. analyzed the Nurses’ Health Study (NHS) and the Health Professionals’ Follow-up Study (HPFS) for correlates of fruit and vegetable consumption and chronic disease. Both of these studies are prospective in design and boast large sample sizes, 71,910 female and 37,725 male participants, respectively. The median intake of fruits and vegetables was 5.2 servings/day for men and 5.3 servings/day for women; median intake of vegetables specifically was 2.94 in the HPFS and 2.88 in the NHS. Comparison of participants in the lowest quintile of fruit/vegetable consumption to those in the highest quintile showed that participants in higher quintiles had slightly lower risks of major chronic diseases. Of specific groups within fruits and vegetables, green leafy vegetables were the only statistically significant group associated with lower risk of major chronic disease and cardiovascular disease (23). Relative risk for chronic disease was .94 in the highest quintile of green leafy vegetable consumption and .99 for those in the lowest quintile of green leafy vegetable consumption, meaning a higher risk of chronic disease for those who have a lower intake of green leafy vegetables. Overall, consumption of vegetables, particularly green leafy vegetables, slightly decreased risk for chronic disease (p=.046); however, the overall chronic disease risk reduction demonstrated by the data is mostly attributed to a lower incidence of cardiovascular disease not other causes of death, including cancer (23).

Type 2 diabetes

Rates of type 2 diabetes among children have recently surged. The incidence of type 2 diabetes has increased 10-fold in adolescents since 1982; it may be assumed, with
current data on rising diabetes incidence and trends for underdiagnosis, that the increase may be even higher (40). It is now recognized as a common disease among children and adults (41). Early onset of the disease provides the opportunity for earlier manifestation of complications of the disease, including retinopathy, nephropathy, neuropathy, cardiovascular disease, and limb amputations (41). The most important risk factor of diabetes in children is obesity (29), which, as previously discussed, can be effectively combated with increased vegetable consumption. The median BMI of those adolescents diagnosed with type 2 diabetes in 1994 was 37; a “healthy” BMI is considered to be less than 25 (40).

*Metabolic syndrome*

As reviewed by Lobstein et al. (29), metabolic syndrome, or the coexistence of hypertension, hypertriglyceridemia, low HDL cholesterol and hyperinsulinemia is common among obese adults who were obese as children. Cardiovascular disease is increased with the presence of metabolic syndrome (42, 43). Metabolic syndrome exists in children as well; nearly 50% of those who are severely obese have metabolic syndrome and it is suggested that adult metabolic syndrome has its roots in childhood (44, 45). This provides another compelling reason for early intervention.

*Cardiovascular disease*

Freedman et al. (46) utilized the Bogalusa Heart Study to examine the relationship of overweight to cardiovascular risk factors using the final measurement from the Bogalusa study. Overall, the study determined that overweight children and adolescents had a higher prevalence of cardiovascular disease risk factors than did healthy-weight
children. Notable increases in risk factors were observed at Quetelet (BMI) index levels higher than the 85th percentile for all genders and ages. The prevalence of all risk factors increased notably between the 95th to 97th percentile and the greater than 97th percentile indicating that the greater the obesity the higher prevalence of cardiovascular disease risk factors (46). Cardiovascular disease risk factors evaluated included total cholesterol, triglycerides, low-density lipoprotein cholesterol, and high density lipoprotein cholesterol (46).

Caprio et al. (47) describe increased blood lipids with a pattern of increased low-density lipoprotein-cholesterol and triglyceride levels and decreased high-density lipoprotein-cholesterol levels in both obese children and adolescents. The odds ratio for obesity at age 35 years increased from ~2 for males and females who were obese between the ages of one and six years to five to ten for children who were obese at ages ten to fourteen years. The odds ratios for obesity at ages 15 to 18 years ranged from 8 to 57 for males and from 6 to 35 for females (41, 47).

A longitudinal study for 15 years of 1159 children aged 5 to 14 years found that their lipoprotein levels as children correlated with their levels when they became adults, total cholesterol \( r=0.6 \) and LDL cholesterol \( r=0.4-0.6 \) (48). The associations were weaker for high-density lipoprotein and triglycerides. The best predictor for adult dyslipidemia was childhood LDL level. Weight gain over the 15-year study period was second to LDL cholesterol in predicting adult plasma lipid levels (29, 48). These studies suggest that cardiovascular disease risk factors that are present in childhood will persist into young adulthood (47, 49).
Obesity is associated with hypertension in adults and children as a risk factor for cardiovascular disease (29). Up to 30% of obese children suffer from hypertension (50). Additionally, waist circumference and skin fold measurements are positively correlated with resting blood pressure in children (29).

One example of a dietary intervention that included generous amounts of fruits and vegetables and was successful at reducing blood pressure among those with hypertension is the DASH diet implemented in the DASH trials. The combination diet providing more fruits and vegetables than the traditional American diet with the added component of higher amounts of calcium in the form of low-fat dairy products was found to be the most effective (2).

The results of the DASH study indicate that fruits and vegetables are an integral part of decreasing blood pressure as a risk factor for heart disease (2). Adoption of a diet similar to either the fruits and vegetables diet or the combination diet can have antihypertensive effects within two weeks. It follows that children would benefit from the same type of intervention; however, no similar trials have been reported among children.

Cancer

The evidence for vegetable consumption for cancer prevention is currently inconclusive. Hung et al. found no association between fruit and vegetable intake and incidence of cancer in analysis of the NHS and the HPFS (23). In a pooled analysis of 14 cohort studies, Koushik et al. (51) found no strong association of colon cancer risk with intake of vegetables, but fruit and vegetable intake may be associated with a lower risk of distal colon cancer. The Polyp Prevention Trial, including an eight-year follow-up of
patients on a high-vegetable, high-fiber, high-fruit, low-fat diet, showed no significant impact of the treatment diet on the occurrence of polyps in the large bowel (52). A prospective study on the effect of lycopene from tomatoes on prostate cancer concluded that greater consumption of lycopene from tomato products does not protect from prostate cancer (53).

Determinants of vegetable consumption

While psychosocial factors such as attitude, social influence, and self-efficacy explain much of vegetable consumption in children, addition of other factors like exposure, parental consumption and habit improve the proportion of explained variance in vegetable intake (54).

Individuals rarely eat food which does not taste good to them and is therefore often considered a minimum criterion for food consumption (55). Pliner et al. (56) explain that even in “safe” environments like cafeterias, individuals are not neophobic because they are frightened that the food might be poisonous as in Paleolithic times, but because they fear that the food will taste bad. Research with children in particular has demonstrated that taste is the most influential determinant of vegetable consumption. Among 9 to 11 year-olds, preference for vegetables was more influential than either parental vegetable intake or attitudes in regards to vegetable consumption patterns (57), (58). It is argued that food preference is learned through experience with both food and eating in contrast to the view that food preference is innate and governed by the body’s need for nutrients (59-61). The etiology of food preference can be seen as a convergence of two broad categories that, together, constitute a developmental systems perspective: 1)
genetic predisposition and, 2) eating environment or the association of food with the context and consequences of eating that food (60).

The genetic predispositions that provide the foundation for food selection include three principles: 1) the innate human preference for sweet and salty and the aversion to sour and bitter tastes; 2) the propensity for rejecting novel food items (neophobia) and acquire a learned preference for the familiar; and 3) the predisposition to associate foods with the contexts in which they are offered (60). Food preferences and food selection patterns are phenotypic behaviors that result from gene and environment interactions (60).

A variety of studies have consistently shown that infants prefer sweet taste, with a greater preference for sweeter concentrations, and a corresponding relaxation of the facial muscles which resembles a smile, indicating that preference is innate through genetics (62-64). When more time elapses (exposure does not occur immediately before food intake), responsiveness and preference is greater (62).

Certain “tastants” are known to suppress bitterness and include aspartame, sodium acetate and salt (65). When studying adults, aspartame, by imparting a sweet flavor, universally increased preference for bitter vegetables. The addition of sodium acetate and salt increased preference slightly, but not as effectively as aspartame (65). When added to vegetables at school, 2/3 of preschoolers preferred the sweetened vegetables over the nonsweetened (65).

A study done by Dinehart et al. explains how sweetness and bitterness mediate preference for respective vegetables (66). Test subjects tasted vegetables typically considered bitter (kale, asparagus, and Brussels sprouts) as well as foods typically
considered sweet (marshmallow fluff and chocolate) (66). Subjects were also asked to fill out a food frequency questionnaire to predict the number of vegetable servings consumed. Those with lower BMIs reported a higher vegetable consumption. Those who tasted 6-\textit{n}-propyliouracil (PROP) as more bitter (supertasters) also detected a higher amount of bitterness in sampled vegetables and a higher amount of sweetness in the sampled sweet foods. Vegetable sweetness and bitterness are positive and negative predictors of vegetable preference, respectively (66).

The degree of neophobia often increases as infants mature into young children. In infants, one exposure to a new food item was sufficient to increase intake of that item at a subsequent feeding (67). In contrast, anywhere from 5 to 10 exposures of a food item is required to increase preference of that food in young children (67). The age of a child at the time of exposure correlates with his/her extent of food neophobia in the future. Pelchat and Pliner found that food neophobia scores were negatively correlated with a child’s exposure to dietary variety between the ages of 2 and 7 (20). They concluded that an early exposure to vegetables may ameliorate future vegetable neophobia or preclude that neophobic response (20).

Reduction in neophobia through exposure to one food generalizes to similar foods. For example, repeated exposure to a carrot may transform an initially neophobic child into a child more accepting of carrots in particular and vegetables in general (67). The neophobic trend declines in older childhood. Neophobia may be more easily overcome as they are able to associate new foods with familiar tastes through “flavor principles” or the ability to correlate taste information they know about similar foods to the food which they have not tasted (68). Children’s dislike for vegetables is consistent
across cultures; vegetables are consistently ranked at the bottom of food preference lists demonstrating the universal preference of food with high fat and sugar content (69).

In Blanchette and Brug’s review of fruit- and vegetable-based interventions, they concluded that the knowledge deficit regarding fruits and vegetables is often addressed and has been observed to be only moderately effective on its own (58); targeting other determinants may demonstrate increased acceptance and consumption of vegetables.

The environmental determinants of vegetable consumption among school-aged children include availability of the vegetable in the home, parental attitudes and behavior, and access to school snack bars and other competitive foods like candy and soda (58). Baranowski et al. (21) concluded through research on vegetable consumption patterns by day and by meal for 7-13 year olds that weekday lunch consumption accounted for most of the weekday servings of vegetables. The average consumption of fruits and vegetables at weekday lunch was positively correlated with participation in school lunch (21).

Low availability of vegetables in the home leads to decreased exposure, leading to potential dislike when the vegetable is consumed (58). Similar dietary habits are developed within families and many studies have shown that the vegetable consumption of the head of the household is directly related to the children’s consumption (58).

Availability of fruits and vegetables, particularly in the home, is one of the most important environmental factors influencing consumption (58, 70, 71). Another component that is relatively new is accessibility and facilitation, meaning fruits and vegetables are easy to obtain and in a form that facilitates children eating them (58).
Methods of increasing vegetable consumption

An understanding of the components of food preference is important in developing effective strategies in promoting healthy diets (60). In recognizing the major role that preference plays in vegetable consumption, Wardle et al. emphasized that interventions that aim to modify preference are those that could have a critical role in changing vegetable consumption (72). Effective methods of increasing vegetable preference and intake include exposure and flavor-flavor conditioning.

Experience or exposure may lead to new food likes, an alteration of current likes, or maintenance of innate likes that may otherwise disappear with mere exposure being a central mechanism. This mechanism has been attributed to influence even in early infancy. The more frequently a food is tasted, the more it is liked. An exposure to a target food once a day for ten days can dramatically increase intake of the target food and intake may nearly double after only one exposure (72). Research supports the fact that early repeated exposure reduces food neophobia in young children (7). The method by which exposure increases preference is through the principle of “learned safety” (69). Another theory is that preference is increased simply with an increase in familiarity of taste (69). In summarizing exposure research, Birch describes that the predisposition to prefer sweet and reject bitter can be readily altered via exposure (60). Research of food preference development confirms that there is a strong link between early exposure and food acceptance (69). In a survey done with 564 mothers of preschoolers, 2 to 6 year-olds who were introduced to fruits and vegetables early during the weaning period had a higher frequency of consumption of fruits and vegetables as preschoolers. In a different
study, two to seven year-olds who were given a larger variety of foods early in life were more willing to try new foods (69).

Exposure methods work best when time has lapsed between exposure and trial (69). In a group of preschoolers, increased response was seen when a week lapsed after an eight-trial exposure (69). Exposure to vegetables is essential in improving intake (60, 73). Not only are individuals more apt to eat that particular vegetable, but individuals are also less reluctant to try other vegetables (72). An exposure-based approach to research aimed at increasing vegetable consumption is validated as “repeated food choices create momentum for making the same food selections in future circumstances. Food choice trajectories provide momentum leading to habitual food selections” (12).

Flavor-flavor conditioning in general is the co-occurrence of a neutral flavor with an already liked or disliked flavor which will then elicit increased like or dislike of the neutral flavor (73, 74). Flavor-flavor conditioning can be a powerful way to increase preference of foods, partially because of the exposure component of conditioning through repeated offerings (17). There are discrepancies in this relationship, however, which can be attributed to the impact of other factors on eating behavior (17).

Zellner et al. (75) demonstrated that humans can learn to prefer a new taste that has been previously paired with a sweet taste, even when unsweetened. Zellner et al. utilized two tea flavors, one of which was served 24 times in sweetened water and the other of which was served in plain water. There was an enhanced preference for the tea flavor sweetened during the intervention as compared to the flavor served in plain water when both flavors were presented unsweetened (75). This approach may be successful in increasing preference for vegetables in that bitter taste exists in both.
Havermans and Jansen found the concept of flavor-flavor learning to be successful in increasing preference for vegetables (73). The Havermans study will be replicated in this thesis. The Havermans study obtained two “neutral” vegetable flavors from 13 total participants (nine boys and four girls) who ranked six different vegetable flavors: zucchini, pumpkin, pea, cauliflower, broccoli, and carrot (73). Mean age of participants was 5.2 years with a standard deviation of 1.1 years. The series of vegetables was chosen based on convenience and availability. Fresh vegetables were cooked separately until soft and then pureed using a kitchen blender. About 50 grams of the puree was diluted with 100 grams of water and poured into an opaque cup. The cup was fitted with a plastic lid through which a straw was placed. The opacity of the cups eliminated any preference bias based on color, scent, or other sensory properties of the vegetables. Small groups of 2 to 5 children per two experimenters were taken away from the larger group of children and tested (73). As the children received the opaque cups, they were instructed to take a sip of each and characterize it as liked, disliked, or just okay. Using these general categories, children were instructed to rank flavors from one (most liked) to six (least liked). The tastes ranked three and four by each child were to serve as their personal conditioning stimuli (CS) during the conditioning phase.

Children received three paired presentations of the two flavors that were ranked neutrally with both flavors prepared the same as the flavors in the pre-test. To one of the tastes, 20 grams of dextrose was added (CS+) and the other flavor remained unsweetened (CS-). The flavor to which the dextrose was added was determined randomly for each child. Carrot and cauliflower served seven times as either CS+ or CS-, broccoli five times, pea four times, zucchini twice, and pumpkin served only once as a CS.
During the conditioning, the children were instructed to taste both the sweetened and unsweetened mixtures every five minutes. The experimenter would also sip from an opaque cup with the child but did not make any remarks or facial expressions that could sway the preference of the child. The following day, the same children were brought from their classroom to receive a further run of three paired presentations of the two flavors. Immediately after the second conditioning session, the children were given a post-test that was the same as the pre-test. The hypothesis was that the flavor conditioned as CS+ would increase in preference at the post-test when it was unsweetened with no change in preference for the CS-.

A 31% preference for the sweetened mixture pre-test and a 54% preference for the sweetened mixture presented unsweetened at post-test demonstrates that flavor conditioning increases preference for a flavor (73). While the children demonstrated increased preference for the sweetened vegetable mixture, they demonstrated no increase in preference for the unsweetened. This was attributed to the low number of exposures as Wardle et al. suggested that children must be exposed to a new flavor 10-15 times before it is accepted (72). It may be assumed that increased exposures in addition to flavor-flavor learning would increase the preference of an unsweetened vegetable (58, 72, 73). It is evident that preference can increase over a short period of time but the question remains as to whether the flavor preference can be sustained over longer periods (73).

An advantage of the flavor-flavor learning method over mere exposure is that it requires few trials to cause a shift in preference (73). It is further argued that flavors acquired through conditioning are resistant to extinction and therefore stable over a longer period
The extended nature of the flavor-flavor conditioning acts to merge the idea with exposure methods. This combination will enhance the preference of vegetables.

Many nutrition interventions are education-based. As an intervention to increase vegetable consumption, nutrition education is only moderately effective, if at all (58). Wardle et al. researched the difference between parent-led exposure versus parent knowledge on the consumption of vegetables in the household (72). Parents were instructed to give their children a taste of red pepper every day for 14 days (72). In the information intervention group, parents were given a pamphlet about increasing fruit and vegetable consumption, and a third group received no intervention. The percentage of children in the exposure group who voluntarily consumed the selected vegetable increased from 47% pre-intervention to 77% post-intervention. In contrast, the information intervention group increased only from 45% to 60% and the control group decreased from 55% to 50%. The increase in willingness to eat the vegetable was only significant for the exposure intervention group. This is significant particularly because it was a “real world” situation in which parents led the exposure rather than a laboratory-type setting (72). It is notable that the provision of nutrition information had such little impact on a change in vegetable consumption (72). This research suggests that greater nutrition knowledge held by parents or children does not predict an increase in the consumption of healthy foods (72).

Baranowski et al. conducted a review of literature on school-based obesity interventions. Of the 20 research studies reviewed by Baranowski et al. that included measures of BMI, seven resulted in the desired changes; 13 did not. A main characteristic of six of the successful studies is that staff trained and educated outside of
the school system conducted the studies. Chances are that teachers who administer the intervention have difficulty implementing it as intended, which results in an ineffective intervention (76).

As to the effectiveness of current reigning methods of increasing vegetable consumption, classroom curriculum in conjunction with school foodservice cooperation and parent/home initiatives is the most effective (58). While multi-directional interventions seem to be the answer, critical components continue to be ignored. Interventions should be tailored to the specific determinants of vegetable aversion in order to have an effect (58). There are both environmental and personal determinants of vegetable consumption and while the current model addresses some, it does not address others, perhaps those that are the most influential (58).

Blanchette and Brug concluded that multi-component, school-based interventions deliver good results (58). Elements that should be included in the classroom component are “asking skills” to improve the accessibility and availability of fruits and vegetables and skills in the preparation of simple and tasty fruit and vegetable recipes (58).

Providing opportunities to experience flavor properties of a food has more impact on increasing food preference than telling a child that the food is beneficial for his/her health (77); including this component in education would make it more effective than traditional informative education.

In Silberman’s book entitled *Active Learning: 101 Strategies to Teach Any Subject*, he describes the importance of hands-on, active learning:

Learning is not an automatic consequence of pouring information into a student’s head. It requires the learner’s own mental involvement and doing. Explanation and demonstration, by themselves, will never lead to real, lasting learning. Only learning that is active will do this. What makes learning “active”? When learning is active, students
do most of the work. They use their brains… studying ideas, solving problems, and applying what they learn. Active learning is fast-paced, fun, supportive, and personally engaging. Often, students are out of their seats, moving about and thinking aloud… To learn something well, it helps to hear it, see it, ask questions about it, and discuss it with others. Above all, students need to “do it”—figure things out by themselves, come up with examples, try out skills, and do assignments that depend on the knowledge they already have or must acquire. (78)

It takes several and different kinds of exposures to material to comprehend it (78).

A study by Benware and Deci (79) examined whether students who learned actively would be more motivated to learn and would learn more than students who learned passively. The active situation was created by having subjects learn material with the expectation of teaching it to another student; the passive situation was created by having subjects learn the same material with the expectation of being tested on it. Subjects who learned in order to teach were more motivated and had higher learning scores (79).

**Hypothesis**

The following hypotheses were studied among elementary school students at three elementary schools in the Cache County School District:

1. Vegetable preference will increase with flavor-flavor conditioning.
2. Flavor-flavor conditioning will have a sustained effect of at least two weeks on vegetable preference in children.
3. Vegetable preference will increase with sensory-based education.
4. Vegetable preference will have a higher increase with flavor-flavor conditioning paired with sensory-based education.
Methods

The methods and procedures of this study were reviewed and approved by the Utah State University (USU) Institutional Review Board, the Cache County School District (CCSD), and the Boys and Girls Club after-school program to ensure the protection of all participants. All participants and participant parents/guardians were informed of potential risks and benefits associated with participating in the study through a letter of information sent home with the students. Signing the forms excluded their children from the data collection associated with the research without penalty.

Participants were recruited from two after-school Boys and Girls Club programs in Cache County School District. Schools were chosen based on higher levels of student participation in the Boys and Girls Club and geographic location in relation to the university. Other schools were excluded based on a high Spanish-speaking population and the inability of the educators to speak Spanish. Schools chosen were North Park Elementary and Park Elementary. Additional participants were recruited from a single fourth-grade class at Summit Elementary; none of the additional students were already participating in an after-school intervention.

Park Elementary received the flavor-flavor conditioning and North Park Elementary received sensory-based vegetable-specific education. The additional recruited fourth-grade class participated in the flavor-flavor intervention only. Data were collected from February 2008 to May of 2008. Students participated in a vegetable buffet/plate waste study and filled out vegetable consumption/attitude/behavior surveys pre- and post-intervention. Both schools received the vegetable buffet.
At those schools receiving the education intervention, 12 intervention days were included with education on four different vegetables: cauliflower, carrots, peas, and broccoli. Educational methods focused on the five senses in experiencing and gaining a preference for vegetables. The curriculum developed for this study was named *Viva Vegetables* (VV). Each vegetable was taught through three modules:

- **A Tasty Little Vegetable**: Emphasized the taste properties of vegetables, the difference between different types (i.e. cooked versus raw, canned versus store-bought versus locally garden-grown) and the mouth-feel of vegetables;

- **Exploring Vegetables with the Senses**: Helped children use all of their senses to experience vegetables. They discussed how vegetables feel, sound, smell and what vegetables look like. They connected sensory experiences to already familiar experiences; and

- **How It Grows**: Helped children understand how vegetables get from the garden to their plate. They expressed an understanding of one reason that the specific vegetable was healthy for them to eat and what part of the plant the vegetable was (root, stem, leaf, flower, fruit, or seed).

At the school receiving the flavor-flavor conditioning intervention, baseline preference data was collected through whole vegetable and vegetable puree with three subsequent conditioning days with the post-conditioning data collected the last day of the conditioning and then again greater than two weeks away from the last post-assessment. Initial preference testing was comprised of ratings and rankings, ratings being the determination of the taste of the vegetable itself and rankings based on the preference of
the vegetable in relation to other vegetables. The rating and ranking sheets used hedonics and numbers in order to assist participants of all ages.

Repeated measures statistics were used to assess effectiveness of the flavor-flavor intervention and paired and unpaired t-tests were used to examine the difference between vegetable consumption and preference at baseline and after interventions using the vegetable buffet and survey data. Pearson Correlations were utilized to determine the effect of multiple lessons on vegetable consumption in individuals who received the education intervention.

References


CHAPTER 2
THE ROLE OF EXTENDED FLAVOR-FLAVOR LEARNING AND SENSORY-BASED, VEGETABLE-THEMED EDUCATION ON WHOLE VEGETABLE PREFERENCE IN ELEMENTARY SCHOOL-AGED CHILDREN: A REVIEW

Abstract

Increased vegetable consumption may be a solution to several of the most severe and chronic health problems including obesity, cardiovascular disease, and diabetes. Americans maintain a trend of decreasing vegetable consumption and the average number of servings consumed is consistently below federal, science-based recommendations for both adults and children. Vegetable consumption is influenced by a myriad of factors including personal preference, exposure, accessibility, and nutrition education. There are opportunities for intervention on several fronts; however, most recent interventions have not resulted in either immediate or long-term behavior change related to vegetable consumption. Modified education approaches and/or extended flavor-flavor conditioning may be an effective way to influence permanent behavior change. This paper reviews the importance of vegetable consumption, the determinants of vegetable preference, and effective and ineffective interventions aimed at increasing vegetable intake and preference in adults and children.

Introduction

Health problems in the United States abound with many of the most prevalent diseases being rooted in or affected by dietary behaviors. Numerous studies indicate a critical role of vegetables in disease prevention by mediating obesity, considered by
many doctors to be the leading cause of death in the United States as a precursor to many chronic diseases (1, 2). Vegetables play a critical role in the prevention of obesity by promoting a feeling of fullness on few calories and replacing less healthy foods in the diet. The trend for inadequate vegetable consumption exists in both adults and children.

Interventions aimed at increasing vegetable preference and consumption in children may be an effective approach to decrease the prevalence of chronic disease. Eating habits and preferences are developed at an early age and can often be difficult to change once established. Factors that contribute to disease also develop at an early age including serum cholesterol, glucose resistance, and blood pressure. Schools are a good place to introduce interventions as children are required to attend school, while at school children are in the attitude of learning, and can be assisted in learning concepts by interacting with peers.

**Background**

**Dietary Guidelines**

The evidence for the need to increase vegetable consumption is reflected in the 2005 Dietary Guidelines for Americans (hereafter referred to as the “Guidelines”) (3). The Guidelines are based on scientific evidence to promote health and reduce risk for chronic disease through diet and physical activity. Mortality and morbidity in the United States are related to poor dietary behaviors and a sedentary lifestyle. Diseases specifically linked to these behaviors include type 2 diabetes, cardiovascular disease, hypertension, osteoporosis, and some cancers. Energy imbalance that results from poor diet and sedentary lifestyle contributes to overweight and obesity in the US. A diet that
provides appropriate amounts of calories for an individual in addition to an active lifestyle should help prevent major chronic disease (3).

As the most recent version of this federal document, the 2005 Guidelines advise individuals to consume between 9 and 13 servings or an average of four and one-half cups of fruits and vegetables daily, an increase from the previous 2000 Guidelines recommendation to consume 5 to 9 servings daily without a concrete recommendation provided in terms of cup measurements (3). The newest recommendations appear in cups in addition to serving sizes to facilitate exactness and understanding; the prior Guideline reference to “serving” was an ambiguous recommendation for the American public to interpret and implement.

The 2005 Guidelines recommendation for fruits and vegetables combined is four and one-half cups for individuals for whom a 2000-calorie diet is appropriate. When servings are calculated based on the low and high ends of the calorie range, this results in a two and one-half cups low end and six and one-half cups high end or 5 to 13 servings per day (3). Vegetables are an isolated and emphasized food group in the Guidelines with a focus on consumption of vegetables from all five vegetable subgroups that include dark green, orange, legumes, starchy vegetables, and other vegetables (3).

The Guidelines, divided into sections that differ from the food groups, emphasize vegetables three times. In addition to vegetables’ initial emphasis with fruit, they are noted again in the carbohydrate section with an emphasis on the fiber notably provided by vegetables. Finally, they are noted in the section regarding sodium and potassium as vegetables are an abundant source of potassium (3).
The recommendations in the Guidelines are based on scientific evidence of specific nutritional factors that lower the risk of chronic disease (3). Many of the nutrients currently deficient in the typical American diet can be provided by an increase in vegetable consumption. Nutrients of concern by age group include:

- calcium, potassium, fiber, magnesium, and vitamins A (as carotenoids), C, and E for adults;
- calcium, potassium, fiber, magnesium, and vitamin E for children; and
- vitamin B12, iron, folic acid, and vitamins E and D for the elderly and women of child-bearing age.

In general, Americans consume too many calories and too much saturated and trans fat, cholesterol, added sugars, and salt (3). A diet rich in vegetables would not only provide the deficient nutrients but would also help Americans meet the goal to consume fewer calories and other overconsumed nutrients.

The Guidelines encourage use of the Dietary Approaches to Stop Hypertension (DASH) eating plan as a plan that exemplifies the Guidelines (3, 4). The DASH diet was a randomized feeding study that evaluated the effects of three different diets on an individual’s hypertension levels (4). The control diet was made to be similar to the diet of most Americans. The fruits and vegetables diet provided potassium, magnesium, and fiber at higher levels than the average American diet. Overall, this diet provided more fruits and vegetables and fewer snacks and sweets but was otherwise similar to the control diet. Finally, the combination diet was the fruit and vegetable diet with the added component of higher amounts of calcium in the form of low-fat dairy products. Those that were randomized to the combination dietary pattern experienced the greatest drops in
blood pressure followed by the fruits and vegetables diet, both of which were rich in fruits and vegetables (4). It is notable that the reduction in blood pressure experienced by those on the combination diet was similar in magnitude to observed trials of drug therapy aimed at decreasing blood pressure suggesting that such a diet may delay or prevent the need for antihypertensive medication (4).

Declining vegetable consumption in the United States

Based on current habits measured by the National Health and Nutrition Education Survey (NHANES) 2001-2002 data, Americans generally need to increase vegetable consumption by 0.9 cups per day, with an increase in all vegetable subgroups with the exception of starchy vegetables among women (3).

Fruit and vegetable consumption in the United States is low when compared to Canada, a country with similar economic status. (5). Canadians, in comparison to Americans, have been receiving public health messages to eat more fruits and vegetables for nearly 20 years longer than Americans (6). Additionally, the long-standing goal in Canada has been to “reach for ten” servings, whereas the United States goal was to consume five to nine daily servings per day until it was changed in 2005 (3, 5).

Canada receives many United States produce exports, which are generally of higher quality than the United States-produced goods that are retained for sale and consumption within the States, with quality being a factor that may increase consumption of a particular good (5). When goods of different quality have the same per unit transportation cost, those higher-quality, higher-priced goods become less expensive in relation to the lower-quality goods at the destination site. Increased demand for the
higher-quality good occurs and the higher-quality goods are increasingly shipped out from their production site rather than being maintained for local consumption (5).

Data from the Behavioral Risk Factor Surveillance System (BRFSS) provides information on the status of vegetable consumption in the United States. BRFSS is a continuous telephone survey of a sample representative of the population that is conducted by state health departments under the direction of the Federal Center for Disease Control (CDC). The survey provides a state-by-state evaluation of trends in food consumption and mortality. Data is collected for a yearly tracking of health behaviors and risk factors (7).

Serdula et al. (8) analyzed fruit and vegetable consumption trends from BRFSS years 1994 and 2000 surveys. The vegetable-related questions evaluated by the surveys included questions on the frequency of consumption of green salad, potatoes (excluding fried varieties), carrots, and other vegetables. The mean frequency consumption of vegetables declined slightly from 2.06 times per day in 1994 to 2.02 times per day in 2000 (8). The difficulty in interpreting the BRFSS model is that it assesses the frequency, not serving size, of vegetable intake. The measurement is therefore insensitive to changes in serving size. Generally speaking, estimates obtained through BRFSS are consistently lower than those obtained through other methods of assessment that include serving size information (9). Despite its limitations, the BRFSS should provide a valid assessment of trends providing that the data collection methods are consistent (8). When compared with the current Guidelines, the BRFSS data demonstrates that Americans are consuming far fewer vegetables than is optimal (3, 8).
The NHANES studies are designed to evaluate the health and nutritional status of children and adults in the United States (10). It combines both physical examinations and interviews to collect the needed data. The survey gathers information from a nationally representative sample of about 5,000 individuals yearly. The survey includes demographic, socioeconomic, dietary, and health-related questions. NHANES is the basis for determining national standards for health-related measurements (10).

Casagrande and colleagues recognized the limitation of the absence of portion size data in previous studies and assessed fruit and vegetable consumption from 24-hour recall data as collected in NHANES III (1988-1994) and NHANES 1999-2000 (11). A 24-hour recall is considered the gold standard in self-report methods of dietary assessment and is considered more accurate than short frequency-based methods (10). Limitations to 24-hour recalls still exist; participants may be unable to remember accurately foods or portions sizes consumed, the foods consumed in the previous day may not be accurately representative of usual intake, and there is a tendency for individuals to over-report low intakes and under-report high intakes (12). In the evaluated NHANES studies, serving sizes were estimated in order to evaluate true consumption status (11).

The NHANES studies examined included 14,997 adults over the age of 18 from 1988-1994 and an additional 8,910 adults from 1999-2002 for a total of 23,907 subjects. As part of the NHANES survey, each subject had provided a 24-hour recall (10). When a fruit or vegetable was the main component of a mixed dish food item, like a casserole, it was counted as that fruit or vegetable. Vegetable servings included white potatoes, fried potatoes, garden vegetables (dark leafy greens, yellow vegetables, tomatoes, green beans,
starchy vegetables), salad, and legumes (11). While fried potatoes are not generally considered a vegetable, they were maintained in the survey to keep consistency with previous NHANES surveys. Salads were considered one serving of vegetables rather than compartmentalized into each ingredient (11).

Results of the 24-hour recall demonstrated a slight decrease in the proportion of individuals meeting the recommended level of vegetable consumption at three or more servings of vegetables daily. This finding is consistent with the BRFSS survey findings in that both surveys demonstrated an overall decrease in vegetable consumption. In 1988-1994, 35% of individuals met the recommendations for vegetable consumption decreasing to 32.5% of individuals in the 1999-2002 survey (p = 0.026). The percentage of individuals who reported no daily vegetable consumption was 25%. Approximately half of the individuals in both surveys indicated consuming at least one serving of garden vegetables and 20% reported consuming at least one serving of fried potatoes. When excluding fried potatoes from consumption totals, both surveys decreased in percentage of vegetable consumption with 1988-1994 consumption decreasing from 35% to 29.9% and 1999-2002 consumption decreasing from 32.5% to 27.4% (p = .020).

Casagrande et al. observed that vegetable consumption was associated with greater variety of vegetables other than fried potatoes. Furthermore, both surveys provided evidence that older individuals were more likely to meet or exceed recommendations for fruit and vegetable guidelines (p = <0.05). According to the NHANES (1988-1994, 1999-2002) surveys, approximately 89% of Americans do not meet the USDA prescribed dietary guidelines for fruit and vegetable intake. Most individuals indicated a static consumption of the same vegetables rather than the
recommended varied diet and there is currently no indication of improvement in vegetable consumption based on the NHANES surveys (11).

In the USDA Center for Nutrition Policy and Promotion Report Card on the Diet Quality of Children Ages 2-9, it is estimated that only 22% of children ages seven to nine eat three servings per day; only 19% of children ages four to six and 35% of children ages two to three meet this guideline, respectively (13). It is notable that vegetable consumption decreases with age and may be correlated with increased consumption of snack foods (13). Overall, the dietary quality of children ages two to nine is less than optimal. Poor eating habits in children lay a poor foundation for adult eating habits and may impair general growth and development in children (13).

Galloway et al. recruited 192 parent-child pairs that included girls ages 7.3 ± 0.3 years old to participate in a study regarding predictors and consequences of food neophobia, an unwillingness to eat unfamiliar foods (14). Extent of food neophobia was determined based on administration of a modified food neophobia scale, a combination of the Food Neophobia Scale for Children, Pliner and Hobden’s food neophobia scale for adults, and the Food Situations Questionnaire (14). Dietary information was collected by administration of three 24-hour food recalls, two on weekdays and one on a weekend day. The mean of the three-day recall was used to represent the estimated usual vegetable intake in servings per day. French fries and potato chips were excluded. Complete data from 189 families was analyzed and mean vegetable intake among the children was 1.3 ± 0.9 servings. The food neophobia score was 0 ± 1.0 with a range of -2.5 to 3.6 indicating approximately 33% of the girls had a medium-high score on the food neophobia scale. Galloway et al. (14) found a modest negative significant relationship between food
neophobia and vegetable consumption. Findings indicate that girls with neophobia ate fewer servings of vegetables compared with girls without food neophobia. Galloway et al. (14) determined that vegetable consumption among girls was well below the USDA recommendations and below the 2.2 servings a day that Krebs-Smith et al. (15) reported as consumption by this age group.

Research generally indicates the decline of both childhood and adulthood vegetable consumption, suggesting that population vegetable intake habits continue into adulthood. A universal foundational component of food choice is termed “life course” (16), which includes past experiences with foods, current perceptions and trends, and anticipation of future food events. A particular age cohort or individuals experiencing unique life roles in the past (i.e., army) were notably affected in their food choice trajectories (16). The life course provides orientations for food choice as a backdrop for food choices (16). Food choice trajectories are a critical component in life course and include persistent thoughts, actions, feelings, and strategies over the lifespan (17). Repeated food choices create momentum for similar food selections in the future (18).

The Cardiovascular Risk in Young Finns Study as analyzed by Mikkilä et al. indicated that there was some degree of dietary tracking, or stability of food choices, over a 21-year period that was stronger in older subjects meaning those greater than the age of 25 (19). This may suggest that as individuals age, food choices are more predictable, validating the early intervention approach to dietary change. Patterns of fruit and vegetable consumption adopted in childhood persist into adulthood; intervention efforts are appropriately directed to children (20). Early intervention is likely to maximize health benefits (21).
Causes of decreasing vegetable consumption

The causes of decreasing vegetable consumption are many, including both inherent genetic factors and environmental factors. Isolating causes may aid in directing approaches for intervention.

Socioeconomic factors

Poverty continues to be a barrier to purchasing and consuming fruits and vegetables (11). Findings using NHANES data indicated that individuals with average to high incomes were more likely to meet recommendations for fruit and vegetable consumption than were individuals with lower incomes (11).

In her book *Food Politics*, Marion Nestle explains that barriers to fruit and vegetable consumption exist because of the competitive availability of inexpensive energy-dense food. Fruits and vegetables entail costs in fresh food distribution whereas the other energy-dense foods are manufactured based on government-subsidized crops and are cheaper for both manufacturers and therefore consumers (22). Research shows that those with limited income have lower total fruit and vegetable consumption than more affluent individuals (23). Quan surveyed 150 low-income African-American and white women at WIC clinics and commodity food distribution locations to identify food consumption patterns and amounts. From this cohort, 25 women who had a higher consumption of fruits and vegetables were interviewed in order to identify common themes and barriers for this population in regards to the obtaining of fruits and vegetables. Data revealed that the most influential factors affecting fruit and vegetable intake included time availability to prepare food, cost, health concerns, and food preferences. Additional interviews were conducted with 218 different low-income
women who were contacted through a pediatric clinic that served low-income individuals in addition to WIC clinics. Analysis of information obtained from the group of 218 women showed that mean vegetable intake was below recommended levels at $2.2 \pm 1.5$ servings per day with a median of 1.9 servings. Women were most likely to eat vegetables at dinner rather than as a snack or at lunch. Behaviors that coincided with higher vegetable consumption included “keeping several forms of vegetables around the house, eating vegetables for a snack, eating a vegetable at dinner, eating two different vegetables at dinner, and eating salads or other vegetables at lunch” (23). Eighty-six to eighty-eight percent of women said that it was easiest to incorporate vegetables by eating them at dinner or just keeping them around the house rather than trying to incorporate them into snacks or lunchtime. Quan suggests that educational methods that reduce barriers to the aforementioned behaviors should be pursued and would be helpful for this cohort in particular (23).

Knowledge

There is confusion as to how to implement the new dietary guidelines (24). Wardle et al. determined that nutrition knowledge and vegetable consumption are positively correlated (25). Nutrition knowledge was assessed in adults using the validated Nutrition Knowledge Questionnaire (25). The questionnaire inquires about experts’ recommendations about healthy eating; knowledge about the nutrient content of different foods; every day food choices; and links between diet and disease.

Food intake of participants was obtained using a modified version of the Dietary Instrument for Nutrition Education (DINE), a weighted food frequency questionnaire that accounts for most fat and fiber in the diet. Participants were recruited through general
practitioners’ offices. Both surveys were sent to participants resulting in a participation rate of 73.6%, 455 men and 584 women. The mean age was 51.5 years and the vast majority of participants were white.

Intake of fruits and vegetables was well below the recommended intake of five servings per day. However, those in the higher knowledge groups reported eating more fruits and vegetables than those participants in lower knowledge groups. Without nutrition knowledge in the model, socio-economic status and occupational status were significant determinants of fruit and vegetable consumption. When nutrition knowledge is added, those two factors decrease to non-significance in regards to prediction of fruit and vegetable consumption. Nutrition knowledge therefore mediates some of the SES variation in intake, especially for fruit and vegetables (25). People in the highest nutrition knowledge category were nearly 25 times more likely than those in the lowest category to consume a healthy diet. The results of the study provide evidence that nutrition knowledge is a significant component of fruit and vegetable consumption and explained 4 to 22% of the variation in intake of fruits and vegetables (25).

**Personal preference**

A review conducted by Eertmans et al. assessed the roots of liking or disliking foods in humans in general (26). Personal preference is believed to play a major role or even to be sole the predictor of human food choice and intake in the absence of other potentially limiting factors like economics or ability to obtain food (26). For example, questionnaire data was obtained about women’s intended and reported consumption of four foods (milk, cheese, ice cream, chocolate and ‘high-fat’ foods—a generic category)
and showed that liking was a stronger predictor of consumption than health beliefs and evaluations (26).

Food neophobia is a prevalent barrier to vegetable consumption, notably in children. Neophobia is different than pickiness in that neophobia is an unwillingness to eat unfamiliar foods; pickiness is an unwillingness to eat many familiar foods (14). It follows that children with food neophobia also maintain lack of variety in their diets (27). Menella et al. concluded that infants who were exposed to carrot juice were more likely to accept cereal made with carrot juice than infants who were not exposed (28). Furthermore, infants who were exposed to a variety of vegetables during the weaning period were more likely to accept new vegetables than those infants who were only exposed to one type of vegetable (29). Pelchat and Pliner concluded that there is a negative correlation between food neophobia and variety in the diet between the ages of 2 to 7 years (30), suggesting that early exposure to vegetables may ameliorate vegetable neophobia specifically.

While parents are often charged with serving enough vegetables at home, Baranowski et al. (31) concluded that most vegetables eaten by children are part of school lunches consumed on weekdays, not in the home. Therefore, school-based interventions should be of interest (31).

The focus on vegetables

Among all the dietary advice to consider, increasing fruit and vegetable intake may reverse current disease trends more so than any other change (32). It is stated best when Bazzano summarizes that an increased intake of fruits and vegetables is associated with a decreased incidence and mortality from the following diseases: cardiovascular
diseases, stroke, hypertension, diabetes, obesity, and certain types of cancer (3, 4, 32, 33). As an isolated factor, severe obesity affects most organ systems, making it obvious that obesity is an extensive health problem (34). Consumption of vegetables is a critical part of a nutrient-dense, low-calorie diet as part of preventing obesity or losing weight. Overweight and obese women on a hypocaloric, high vegetable diet decreased their weight, BMI, and fat mass (35).

In many research studies, fruits and vegetables are evaluated together because of the frequency in which they occur together in dietary advice. Not many studies have been conducted to isolate the effects of different and specific fruits and vegetables in terms of their satiation. They are also similar in their characteristic low energy density, low fat content, and high water and fiber contents (36, 37). These properties of fruits and vegetables can contribute to increased satiety and reduced food intake, leading to enhanced weight management (36, 37).

There are many properties unique to vegetables that provide for decreased prevalence of chronic disease. Vegetables provide many micronutrients, fiber, a high water content, and low calorie density (3, 36, 37). There are at least two reports from large observational studies that find a benefit for fruits and vegetables when assessed together, but when broken out, benefits were only observed for vegetable intake and not fruit (38, 39).

*Increased satiety and weight management*

In a CDC Brief entitled “Can eating fruits and vegetables help people to manage their weight?”, several research articles are cited to support the fact that foods of lower energy density, namely fruits and vegetables, can replace high energy density foods as
part of an effective weight management plan based on the inherent properties of fruits and vegetables (40). This report provides evidence that people do not stop eating based on calories alone, but based on a feeling of satiety (36, 40). Short-term studies show that the volume of food eaten at a meal imparts a feeling of fullness and causes a person to stop eating regardless of the calorie content of the meal (36,40). Foods that provide relatively few calories in a relatively greater volume include foods with a high fiber and water content, including fruits and vegetables, and when holding calorie consumption constant allow a greater volume of food to be consumed in comparison to high energy-density foods (36, 37, 40). This property may help people feel fuller faster on fewer calories and thus be a helpful weight management strategy. Energy density of foods as the relationship of calories to the weight of food (calories per gram) is the principle emphasized by these volume-specific recommendations. Foods range from high energy density (four to nine calories per gram, usually low in moisture) to low energy density (.7 to 1.5 calories per gram, usually high in moisture) (40).

Nutrient density and energy density are distinct properties of food, often with an inverse relationship. Energy density focuses on calories; nutrient density focuses on the vitamins, minerals, and other health-promoting components of foods within a particular volume of food. Foods with low nutrient density are generally high in energy density; individuals who consume mostly low nutrient-dense foods often lack optimal levels of key nutrients (3). The greater the consumption of foods or beverages that are low in nutrient density, the more difficult it is to consume enough nutrients without gaining weight, especially for those individuals with a sedentary lifestyle (3). An increased consumption of vegetables is associated with a healthier dietary intake overall in both
adults and children (9). More specifically, vegetables and fruit may replace the fatty foods consumed by children to help them maintain a healthy weight (41).

The primary reasons for which fruits and vegetables are involved in weight management concerns their high water content (36). Adding fruits and vegetables to the diet decreases the overall calorie density but increases the amount of food that can be consumed for a given amount of calories, thereby causing individuals to feel fuller faster. While the fiber content of fruits and vegetables is attributed to increased satiety, its effects are not as notable as the water content. Overall, studies of satiation show that the addition of vegetables to mixed dishes is associated with a decrease in calorie consumption; the decreased calorie consumption, however, is not associated with a decrease in satiation and most participants reported feeling equally satisfied (36).

Decreased obesity

Overweight and obese children are more likely to become overweight and obese adults (42, 43). Higher vegetable diets for children may be beneficial as weight and dietary trajectories persist from childhood to adulthood. Guo and Chumlea (44) utilized the Fels, Guidance, Harvard, and Oakland longitudinal studies to determine the persistence of obesity from childhood to adulthood. Weight in early childhood may be indicative of weight in later childhood years. They concluded that BMI values during adulthood are not related to BMI during infancy, but they are related to BMI patterns by six years of age (44). The odds ratios of overweight for males at 35 years of age with childhood BMI values at the 95th percentile compared to those with BMI values at the 75th percentile doubled after about 10 years of age (44). The same odds ratios doubled in girls after eight years of age. The odds of overweight at age 35 of those individuals at the
75th percentile between the ages of 8 to 18 were at least double of those participants at the 50th percentile for weight (44). The odds of overweight in adulthood for those with childhood BMI values at 95th percentile were 1.3 to 6.1 and 1.4 to 4.9 times as great for those with BMI values at the 75th percentile for males and females, respectively (44). A later, similar study focused on analysis of only the Fels sample had similar findings (45).

In the Avon longitudinal birth cohort study (46), children were monitored periodically from birth to age seven utilizing questionnaires, medical records, and physical examinations. At age seven, those children who had an unspecified junk food-type diet that included low intakes of fruits and vegetables at age three were at greater risk for obesity, although this difference was not statistically significant (46). Children in the highest quarter of weight at both eight and 18 months of age were more likely to be obese at age seven than were those in the lowest quarter (46). Overall, the study confirms that a child’s environment at an early age, including nutritional environment, can influence the risk of obesity later in life (46).

McCrory et al. concluded that there was a negative association between the variety of vegetable consumption (excluding potatoes) and body fatness (47). Comparatively, all other food groups examined were positively associated with body fatness. Increased variety in diet in general is associated with increased caloric intake (47). The differential risk of food group variety on weight was explained by energy density. Adults tend to consume a consistent weight of food, so if low energy-dense vegetables are substituted for higher energy-dense foods, prompted by an increased variety, a lower BMI and caloric intake results (47). Consumption of a variety of vegetables may increase absolute consumption of vegetables and may decrease absolute
consumption of other foods potentially higher in energy density. Decreased total calorie intake due to shifts in consumption of nutrient-dense versus energy-dense foods may contribute to decreases in body fatness. This relationship may be associated with the prevalence of obesity in the United States (47).

The Bogalusa (Louisiana) Heart Study is a community-based study of the natural history of cardiovascular disease risk factors beginning early in life, following children who matured to adults during the study (43). Of those who participated in the study, a subset of 841 participants was recruited to look at weight change and overweight status, specifically. At baseline when participants were nine to eleven years of age, 24.7% of participants were overweight; at follow-up, when participants were 19-35 years of age 57.7% of participants were overweight. Nearly two-thirds of the participants that were in the highest BMI quartile in childhood were in the highest BMI quartile in adulthood; more than half of those individuals in the lowest quartile in childhood were still in the lowest quartile in adulthood. Less than 15% of the individuals who were in the highest quartile in childhood moved to the lowest quartile in adulthood. These findings indicate that childhood obesity tracks into adulthood and that children who are overweight are more likely to become adults who are overweight or obese (43). These results support the urgent need for obesity prevention efforts aimed at children and young adults.

Reduction of chronic disease prevalence through reduction of overweight and obesity

Frazao (48) estimates that healthier diets that include generous amounts of vegetables may decrease financial burden on the United States by $71 billion in costs related to CHD, cancer, stroke, and diabetes. This includes diet-related medical costs,
diet-related productivity losses from disability, and the economic value of diet-related premature deaths (48). Avoidance of chronic disease not only allows for longer life but better quality of life. Diet plays a major role in the development and prevention of many of the leading causes of death as listed by the CDC (48).

Diet is a complex behavior that interacts with both individual genetic profiles and environmental conditions to impact health. It is difficult to isolate the causes, effects, and costs of poor diet on individuals and society. Even diet as an isolated factor is difficult to directly attribute to chronic disease. Dietary intake patterns change over time so it is unclear when the dietary patterns that affect chronic disease are developed (48). Obesity is considered by many experts to be the leading precursor to premature death in the United States (1, 2).

Diabetes

Rates of type 2 diabetes among children have recently surged and it is now recognized as a common disease among children and adults (49). Early onset of the disease provides the opportunity for earlier manifestation of complications of the disease, including retinopathy, nephropathy, neuropathy, cardiovascular disease, and limb amputations (49). The most important risk factor for diabetes in children is obesity (34), which, as previously discussed, can be effectively combated with increased vegetable consumption.

Glucose intolerance is a characteristic of obese children and adolescents and contributes to type 2 diabetes. In a study done in Cincinnati adolescents (50), one-third of the newly diagnosed cases of diabetes were non-insulin dependent diabetes mellitus (NIDDM), which is strongly correlated with obesity. The incidence of NIDDM has
increased 10-fold in adolescents since 1982; it may be assumed, with current data on rising diabetes incidence and trends for under-diagnosis, that the increase may be even higher. The median BMI of those adolescents diagnosed with NIDDM in 1994 was 37 whereas a healthy BMI is <25 (42).

The etiology of obesity is complex and includes overconsumption of energy-dense foods, underconsumption of nutrient-dense food, physical inactivity and genetic predisposition: the challenge for effective intervention is real. There is some evidence that increasing fruit and vegetable intake among adolescents effectively decreases BMI (19). Baranowski et al. states that promoting fruit and vegetable consumption would likely be effective obesity prevention strategy because it is a positive message; the foods displace fat in the diet, and also lead to enhanced sense of fullness (51).

**Cardiovascular disease and metabolic syndrome**

As reviewed by Lobstein et al., metabolic syndrome, or the coexistence of hypertension, hypertriglyceridemia, low HDL cholesterol and hyperinsulinemia is common among obese adults who were obese as children (34). Cardiovascular disease is increased with the presence of metabolic syndrome (52, 53). Metabolic syndrome exists in children as well; nearly 50% of those who are severely obese have metabolic syndrome and it is suggested that adult metabolic syndrome has its roots in childhood (54, 55). This provides another compelling reason for early intervention.

Hung et al. analyzed the Nurses’ Health Study (NHS) and the Health Professionals’ Follow-up Study (HPFS) for correlates of fruit and vegetable consumption and chronic disease. Both of these studies are prospective in design and boast large sample sizes, 71,910 female and 37,725 male participants, respectively. Additionally,
data was gathered every two years in the form of questionnaires to update changes in behavior and incidence of cardiovascular disease and cancer. All participants were free from chronic disease at the time of enrollment and usual dietary intake was assessed by a food frequency questionnaire (FFQ) at baseline interviews. FFQs for both studies were evaluated three times. Each subsequent FFQ contained more detailed questions on fruit and vegetable consumption. To standardize FFQs fruits and vegetables were listed in common units, such as one glass of juice or one tomato. Participants then indicated an average consumption of that food item throughout the year. Options for consumption frequency were in nine categories, from less than once a month to six or more times per day. Amounts were computed and averaged per participant to obtain average usual consumption of fruits and vegetables over the periods of observations. The primary endpoint of the study was cardiovascular disease, cancer, or nontraumatic death, whichever came first.

Participants with implausible caloric intake were excluded from the analyses (33). The median intake of fruits and vegetables was 5.2 servings/day for men and 5.3 servings/day for women; median intake of vegetables specifically was 2.94 in the HPFS and 2.88 in the NHS. Comparison of participants in the lowest quintile of fruit/vegetable consumption to those in the highest quintile showed that participants in higher quintiles had slightly lower risks of major chronic diseases. Of specific groups within fruits and vegetables, green leafy vegetables were the only statistically significant group associated with lower risk of major chronic disease and cardiovascular disease (33). The relative risk for chronic disease was .94 (a 6% lower risk of chronic disease) in the highest quintile of green leafy vegetable consumption compared to the lowest. Overall,
consumption of vegetables, particularly green leafy vegetables, slightly decreased risk for chronic disease \( (p = .046) \); however, the overall chronic disease risk reduction demonstrated by the data is mostly attributed to a lower incidence of cardiovascular disease not other causes of death, including cancer (33).

Freedman et al. (56) utilized the Bogalusa Heart Study to examine the relationship of overweight to cardiovascular risk factors using the final measurement from the Bogalusa study. The population consisted of those who participated in the Bogalusa Heart Study between 1973 and 1994. The mean age of the 9167 school children in the analysis was 11.6 years and 11\% were considered overweight. Overall, the study determined that overweight children and adolescents had a higher prevalence of cardiovascular disease risk factors than did healthy-weight children. Notable increases in risk factors were observed at Quetelet (BMI) index levels higher than the 85th percentile for all genders and ages. The prevalence of all risk factors increased notably between the 95th to 97th percentile and the greater than 97th percentile indicating that the greater the obesity the higher prevalence of cardiovascular disease risk factors (56). Cardiovascular disease risk factors evaluated included total cholesterol, triglycerides, low-density lipoprotein cholesterol, and high-density lipoprotein cholesterol (56).

Caprio et al. (57) describes increased blood lipids with a pattern of increased low-density lipoprotein-cholesterol and triglyceride levels and decreased high-density lipoprotein-cholesterol levels in both obese children and adolescents. Data obtained from the Fels sample of 166 males and 181 females shed light on the trend of obesity from childhood to adulthood. Children were followed from birth and data on weight and height were collected annually from 3 to 20 years of age and 30 to 39 years of age. The
odds ratios for obesity at ages 15 to 18 years ranged from 8 to 57 for males and from 6 to 35 for females. The odds of obesity at age 35 years increased from about 2 for males and females who were obese between the ages of 1 and 6 years to 5 to 10 for children who were obese at ages 10 to 14 years (45).

Serum lipid and lipoprotein levels can persist from childhood to adulthood. A longitudinal study conducted over 15 years of 1159 children aged 5-14 years found that their serum cholesterol levels as children correlated with their levels when they became adults, (r=0.6; .4 to 0.6, total and LDL cholesterol, respectively) (58). The associations were weaker for high-density lipoprotein and triglycerides. The best predictor for adult dyslipidemia was childhood LDL level. Weight gain over the 15-year study period was second to LDL cholesterol in predicting adult plasma lipid levels (34, 58). These studies suggest that cardiovascular disease risk factors that are present in childhood will persist into young adulthood (57, 59). If vegetable consumption can promote weight maintenance in children, it follows that vegetable consumption may also help decrease cardiovascular disease risk factors in the same population.

Obesity is associated with hypertension in adults and children as a risk factor for cardiovascular disease (34). Up to 30% of obese children suffer from hypertension (60). Additionally, waist circumference and skin fold measurements are positively correlated with resting blood pressure in children (34).

One example of a dietary intervention that included generous amounts of fruits and vegetables and was successful at reducing blood pressure among those with hypertension is the Dietary Approaches to Stop Hypertension (DASH) diet implemented in the DASH trials (4). The DASH diet was a randomized feeding study (n= 459) that
evaluated the effects of three different diets on an individual’s hypertension levels. The control diet was made to be similar to the diet of most Americans. The fruits and vegetables diet provided potassium, magnesium, and fiber at higher levels than the average American diet. Overall, this diet provided more fruits and vegetables and fewer snacks and sweets but was otherwise similar. Finally, the combination diet was the fruit and vegetable diet with the added component of higher amounts of calcium in the form of low-fat dairy products.

Results of the DASH study indicated that the combination diet reduced systolic blood pressure by 5.5 mm Hg more and diastolic blood pressure by 3.0 mm Hg more than the control diet did (p<0.001 for both). The fruits and vegetables diet reduced systolic blood pressure by 2.8 mm Hg (p=<0.001) and 1.1 mm Hg (p=0.07) greater than with the control diet. The results of the DASH study indicate that fruits and vegetable consumption is an integral part of decreasing blood pressure as a risk factor for heart disease (4). Adoption of a diet similar to either the fruits and vegetables diet or the combination diet can have antihypertensive effects within two weeks. It follows that children may benefit from the same type of intervention. No similar trials have been reported among children.

**Cancer**

The evidence for vegetable consumption for cancer prevention is currently inconclusive. Hung et al. found no association between fruit and vegetable intake and incidence of cancer in analysis of the NHS and the HPFS (33). In a pooled analysis of 14 cohort studies, Koushik et al. (61) found no strong association of colon cancer risk with intake of vegetables, but fruit and vegetable intake may be associated with a lower risk of
distal colon cancer. The Polyp Prevention Trial, including an eight-year follow-up of patients on a high-vegetable, high-fiber, high-fruit, low-fat diet, showed no significant impact of the treatment diet on the occurrence of polyps in the large bowel (62). A prospective study on the effect of lycopene from tomatoes on prostate cancer concluded that greater consumption of lycopene from tomato products does not protect from prostate cancer (63).

Determinants of vegetable preference

While psychosocial factors such as attitude, social influence, and self-efficacy explain much of vegetable consumption in children, addition of other factors like exposure, parental consumption and habit improve the proportion of explained variance in vegetable intake (64).

Personal food consumption determinants include taste preference, outcome expectations, personal skills, and knowledge (65). The personal food system as portrayed by Furst and Connors is the mental process whereby people translate influences upon their food choices into how and what they eat (16, 66). The word “taste” can be understood to encompass all sensory perceptions experienced during food consumption including many odor, texture, flavor, and appearance and is one of the primary considerations when making food choices. Taste refers specifically to the four basic sensations of sweet, salty, sour, and bitter (67). Flavor is used as a common synonym but is more comprehensive than the word “taste” (67). Flavor is a more complex concept that encompasses more sensory cues including taste, olfaction, and touch systems, all of which greatly influence food preference (67).
**Innate preference**

Individuals rarely eat food that does not taste good to them and is therefore often considered a minimum criterion for food consumption (68). Citing Pliner et al., Birch points out that even in “safe” environments like cafeterias, individuals are not neophobic because they are frightened that the food might be poisonous as in Paleolithic times, but because they fear that the food will taste bad (69). Research with children in particular has demonstrated that taste is the most influential determinant of vegetable consumption. Among nine to eleven year-olds, preference for vegetables was more influential than either parental vegetable intake or attitudes in regards to vegetable consumption patterns (65, 70). When referring to vegetable consumption, the word “preference” connotes that liking is the basis for selection, or the selection of a certain item over another (67).

It is argued that food preference is learned through experience with both food and eating in contrast to the view that food preference is innate and governed by the body’s need for nutrients (16, 66, 67). The etiology of food preference can be seen as a convergence of two broad categories that, together, constitute a developmental systems perspective: 1) genetic predisposition and, 2) eating environment or the association of food with the context and consequences of eating that food (67).

The genetic predispositions that provide the foundation for food selection include three principles: 1) the innate human preference for sweet and salty and the aversion to sour and bitter tastes; 2) the propensity for rejecting novel food items (neophobia) and acquire a learned preference for the familiar, and; 3) the predisposition to associate foods with the contexts in which they are offered (67). Food preferences and food selection patterns are phenotypic behaviors that result from gene and environment interactions.
While it was genetically adaptive to prefer certain foods to support survival in an environment of scarcity, that adaptation does not properly serve individuals now in an environment of plenty, now called an “obesigenic environment” or an environment in which foods high in fat, calories, salt and sugar are inexpensive and obtainable (71). In a study done by Hursti and Sjoden (n=722), the results showed a moderate relationship between a child’s neophobia and parental neophobia which may be attributed to genetics (72).

Adult 6-n-propylthiouracil (PROP) and phenylthiocarbamide (PTC) testing can isolate those individuals who are nontasters (those with two recessive alleles) and supertasters (those with one or two dominant alleles) in regards to bitter taste (67). Within the genetic determination of tasting versus nontasting, gender plays a role: females are more likely to be tasters than are males (67). Population-wide, 30% are nontasters and 70% are tasters which may explain why most Americans do not get enough vegetables daily (Birch). The variances in bitter taste ability translate to other tastes as well. Tasters are more sensitive to flavors in general, preferring milder tastes to harsh tastes, with a dislike of intensely sweet flavors (67).

A variety of studies have consistently shown that infants prefer sweet taste, with a greater preference for sweeter concentrations, and a corresponding relaxation of the facial muscles which resembles a smile, indicating that preference is innate through genetics (28, 73, 74). This reaction is attributed to endogenous opioid release that may mediate the infant’s pleasure response to a sweet taste (75). Distress during traumatic experiences, like circumcision, is decreased with the administration of a sweet taste (76). Infants who received a certain flavor through human milk from their mothers demonstrated an
increased preference for that flavor when offered in cereal (28). The critical component in the success of this study was the amount of time between the exposure to the flavor and acceptance of the cereal with the same flavor; when more time elapses (exposure does not occur immediately before food intake), responsiveness and preference is greater (28).

In early human days, sensitivity to bitter tastes was a beneficial genetic innate trait inducing aversive reactions to potentially life-threatening compounds (77). Wardle states that these behaviors reflect historical context by promoting survival during times of food scarcity as survival was maximized by adopting behaviors that maximized food consumption when food was plentiful and selecting safe and energy-dense food (78).

Most components that are poisonous and potentially deadly to humans are bitter, namely secondary plant metabolites, synthetic chemicals and rancid fats. In this light, sensitivity to bitterness is a defense mechanism (77). A facial expression opposite that of response to sweet taste is elicited in response to bitter tastes with the “depression of the mouth angles accompanied by an arching of the center portion of the upper lip” or a frown. This reaction occurs prior to exposure to food, even at birth (74). While infants are not able to initially control intake based on perception of bitter taste, the ability to choose based on a bitter taste emerges within the first months of life, generally between 14 and 180 days. Along with the ability to choose comes the response to exposure. Infants exposed to the bitter taste of protein hydrolysates found in infant formulas very early in life accept these formulas more readily than do infants who lack early exposure (79).
Certain “tastants” are known to suppress bitterness and include aspartame, sodium acetate and salt (80). When studying adults, aspartame, by imparting a sweet flavor, universally increased preference for bitter vegetables. The addition of sodium acetate and salt increased preference slightly, but not as effectively as aspartame (80). When added to vegetables at school, 2/3 of preschoolers preferred the sweetened vegetables over the non-sweetened (80).

A study done by Dinehart et al. explains how sweetness and bitterness mediate preference for respective vegetables (81). Test subjects tasted vegetables typically considered bitter (kale, asparagus, and Brussels sprouts) as well as foods typically considered sweet (marshmallow fluff and chocolate) (81). Subjects were also asked to fill out a food frequency questionnaire to predict the number of vegetable servings consumed, excluding potato and salad consumption. According to PROP testing, 23 subjects were nontasters, 66 were medium tasters, and 21 were nontasters. PROP bitterness was not associated with age or sex. Those with lower BMIs reported a higher vegetable consumption. Those who tasted PROP as more bitter (supertasters) also detected a higher amount of bitterness in sampled vegetables and a higher amount of sweetness in the sampled sweet foods. Vegetable sweetness and bitterness are positive and negative predictors of vegetable preference, respectively (81). Those subjects who perceived the vegetables as most sweet and least bitter consumed vegetables more frequently. Those who tasted PROP as most bitter (supertasters) consumed vegetables less frequently. The components in vegetables that impart disease-protective effects are those components that impart a bitter taste, namely glucosinolates, phenols, flavonoids, and isoflavones (82). The development of “innate predispositions” for sweet and salty
and aversions to bitter and sour tastes are generally not conducive to vegetable preference (65).

The degree of neophobia often increases as infants mature into young children. In infants, one exposure to a new food item was sufficient to increase intake of that item at a subsequent feeding (83). In contrast, anywhere from 5 to 10 exposures of a food item is required to increase preference of that food in young children (83). The age of a child at the time of exposure correlates with his/her extent of food neophobia in the future. Pelchat and Pliner found that food neophobia scores were negatively correlated with a child’s exposure to dietary variety between the ages of two and seven (30). They concluded that an early exposure to vegetables may ameliorate future vegetable neophobia or preclude that neophobic response (30).

Reduction in neophobia through exposure to one food generalizes to similar foods. For example, repeated exposure to a carrot may transform an initially neophobic child into a child more accepting of carrots in particular and vegetables in general (83). The neophobic trend declines in older childhood. Neophobia may be more easily overcome as they are able to associate new foods with familiar tastes through “flavor principles” or the ability to correlate taste information they know about similar foods to the food which they have not tasted (84). Children’s dislike for vegetables is consistent across cultures; vegetables are consistently ranked at the bottom of food preference lists demonstrating the universal preference of food with high fat and sugar content (85). The foods that children prefer most are not typically foods of high nutritional value being high in both fat and sugar. In a survey of four to sixteen year-olds, vegetables were rated
lowest and sugary foods were rated the highest (86). In a study of twin pairs, liking of a food was positively correlated with the percentage of the children who had tried it (87).

In Blanchette and Brug’s review of fruit- and vegetable-based interventions, they concluded that the knowledge deficit regarding fruits and vegetables is often addressed and has been observed to be only moderately effective on its own (65); targeting other determinants may demonstrate increased acceptance and consumption of vegetables.

*Environmental determinants*

The environmental determinants of vegetable consumption among school-aged children include availability of the vegetable in the home, parental attitudes and behavior, and access to school snack bars and other competitive foods like candy and soda (65). Baranowski et al. concluded through research on vegetable consumption patterns by day and by meal for seven to thirteen year olds that weekday lunch consumption accounted for most of the weekday servings of vegetables (31). The average consumption of fruits and vegetables at weekday lunch was positively correlated with participation in school lunch (31).

Low availability of vegetables in the home leads to decreased exposure, leading to potential dislike when the vegetable is consumed (65). Similar dietary habits are developed within families and many studies have shown that the vegetable consumption of the head of the household is directly related to the children’s consumption (65). It is not just the genetic component of neophobia that contributes to the child’s neophobic response; neophobic mothers structure the food environment with little opportunity to experience new foods, decreasing a child’s exposure and ability to decrease their own neophobia (67).
The food context in which certain tastes are experienced is that in which they are accepted among those past the infant stage (88). Preschool children who were given tofu salted, plain, or sweetened, acquired a preference to that tofu that had become familiar to them (88). This is an indicator that sweet tastes are preferred largely in familiar food contexts; based on their experience with sweet taste in food, children learn that some foods are appropriate contexts for sweetness and others are not (88).

A large part of proper (i.e., nutritionally balanced) food selection is dependent upon what is offered to the individual; whether or not children select nutritionally adequate diets is based upon the food from which they have to choose (67). Essentially, this means that if a child’s environment is not rich in a certain food, exposure is limited and preference for that food cannot be acquired (67). In summary, “our genetic predispositions include the preference for sweet and salty tastes, the tendency to reject new foods, and food preferences based on the postingestive consequences and social contexts of eating” (67).

Availability of fruits and vegetables, particularly in the home, is one of the most important environmental factors influencing consumption (65, 89, 90). Another component that is relatively new is accessibility and facilitation, meaning fruits and vegetables are easy to obtain and in a form that facilitates children eating them (65).

Methods of increasing vegetable consumption

An understanding of the components of food preference is important in developing effective strategies in promoting healthy diets (67). Wardle et al. in recognizing the major role that preference plays in vegetable consumption emphasized that interventions that aim to modify preference are those that could have a critical role in
changing vegetable consumption (91). There are a number of both effective and ineffective methods of increasing vegetable consumption. Effective methods include exposure and flavor-flavor conditioning; ineffective methods include rewarding and education without a reinforcing component.

Exposure

Experience may lead to new food likes, an alteration of current likes, or maintenance of innate likes that may otherwise disappear with mere exposure being a central mechanism. Ignoring stimulus recognition, repeated exposure to a stimulus object enhances preference for it and an initially negative response can be overcome (26). This mechanism has been attributed to influence even in early infancy. The more frequently a food is tasted, the more it is liked. An exposure to a target food once a day for 10 days can dramatically increase intake of the target food and intake may nearly double after only one exposure (91). Research supports the fact that early repeated exposure reduces food neophobia in young children (14).

Exposure is an effective method of decreasing neophobia. Learning through experience can change a neophobic reaction into a food preference (67). The neophobic response is naturally reduced with a widened and repeated exposure to new foods (67). The method by which exposure increases preference is through the principle of “learned safety” (85). Another theory is that preference is increased simply with an increase in familiarity of taste (85). In summarizing exposure research, Birch describes that the predisposition to prefer sweet and reject bitter can be readily altered via exposure (67). Exposure is only beneficial when it corresponds properly with the desired outcome; for example, if a change of taste is desired, exposure to taste is required. Visual images of
vegetables will not change a child’s preference for the taste of vegetables and will not increase consumption (85).

Research of food preference development confirms that there is a strong link between early exposure and food acceptance (85). In a survey done with 564 mothers of preschoolers, 2-6 year-olds who were introduced to fruits and vegetables early during the weaning period had a higher frequency of consumption of fruits and vegetables as preschoolers. In a different study, 2-7 year-olds who were given a larger variety of foods early in life were more willing to try new foods (85).

Exposure methods work best when time has lapsed between exposure and trial (85). In a group of preschoolers, increased response was seen when a week lapsed after an 8-trial exposure (85). It may be assumed that increasing preference for sweetened foods requires fewer exposures than increasing preference for other flavors, including salty and sour, due to innate predisposition to prefer sweet tastes (85).

Exposure to vegetables is essential in improving intake (67, 92). Not only are individuals more apt to eat that particular vegetable, but individuals are also less reluctant to try other vegetables (91). Food preferences continually change with exposure, experience and learning. In her review of eating behavior and obesity, Jane Wardle says, in summary of Myers and Sclafani’s work,

The taste of foods eaten just before being sick often becomes disliked, while tastes that are associated with good consequences, such as a ready supply of calories, tend to be more liked. This is probably the basis of the ‘familiarity effect, in which foods that have been eaten before—and whose consequences proved to be favorable—tend to be preferred and this is strongly the case in children. (78)
An exposure-based approach to research aimed at increasing vegetable consumption is validated as repeated food choices create momentum for making the same food choices in the future (18).

**Flavor-flavor conditioning**

Flavor-flavor conditioning in general is the co-occurrence of a neutral flavor with an already liked or disliked flavor which will then elicit increased like or dislike of the neutral flavor (92, 93). Flavor-flavor conditioning can be a powerful way to increase preference of foods, partially because of the exposure component of conditioning through repeated offerings (26). There are discrepancies in this relationship, however, which can be attributed to the impact of other factors on eating behavior (26).

Zellner et al. (94) demonstrated that humans can learn to prefer a new taste that has been previously paired with a sweet taste, even when unsweetened. Zellner et al. utilized two tea flavors, one of which was served 24 times in sweetened water and the other of which was served in plain water. There was an enhanced preference for the tea flavor sweetened during the intervention than for the flavor served in plain water when both flavors were presented unsweetened (94). This approach may be successful in increasing preference for vegetables in that bitter taste exists in both.

Havermans and Jansen found the concept of flavor-flavor learning to be successful in increasing preference for vegetables among children (92). The Havermans study obtained two “neutral” vegetable flavors from 13 total participants (9 boys and 4 girls) who ranked six different vegetable flavors: zucchini, pumpkin, pea, cauliflower, broccoli, and carrot. Mean age of participants was 5.2 years with a standard deviation of 1.1 years. The series of vegetables was chosen based on convenience and availability.
Fresh vegetables were cooked separately until soft and then pureed using a kitchen blender. About 50 grams of the puree was diluted with 100 grams of water and poured into an opaque cup. The cup was fitted with a plastic lid through which a straw was placed. The opacity of the cups eliminated any preference bias based on color, scent, or other sensory properties of the vegetables. Small groups of 2 to 5 children per two experimenters were taken away from the larger group of children and tested (92). As the children received the opaque cups, they were instructed to take a sip of each and characterize it as liked, disliked, or just okay. Using these general categories, children were instructed to rank flavors from one (most liked) to six (least liked). The tastes ranked three and four by each child were to serve as their personal conditioning stimuli (CS) during the conditioning phase.

Children received three paired presentations of the two flavors that were ranked neutrally with both flavors prepared the same as the flavors in the pre-test. To one of the tastes, 20 grams of dextrose was added (CS+) and the other flavor remained unsweetened (CS-). The flavor to which the dextrose was added was determined randomly for each child. Carrot and cauliflower served seven times as one of the two CSs, broccoli five times, pea four times, zucchini twice, and pumpkin served only once as a CS.

During the conditioning, the children were instructed to taste both the sweetened and unsweetened mixtures every five minutes. The experimenter would also sip from an opaque cup with the child but did not make any remarks or facial expressions that may sway the preference of the child. The following day, the same children were brought from their classroom to receive a further run of three paired presentations of the two flavors. Immediately after the second conditioning session, the children were given a
post-test that was the same as the pre-test. The hypothesis was that the flavor conditioned as CS+ would increase in preference at the post-test when it was unsweetened with no change in preference for the CS-.

A 31% preference for the sweetened mixture pre-test and a 54% preference for the sweetened mixture presented unsweetened at post-test demonstrates that flavor conditioning increases preference for a flavor (92). While the children demonstrated increased preference for the sweetened vegetable mixture, they demonstrated no increase in preference for the unsweetened. This was attributed to the low number of exposures as Wardle et al. suggested that children must be exposed to a new flavor 10-15 times before it is accepted (91). It may be assumed that increased exposures in addition to flavor-flavor learning would increase the preference of an unsweetened vegetable (65, 91, 92). It is evident that preference can increase over a short period of time but the question remains as to whether the flavor preference can be sustained over longer periods (92).

An advantage of the flavor-flavor learning method over mere exposure is that it requires few trials to cause a shift in preference (92). The most accurate way to evaluate food preference is a tasting method as opposed to a food picture or food model method (70). Guthrie makes a point in stating that rank orders of foods are not necessarily equivalent to what a child or individual would choose in every day life. It may be that foods ranked higher may be preferred in different ways; for example, they may be chosen sooner, consumed in larger quantities or consumed at lower levels of deprivation (70).

In testing the resiliency of flavor preference acquired through flavor-flavor conditioning, Baeyens tested 48 undergraduate psychology students. Each student received either 6 or 12 presentations of both CS+/Tween compounds and CS-/water or
sugar compounds. The number of trials did not have a significant effect on the size of the conditioning effect (93). Additionally, the conditioning effect did not weaken between trials—an equally strong CS+/CS- differentiation existed between the first and second block of trials. Baeyens argues that flavors acquired through conditioning are resistant to extinction and therefore stable over a longer period (93). The extended nature of the flavor-flavor conditioning acts to merge the idea with exposure methods. This combination will enhance the preference of vegetables.

**Education**

Many nutrition interventions are education-based. As an intervention to increase vegetable consumption, nutrition education is only moderately effective, if at all (65). Wardle et al. researched the difference between parent-led exposure versus parent knowledge about the importance of vegetables on the consumption of vegetables in the household (91). Parents were instructed to give their children a taste of red pepper every day for 14 days (91). In the information intervention group, parents were given a pamphlet about increasing fruit and vegetable consumption, and a third group received no intervention. The vegetable to which preference was to be increased was determined by ranking of six vegetables by the child. The vegetable ranked number 3 was chosen as the exposure vegetable. The percentage of children in the exposure group who voluntarily consumed the selected vegetable increased from 47% pre-intervention to 77% post intervention. In contrast, the information intervention group increased from 45% to 60% and the control group decreased from 55% to 50%. The increase in willingness to eat the vegetable was only significant for the exposure intervention group. This is significant particularly because it was a “real world” situation in which parents led the exposure
rather than a laboratory-type setting (91). It is notable that the provision of nutrition information had very little impact on change in vegetable consumption (91). This research suggests that greater nutrition knowledge held by parents or children does not predict an increase in the consumption of healthy foods (91). However, education still had somewhat of an impact, though not as great as the exposure group.

In a review of 57 research studies on nutrition education to both adults and children, it was concluded that nutrition education is not effective; only 4 out of the 57 studies showed any positive change as a result of nutrition education (95). Knowledge about diet and health has not been found statistically significant in changing diet-related behaviors concluding that changing knowledge is not going to have the desired effect of permanent dietary change (25). A more sustainable method is needed to increase consumption by first increasing preference for vegetables.

Schools are a good place for interventions aimed at children. In the U.S. children are required to go to school and most children attend public or private schools. Additionally, they are already in an attitude of learning and have peers with whom they can interact and participate in active learning methods. Baranowski et al. (51) conducted a review of literature on school-based obesity interventions. Additionally, schools offer many nutrition-related services including physical education, foodservice (school breakfast and lunch programs), and also provide after-school care. Some teachers incorporate nutrition information into their curriculum. Of the twenty research studies reviewed by Baranowski et al. that included measures of BMI, seven resulted in the desired changes; thirteen did not. A main characteristic of six of the successful studies is that staff trained and educated outside of the school system conducted the studies.
Chances are that teachers who administer the intervention have difficulty implementing it as intended, which results in an ineffective intervention. Baranowski’s review also suggests that interventions are more effective in older populations who are more mature and can understand the intervention, have more control over their own food choices, and have a level of adiposity that allows change to be detected (51).

As to the effectiveness of current reigning methods of increasing vegetable consumption, classroom curriculum in conjunction with school foodservice cooperation and parent/home initiatives is the most effective (65). While multi-directional interventions seem to be the answer, critical components continue to be ignored. Interventions should be tailored to the specific determinants of vegetable aversion in order to have an effect (65). There are both environmental and personal determinants of vegetable consumption and while the current model addresses some, it does not address others, perhaps those that are the most influential (65).

In Baranowski’s study of effective behavioral interventions (96), he suggests that the mediating variable model is in place in regards to food preference and related behavior change. The mediating variable model explains that the interventions themselves do not change the behavior but instead change mediating variables which will then change behavior. The problem is that most interventions are not focused on the mediating variables. Variables that are strongly related to behavior should be selected for intervention (96).

Blanchette and Brug concluded that multi-component, school-based interventions deliver good results (65). Elements that should be included in the classroom component
are asking skills to improve the accessibility and availability of fruits and vegetables and skills in the preparation of simple and tasty fruit and vegetable recipes (65).

*Why sensory-based education may be effective*

Providing opportunities to experience flavor properties of a food has more impact on increasing food preference than telling a child that the food is beneficial for his/her health (97); including this component in education would make it more effective than traditional informative education.

In Silberman’s book entitled *Active Learning: 101 Strategies to Teach Any Subject*, he describes the importance of hands-on, active learning:

Learning is not an automatic consequence of pouring information into a student’s head. It requires the learner’s own mental involvement and doing. Explanation and demonstration, by themselves, will never lead to real, lasting learning. Only learning that is active will do this. What makes learning “active”? When learning is active, students do most of the work. They use their brains… studying ideas, solving problems, and applying what they learn. Active learning is fast-paced, fun, supportive, and personally engaging. Often, students are out of their seats, moving about and thinking aloud… To learn something well, it helps to hear it, see it, ask questions about it, and discuss it with others. Above all, students need to “do it”—figure things out by themselves, come up with examples, try out skills, and do assignments that depend on the knowledge they already have or must acquire. (98)

Silberman continues by describing the scientific need for the active learning approach. It’s difficult for students to concentrate for a sustained period of time as minds wander and attention decreases. Johnson et al. (99) found that lecture-based learning is generally ineffective. The learner experience decreased attention with time; the format of lecturing appeals only to auditory learners and neglects those who are visual or experiential learners; lecturing promotes lower-level learning of factual information; and, students do not enjoy lecture format.
Adding pictures to lecture increases comprehension; however, pictures and lecture are still lacking in comprehension. Rather than just hearing and accepting information, the brain processes incoming information and questions it based on what they already know: where does the information fit in? Have they seen or heard it before? Silberman states, “Without the opportunity to discuss, ask questions, do, and perhaps even teach someone else, real learning will not occur.” It takes several and different kinds of exposures to material to comprehend it (98).

A study by Benware and Deci (100) examined whether students who learned actively would be more motivated to learn and would learn more than students who learned passively. The active situation was created by having subjects learn material with the expectation of teaching it to another student; the passive situation was created by having subjects learn the same material with the expectation of being tested on it. Subjects who learned in order to teach were more motivated and had higher learning scores (100).

**Ineffective methods of increasing vegetable consumption**

Rewarding children for vegetable consumption is not effective in sustaining increased consumption (67). While rewarding children for vegetable consumption increases intake in the short run, it may only be detrimental in the long run by causing the child to resent vegetables (67). The foods eaten as a result of the reward may actually become less preferred and the effort is seen as a parental control attempt (67). Environments in which parents are very controlling over the food have a counter-productive influence on a child’s fruit and vegetable intake (67).
Offering rewards for eating food may lead to further dislike of that food (65). A randomized, controlled trial examined vegetable consumption based on a rewards-based system versus an exposure-based system. Children were exposed to red pepper for eight consecutive days, with the rewards group receiving a sticker after each trial. The exposure group had increased preference and consumption when compared to the control group. The effect of the reward group was intermediate and did not differ much from either the exposure or control conditions indicating that offering a reward might damage the impact of exposure alone (85).

**Why children should be targeted for intervention**

Lobstein et al. and the International Obesity Task Force cited that nearly ten percent of children ages five to seventeen years in the world are overweight (including obesity); about 2% to 3% worldwide are obese (34). Underdeveloped countries have an overweight prevalence average of well under 10% whereas many developed countries, including the United States, have an obesity prevalence rate of well over 20%. The rates are increasing at about 0.5% in the United States annually (34). In wealthier countries, it is the individuals of lower socioeconomic status that are prevalent in obesity (34). The NHANES data collected between 1971 and 2000 show that that combined prevalence of obesity and overweight has more than doubled with the prevalence of obesity alone has increased four-fold (34).

Honing in on a more immediate and closer problem, Ogden et al. demonstrated that the prevalence of national obesity in two to nineteen year-olds had increased from 28.2% to 33.6% in a matter of just two years (101). Kumanyika et al. (102) point out that the majority of those who are obese in the United States are typically in the ethnic
minority or live in low-income communities. As an unfortunate consequence of early obesity, children may lose 17 to 26 life years because of early diabetes that often accompanies obesity even at a young age. The loss of years is a reflection of both reduction in quantity and quality of the years of life (102).

Conclusion

Increased vegetable consumption may be the key to increased health for an American population that struggles with rising rates of obesity and chronic disease. Interventions aimed at increasing preference for vegetables during childhood may result in increased vegetable consumption. Modified education approaches and/or extended flavor-flavor conditioning may be an effective way to influence permanent behavior change.

References


CHAPTER 3
THE EFFECTIVENESS OF FLAVOR-FLAVOR CONDITIONING ON INCREASING VEGETABLE PREFERENCE AND CONSUMPTION AMONG ELEMENTARY SCHOOL CHILDREN

Abstract

Background Obesity is a leading cause of death in the United States. Research indicates that increased vegetable consumption may play a critical role in obesity prevention. Flavor-flavor conditioning may be an effective way of increasing vegetable preference and thereby consumption by presenting a neutral vegetable flavor with an already preferred flavor.

Objectives This study sought to increase vegetable preference and consumption by implementing flavor-flavor conditioning.

Methods Children ages five to eleven (n=59) were exposed to sweetened vegetable purees to increase preference for that vegetable flavor. Nine paired tastings were presented. Children received a post-test immediately after the final conditioning (n=27) and again two to three weeks after the final conditioning (n=24) to assess the resilience of flavor-flavor interventions on behavior change. Children also participated in a vegetable buffet plate waste both pre- and post-intervention to assess the intervention’s effect on whole vegetable consumption (n=22). Attitudes and behaviors towards vegetables were assessed with pre- and post-intervention surveys.

Statistical analyses performed A repeated measures ANOVA was used to examine the effect of conditioning on flavor-preference. The change in attitudes and behaviors was
evaluated using an independent samples t-tests. Pre and post-flavor conditioning change in whole vegetable consumption was assessed using paired t-tests.

**Conclusion** Flavor-flavor conditioning is not an effective strategy to increase whole vegetable consumption or preference for vegetables in elementary school-aged children.

**Introduction**

The evidence for increased vegetable consumption is reflected in the 2005 Dietary Guidelines for Americans (hereafter referred to as the “Guidelines”) (1). The Guidelines are based on scientific evidence to promote health and reduce risk for chronic disease through diet and physical activity. An increased intake of fruits and vegetables is associated with a decreased incidence and mortality from the following diseases: cardiovascular diseases, stroke, hypertension, diabetes, obesity, and certain types of cancer (1-4). Energy imbalance that results from poor diet and sedentary lifestyle contributes to overweight and obesity in the US.

As the most recent version of this federal document, the 2005 Guidelines advise individuals to consume between 9 and 13 servings or an average of four and one-half cups of fruits and vegetables daily, an increase from the previous 2000 Guidelines recommendation to consume 5 to 9 servings daily. Many of the nutrients currently deficient in the typical American diet including calcium, potassium, fiber, folic acid, magnesium, and vitamins A, C, and E (3) can be provided by an increase in vegetable consumption. A diet rich in vegetables would not only provide the deficient nutrients but would also help Americans meet the goal to consume fewer calories and other overconsumed nutrients. Consumption of vegetables is a critical part of a nutrient-dense, low-calorie diet that promotes energy balance and healthy weight (5, 6).
The recommendations in the Guidelines are based on scientific evidence of specific nutritional factors that lower the risk of chronic disease (3). Among all the dietary advice to consider, increasing fruit and vegetable intake may reverse current disease trends more so than any other change (2). As an isolated factor, severe obesity affects most organ systems making it obvious that obesity is an extensive health problem (7). There are several observations that find a health benefit for fruits and vegetables when assessed together, but when broken out, benefits were only observed for vegetable intake and not fruit (8, 9).

Based on current habits measured by the National Health and Nutrition Education Survey (NHANES) 2001-2002 data, Americans generally need to increase vegetable consumption by 0.9 cups per day, with an increase in all vegetable subgroups with the exception of starchy vegetables among women 3. Analysis of the Behavioral Risk Factor Surveillance System (BRFSS) survey yielded similar results as the mean frequency consumption of vegetables declined slightly from 2.06 times per day in 1994 to 2.02 times per day in 2000 (10). Both surveys demonstrate that Americans are consuming far below that which is optimal (3, 10). Analysis of NHANES data over a period of years reveals a decreasing trend. In 1988-1994, 35% of individuals met the recommendations for vegetable consumption decreasing to 32.5% of individuals in the 1999-2002 survey (p = 0.026) (8,9). The percentage of individuals who reported no daily vegetable consumption was 25%. Approximately half of individuals in both surveys indicated consuming at least one serving of garden vegetables and 20% reported consuming at least one serving of fried potatoes. When excluding fried potatoes from consumption totals, both surveys decreased in percentage of vegetable consumption with 1988-1994
consumption decreasing from 35% to 29.9% and 1999-2002 consumption decreasing from 32.5% to 27.4% (p= .020).

In the Report Card on the Diet Quality of Children Ages 2-9 it is estimated that only 22% of children ages seven to nine eat three servings per day; only 19% of children ages four to six and 35% of children ages two to three meet this guideline, respectively (11). It is notable that vegetable consumption decreases with age and may be correlated with increased consumption of snack foods (11). Overall, the dietary quality of children ages two to nine is less than optimal which is a concern as eating habits in children lay a foundation for adult eating habits and may impair general growth and development in children (11, 99). Repeated food choices create momentum for similar food selections in the future (12). This may suggest that as individuals age, food choices are more predictable, suggesting that interventions targeted to children may impact dietary behaviors across the lifespan (13).

Psychosocial factors such as attitude, social influence, and self-efficacy explain much of the variability in vegetable consumption among children. However, other factors like exposure, parental consumption and dietary habits are also important (14). In Blanchette and Brug’s review of fruit- and vegetable-based interventions, they concluded that the nutrition knowledge deficit regarding fruits and vegetables is often addressed but nutrition education has been observed to be only moderately effective on its own (15); targeting other determinants may demonstrate increased acceptance and consumption of vegetables. Personal preference, in the absence of other potentially limiting factors like economics or the ability to obtain food, is believed to play a major role in individual food choices.
Food neophobia, an unwillingness to eat unfamiliar foods, is a prevalent barrier to vegetable consumption, notably in children (16). The degree of neophobia often increases as infants mature into young children. In infants, one exposure to a new food item was sufficient to increase intake of that item at a subsequent feeding (17). In contrast, anywhere from five to ten exposures of a food item is required to increase preference of that food in young children (17). The age of a child at the time of exposure correlates with his/her extent of food neophobia in the future. Pelchat and Pliner concluded that an early exposure to vegetables may ameliorate future vegetable neophobia or preclude that neophobic response (18).

Reduction in neophobia through exposure to one food generalizes to similar foods. For example, repeated exposure to a carrot may transform an initially neophobic child into a child more accepting of carrots in particular and vegetables in general (17). Neophobia may be more easily overcome as they are able to associate new foods with familiar tastes through “flavor principles” or the ability to correlate taste information they know about similar foods to the food which they have not tasted (19). The foods that children prefer most are not typically foods of high nutritional value being high in both fat and sugar. In a survey of 4 to 16 year-olds, vegetables were rated lowest and sugary foods were rated the highest in preference (20). In a study of twin pairs, liking of a food was positively correlated with the percentage of the children who had tried it indicating more familiar foods were preferred foods (21).

Individuals rarely eat that which does not taste good to them and is therefore often considered a minimum criterion for food consumption (19). Research with children in particular has demonstrated that taste is the most influential determinant of vegetable
consumption. Among 9 to 11-year-olds, preference for vegetables was more influential than either parental vegetable intake or attitudes in regards to vegetable consumption patterns (15, 22). When referring to vegetable consumption, the word “preference” connotes that liking is the basis for selection, or the selection of a certain item over another (23). It is argued that food preference is learned through experience with both food and eating in contrast to the view that food preference is innate and governed by the body’s need for nutrients (23-25).

The etiology of food preference can be seen as a convergence of two broad categories that, together, constitute a developmental systems perspective: 1) genetic predisposition and, 2) eating environment or the association of food with the context and consequences of eating that food (23). The genetic predispositions that provide the foundation for food selection include three principles: 1) the innate human preference for sweet and salty and the aversion to sour and bitter tastes; 2) the propensity for rejecting novel food items (neophobia) and acquire a learned preference for the familiar, and; 3) the predisposition to associate foods with the contexts in which they are offered (23). Food preferences and food selection patterns are phenotypic behaviors that result from gene and environment interactions (23).

A variety of studies have consistently shown that infants prefer sweet taste (26-27, 28); furthermore, infants who received a certain flavor through human milk from their mothers demonstrated an increased preference for that flavor when offered in cereal even when that flavor was not sweet (26). The critical component in the success of this study was the amount of time between the exposure to the flavor and acceptance of the cereal
with the same flavor; when more time elapses between the exposure and response, responsiveness and preference is greater (26).

Opposite to the reaction for sweet tastes, infants frown when exposed to bitter tastes, a common property of vegetables. This reaction occurs prior to exposure to food, even at birth (28). While infants are not able to initially control intake based on perception of bitter taste, the ability to choose based on a bitter taste emerges within the first months of life, generally between 14 and 180 days. Along with the ability to choose comes the response to exposure. Infants exposed to the bitter taste of protein hydrolysates found in infant formulas very early in life accept these formulas more readily than do infants who lack early exposure (29). The development of “innate predispositions” for sweet and salty and aversions to bitter and sour tastes are generally not conducive to vegetable preference (15).

Certain “tastants” are known to suppress bitterness and include aspartame, sodium acetate and salt (30). When studying adults, aspartame, by imparting a sweet flavor, universally increased preference for bitter vegetables. When added to vegetables at school, 2/3 of preschoolers preferred the sweetened vegetables over the non-sweetened (30). Those subjects who perceived the vegetables as most sweet and least bitter consumed vegetables more frequently.

The food context in which certain tastes are experienced is that in which they are accepted among those past the infant stage (31). Preschool children who were given tofu salted, plain, or sweetened, acquired a preference to that tofu that had become familiar to them (31). This is an indicator that sweet tastes are preferred largely in familiar food
contexts; based on their experience with sweet taste in food, children learn that some foods are appropriate contexts for sweetness and others are not (31).

The objective of this study was to examine the role of a flavor-flavor conditioning by expanding the methods described by Havermans (32). The Havermans study recruited 21 girls and boys with a mean age of 5.2, indicating that most participants were fairly young. Children were tested in small groups of two to five using six flavors: pumpkin, zucchini, pea, cauliflower, carrot, and broccoli. Purees were prepared as follows: Vegetables were cooked until soft and then mashed using a kitchen blender. Approximately 50 g of mash was diluted with 100 mL of water. The mixture was placed in a 250 mL opaque cup with opaque lid to minimize influence of color on preference. A straw was inserted through the lid. Children were instructed to take a sip of the puree and characterize it as liked, just okay, or disliked. Using these categories, children ranked the vegetable flavors from one (most liked) to six (least liked). The flavors ranked three and four were selected as the conditioning stimuli (CS).

The children received three paired presentations of the neutral vegetables ranked three and four. These were prepared and served in a similar manner as the pre-test. To one of the flavors, 20 g of dextrose was added. The taste to which the dextrose was added was determined randomly for each child. During the conditioning, children were instructed to sip and swallow from both drinks every 5 minutes. The experimenter would also take a sip of a given vegetable taste with each pair of conditioning trials. The experimenter did not make any sounds, remarks or facial expressions. During the conditioning, the children were allowed to make a drawing. After the trials, the children were escorted back to their classroom.
The following day, the same children were taken from the classroom and escorted into a separate room where they received a further three pairs of flavor conditioning trials. Directly after the second session, the children received a post-test that was the same as the pre-test, with all vegetable flavors unsweetened. Thirteen children completed the experiment. At pre-test, 31% of the participants categorized CS- as liked and a similar percentage of participants categorized CS+ as liked. At post-test, 15% of the participants categorized CS- as liked, whereas 54% categorized CS+ as liked. This implies an increase in preference for CS+ but not CS-.

The objective of this study is to further contribute to the growing body of research trying to identify effective strategies and interventions to increase vegetable consumption among children. This study implements an extended flavor-flavor conditioning intervention and measures the intervention’s impact on vegetable-related attitudes and behaviors and whole vegetable consumption in a real-world setting.

**Subjects and Methods**

**Study participants**

This intervention was developed to target children ages five to eleven in kindergarten through fifth grades attending public schools. Participants were recruited from two after-school Boys and Girls Club programs in Cache County School District at Park and Summit Elementary schools. Additional participants were recruited from a single fourth-grade class at Summit elementary; none of the additional students from the fourth-grade class were already participating in the after-school intervention (n=59 at pre-test, n= 27 at immediate post-test, and n=24 at extended post-test). The schools were chosen based on higher levels of student participation in the after-school program and
geographic location in relation to the University. Other schools were excluded based on a high Spanish-speaking population and the inability of the examiners to speak Spanish. Ages of the children were not available; mean age was not obtained.

Flavor-flavor conditioning was implemented for a total of three days of conditioning with time between pre-test and initial conditioning and post-test occurring on a different day than the final conditioning. An additional post-test was implemented two to three weeks after the initial post-test to examine the resilience of the effect of conditioning. Whole vegetables were also ranked in the same way as purees to examine the impact of flavor-flavor conditioning on whole vegetable preference. A vegetable buffet plate waste study was implemented to examine the effect of flavor-flavor conditioning on whole vegetable consumption, whether it increased or decreased consumption.

**Methods**

The methods and procedures of this study were reviewed and approved by the Utah State University (USU) Institutional Review Board, the Cache County School District (CCSD), and the Boys and Girls Club after-school program to ensure the protection of all participants. All participants and participant parents/guardians were informed of potential risks and benefits associated with participating in the study through a letter of information sent home with the students. Signing the forms excluded their children from the data collection associated with the research without penalty. Data were collected from February to May of 2008.
Puree dilution

The purees were mixed in a one to two ratio of grams of mash to milliliters of water ratio, or 25 g mash to 50 mL of water. When sucrose was added for conditioning, 7 g were added to impart the same flavor as the Havermans (32) study with a conversion factor of 10:7 dextrose to sucrose being used. The vegetables chosen were peas, carrots, cauliflower, and broccoli. To prepare the mash, each vegetable was cooked until soft then mashed either by hand or in a blender. The mash was then measured on a food scale, placed in an opaque cup, and then diluted with tap water. Lids were placed on the cups with a straw for children to sip through. Shields were placed over the lids to avoid color being an influencing factor on preference.

Initial puree testing

At a visit subsequent to vegetable buffet and survey collection, initial testing was administered to after-school children and those in the fourth-grade classroom. Initial testing was comprised of both ratings and rankings of vegetable purees and whole vegetable pieces. Ratings were defined as the determination of the taste of the vegetable (puree or whole piece) itself and rankings were defined as the preference of the vegetable (puree or whole piece) in relation to other vegetables. The rating and ranking sheets used hedonics to accommodate participants of all ages (see Appendix for rating and ranking sheets). The rating form measured preference on a scale of one to nine with one being “dislike,” five being “not sure,” and nine being “like.” The ranking form measured preference on a scale of one to four with one being “dislike,” two and three being “neutral,” and four being “like.” The forms, however, did not have the numbers written prior to testing in order to avoid confusion to young participants.
Subjects were instructed to take a sip from each of the four cups labeled A through D, taking a sip of water between each one. Trained researchers were allowed to help participants only by clarifying the preference ranking and rating procedures. After tasting each puree, the subject was asked to place the cup on the circle that reflected his/her opinion about the taste of the puree. After tasting each puree, the subject was also asked to mark with a pencil on another form what they would rate the flavor. Children were allowed to move the cups to reflect true preference as more purees and whole vegetables were tasted.

Subsequent to puree tasting, subjects tasted whole vegetables. Whole vegetables were presented in small clear containers with lids labeled A through D. Subjects were asked to pretend that they were tasting these vegetables for the first time. After tasting each whole vegetable, the subject was asked to place the cup on the circle that reflected his/her opinion about the taste of the vegetable. After tasting each vegetable, the subject was also asked to mark with a pencil on another form what they would rate that flavor. After the ranking and rating procedures, subjects were dismissed to be with the rest of the group. Participants received all testing in small groups of less than four with each child in his/her own space to minimize influence from peers. The classroom subjects were separated into different areas of the classroom with desks turned to minimize peer contact and influence.

**Conditioning**

The two neutral vegetables (those ranked two and three) were those to which preference was experimentally increased per individual. Sucrose was added to one of the neutrally-ranked flavors and was determined randomly for each subject. Subjects
received three paired presentations of the two vegetable tastes they had ranked as having neutral preference. These were prepared and served in a similar manner as the tastes during the pretests. To one of these tastes, however, sucrose was added (CS+). Dextrose was used in the Havermans study; the amount of dextrose used in the Havermans study (20 g) was divided by two since the mash/water mixture was half that of the Havermans study. The 10 g of dextrose was converted to 7 g of sucrose. The other taste remained unsweetened (CS-). The puree ranking was the determinant of the neutral flavors; no other baseline preference tests were included.

For the three days immediately after the initial preference testing, subjects received repeated tastings of their neutral vegetables. For the after-school group, subjects were taken from the large group into a separate area with at least one trained researcher per two subjects. Subjects were not in the same area of the room. The classroom subjects were moved to different parts of the classroom and unable to make eye contact with other students. Separating small groups of children from a larger group for testing was not feasible due to time and space restrictions.

Each subject was instructed to take a sip and swallow from both the CS- and CS+ cup every 5 minutes for a total of three tastings. Subjects were allowed to drink water between tastings if they wished. The researchers were instructed not to make any comments during the conditioning but express appreciation for the subjects’ participation. Children drew pictures while they waited between tastes. The same method was followed for a total of three conditioning days, one day longer than the Havermans study. Directly after the third conditioning session, the children received a post-test that was identical to the pretest. Again, the four different vegetable tastes were served
(unsweetened) and children had to evaluate and rank these tastes. If the flavor-flavor conditioning were to be successful, an increase in preference for the taste previously sweetened (CS+) would be observed and no change in preference for the taste not paired with sucrose (CS-) would be observed).

A preference posttest was administered 2 to 3 weeks after the last day of conditioning the same as the pre- and immediate post-test in order to assess long-term sustainability of flavor-flavor conditioning; the Havermans study also lacked this long-term measure.

**Additional assessments**

*Vegetable buffet/plate waste evaluation*

Prior to the flavor-flavor conditioning intervention, after-school program participants participated in a vegetable buffet plate waste study. The children in the fourth-grade class at Summit Elementary were unable to participate in the vegetable buffet due to time constraints. The vegetable buffet consisted of raw cauliflower, peas, carrots, and broccoli presented in large bowls. None of the vegetables were pre-portioned with the exception of peas, which were portioned in small cups to the amount of ⅛ cup. Students were instructed to take as many vegetables as they wanted. Students could return for multiple portions with the number of times the student had returned to the buffet written on the plate prior to each visit to the buffet. Plates were photographed immediately after vegetable selection and prior to vegetable consumption. The second photograph was taken after the students had eaten vegetables and before they threw away their plates or revisited the buffet for an additional portion with the same plate. The same methods were followed for the post-intervention vegetable buffet, which was conducted
after all flavor-flavor related interventions were complete, at least three weeks from the initial test.

*Attitude/behavior survey*

All participants in the after-school program were given a baseline survey (see Appendix) to evaluate their attitudes and behaviors regarding vegetable consumption. The children in the fourth grade class were unable to participate in the survey due to time constraints. The survey included 14 questions about attitudes and behaviors and an evaluation of the child’s knowledge of 31 different vegetables. The questions about attitudes and behaviors were assessed using hedonics in a grid fashion where children could check the box under the face that reflected their feelings about the question. Color pictures of the 31 vegetables were provided if children desired clarification or were of a younger age. Children were taken in groups of no more than three into a room separate from other participants to minimize distraction. Two proctors administered the survey to the small group and were available to help each child one-on-one as needed. Upon survey completion, children returned to the larger group. Student desks during the survey were separated for minimal eye contact and peer influence among students.

*Data Collection*

A visual plate waste study was implemented to examine children’s at-will vegetable consumption pre- and post-intervention. Children were assigned identification numbers that were written on the disposable plate used for the plate waste study. Pictures of the plates were taken before and after consumption of the vegetables to compare how much was taken versus how much was left in order to determine how much was
consumed. The students were not included in the pictures in order to maintain confidentiality. Trained observers assessed waste by viewing the photographs and counting the individual pieces of broccoli, cauliflower, and carrots and assessing the amount of peas to the nearest $\frac{1}{4}$ cup. Five observers analyzed the pictures and the mode amount was utilized for analysis.

Ranking and rating for purees and whole vegetables was assessed using a form with a hedonic scale. Forms were collected and entered for analysis.

**Statistical Analysis**

Repeated measures analysis of variance (ANOVA) as well as paired and unpaired t-tests were used to examine pre-post conditioning changes in preference and intake. A repeated measures ANOVA was conducted to examine changes in preference with Test (pre-test vs. post-test) and CS (plus vs. minus) as the within-subject factors and ranking scores at pre-test and post-test as the dependent variable. This analysis was conducted on each of eight sets of data: puree ranking, puree rating, whole vegetable ranking, and whole vegetable rating, both pre- versus immediate post-test and pre versus greater than two weeks out post-test. Puree ranking was defined as the taste of one puree relative to the taste of another puree. Puree rating was defined as the taste of a puree based on itself (i.e., how much do they like that flavor alone?). Whole vegetable ranking was defined as the taste of one whole vegetable relative to the taste of another whole vegetable. Whole vegetable ranking was defined as the taste of a whole vegetable based on itself (i.e., how much do they like that flavor alone?). The immediate post-test and greater than two weeks post-test were run in order to determine the resilience of the conditioning. Attitude/behavior survey results were evaluated using an independent samples t-test with
zero indicating pretest and one indicating posttest. Paired t-tests were run on the vegetable buffet plate waste data to determine whether or not conditioning translated into greater whole vegetable consumption. SPSS (SPSS, Chicago, IL, USA) software package was utilized for data analysis.

**Results**

Twenty-seven subjects completed flavor-flavor baseline and the immediate post-test and were used for baseline versus immediate posttest analysis (Table 3.1). No significant effect of test was found in the puree ranking and rating or in the whole vegetable ranking when baseline was compared to immediate post-test preference. However, a marginally significant effect of test (p=0.058) was found in whole vegetable rating when baseline was compared to immediate post-test preference. This suggests that more testing (i.e. more exposure to flavors) increased preference for whole vegetables. The effect of Test*CS was insignificant in all cases. This suggests that the conditioning (to sweet flavor) had no effect on preference, post-hoc statistics were not run on this set of data. Had Test*CS been significant, it would have meant that the conditioning stimulus itself may be responsible for the increase in preference for that flavor. The ubiquitous insignificance Test*CS statistic suggested that conditioning was not effective in increasing preference for vegetables, either whole or pureed.

Twenty-four subjects completed baseline and >2 weeks posttest of purees (see Table 3.1). Analysis yielded similar results for both puree rating and ranking with no significant main effect of test or CS or Test*CS interaction. This signifies that neither the amount of testing nor the conditioning impacted preference in a positive or negative way. However, the effect of Test was significant for both whole vegetable ranking and rating
(p=.039 and p=.015, respectively), Test signifying the number of times that the individual was exposed to the intervention. The Test*CS interaction remained insignificant meaning that the exposure to the vegetable purees increased preference for whole vegetables but the preference was not based on whether or not that particular flavor was conditioned to be sweet (be consistent with how you describe this).

The flavor-flavor conditioning did not have a significant impact on attitudes and behaviors as self-reported by participants (Table 3.2). The survey results further confirm that the flavor-flavor conditioning elicited no effect on behavior or attitude change as self-reported by participants.

Flavor-flavor conditioning did not have a significant impact on the amount of vegetables taken from the vegetable buffet when comparing amounts taken before and after intervention (see Table 3.3). The only significant change in vegetable amounts taken was peas (p=0.033) which had a mean decrease of 0.417 cups, or almost half a cup. Flavor-flavor conditioning had no significant impact on the actual consumption of any whole vegetables in comparing amounts eaten pre- and post-intervention (see Table 3.4).

**Discussion**

Results from puree ranking and rating and whole vegetable ranking and rating in this study indicate that conditioning to a sweet stimulus is not an effective way to increase vegetable preference in elementary school-aged individuals. In addition, among elementary-aged children preference is resilient over at least a 2-week period of time, whether that resilience exists as no change in preference or change in preference.

Our results are not consistent with results observed by Havermans et al. (32). Although we followed the method outlined by Havermans, our method differed by the
range of ranking available to children. Havermans used a six point rating scale, this intervention used a four point rating scale and an effect may not have been seen because of the tight range (one through four) of ranking and the inability to truly see preference “move” within that ranking.

Guthrie argues that young children can effectively rank flavors. In the Guthrie study (22), children 3-5 years-old were asked to categorize common foods based on hedonic representations of their preference—smiling (“this food is yummy”), frowning (“this food is yucky”), and a face expressing neither emotion (“this food just tastes okay”). The children initially placed their preferences in one of the three categories. Upon completion, the children ranked the foods within that category. They were asked to pick the food that was the “yummiest” in the yummy category. Once that food was isolated, it was removed and the question was asked again. Once all foods in the yummy category had been ranked, the procedure was done again for the just okay and the yucky categories, eliciting a comprehensive ranking (22). The procedure was done with food tasting, food models, and food photographs. The procedure was done with preschoolers between the ages of 3 and 5 who were able to successfully complete the task, particularly when tasting the food when ranking or utilizing pictures of the foods. The reliability of the food tasting method versus a food model method and food photograph method was significant at a level of p=0.003. The picture method was found to be less significant the younger the child was (22).

Children may not perceive sweetness as an appropriate flavor when paired with vegetables. Had conditioning been done based on flavors that children deem appropriate with vegetables, a preference shift may have been seen. For example, some children
prefer salt or fat (like butter or cheese) added to vegetables rather than sugar either due to innate genetic preference or exposure to those flavors throughout their childhood.

There is a major difference in the taste of cooked versus overcooked versus raw vegetables. Making purees involves overcooking vegetables; this increases the bitter-tasting compound release in the broccoli and cauliflower which can further deter individuals who are sensitive to bitterness from preferring those flavors and vegetables. In the future, testing children’s preference for whole cooked vegetables in correlation with flavor-flavor conditioning using cooked vegetables would perhaps elicit stronger results and reflect effectiveness of flavor-flavor conditioning. Also, conditioning to flavors preferred by the individual may also elicit stronger results in preference for vegetables.

Had the vegetable buffet utilized cooked vegetables, there may have been a different relationship between vegetable buffet data and flavor-flavor conditioning data. It was difficult to justify associations as the difference in cooking and preparation of vegetables changes the flavor profile. However, in this research situation, there was not an opportunity to use cooked vegetables as there were not resources to keep a large amount of vegetables heated to the proper temperature.

In future studies of flavor-flavor conditioning, it may be wise to determine what children prefer as paired flavors with vegetables and try to increase preference for vegetables utilizing that flavor in particular. Generally, the flavor-flavor method may also be more effective when using the form of vegetable to which preference is being increased (i.e., use cooked whole vegetables with a conditioning flavor in order to increase preference to cooked whole vegetables). The puree approach may not be
effective though easier for research purposes in order to decrease bias through elimination of vegetable appearance.

The buffet plate waste approach may be an effective way to monitor the preference for vegetables. Amounts can be isolated and measured concretely with the ability to re-examine pictures of the buffet results. The buffet may not be effective in that children do not eat the same food items daily and may or may not prefer vegetables on a given day. If a child does not feel well or has already eaten vegetables recently within that day, it may result in decreased vegetable consumption that day. Past experience with vegetables was not controlled for. Several outside factors could affect the preference of a vegetable including the use of a new recipe in the home, vegetable availability in the home, or recent experiences with illness around the time of vegetable consumption. It could also depend on the hunger level of the participant and what and when they last ate. The pre-post vegetable buffet was administered at the same time of day to attempt to control for this variable. For research purposes in this case, a vegetable buffet plate waste was a suitable method for a real-world measuring intake and preference but may have been affected by several outside factors.

In addition, this study may not have elicited the same results as the Havermans study in that there was a high participant dropout rate. Whether or not subjects were present for the pre- and post-ranking and rating procedures was unable to be predicted for those individuals who participated in the after-school program because the population was rarely constant. This resulted in a fairly small sample size. In the future, a constant population should be recruited for a study of this type and facilities that include a kitchen would facilitate provision of adequate vegetable buffet food items.
Conclusion

Flavor-flavor conditioning is ineffective in increasing whole vegetable consumption and preference for vegetables in elementary school-aged children, regardless of the length of time between conditioning and post-test. This may be due to a combination of intrinsic and/or extrinsic factors that were unable to be controlled by the researchers.

References


### Table 3.1. Mean baseline and posttest ranking and ratings.

<table>
<thead>
<tr>
<th>Baseline vs. immediate post-test</th>
<th>Mean difference (pre vs. post)</th>
<th>Mean difference (pre vs. post)</th>
<th>Test</th>
<th>Sig</th>
<th>Test*CS</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CS-</td>
<td>CS+</td>
<td>F</td>
<td>Sig</td>
<td>F</td>
<td>Sig</td>
</tr>
<tr>
<td>Puree ranking</td>
<td>-0.08</td>
<td>0.11</td>
<td>0.078</td>
<td>0.782</td>
<td>0.28</td>
<td>0.601</td>
</tr>
<tr>
<td>Puree rating</td>
<td>0.96</td>
<td>1.59</td>
<td>1.286</td>
<td>0.267</td>
<td>1.037</td>
<td>0.318</td>
</tr>
<tr>
<td>Whole vegetable ranking</td>
<td>-0.08</td>
<td>0.03</td>
<td>2.426</td>
<td>0.131</td>
<td>0.165</td>
<td>0.688</td>
</tr>
<tr>
<td>Whole vegetable rating</td>
<td>-0.48</td>
<td>-0.45</td>
<td>3.932</td>
<td>0.058</td>
<td>0.007</td>
<td>0.932</td>
</tr>
<tr>
<td><strong>Baseline vs. two weeks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Puree ranking</td>
<td>0.33</td>
<td>-0.21</td>
<td>0.975</td>
<td>0.334</td>
<td>2.026</td>
<td>0.168</td>
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<tr>
<td>Puree rating</td>
<td>2.13</td>
<td>0.79</td>
<td>1.335</td>
<td>0.26</td>
<td>3.617</td>
<td>0.07</td>
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<tr>
<td>Whole vegetable ranking</td>
<td>0.26</td>
<td>0</td>
<td>4.814</td>
<td>0.039</td>
<td>0.633</td>
<td>0.435</td>
</tr>
<tr>
<td>Whole vegetable rating</td>
<td>0.14</td>
<td>-0.41</td>
<td>7.039</td>
<td>0.015</td>
<td>1.17</td>
<td>0.292</td>
</tr>
</tbody>
</table>
Table 3.2. Survey behavior and attitude questions: Difference between baseline and post-intervention surveys.

<table>
<thead>
<tr>
<th>#</th>
<th>Question</th>
<th>Mean difference between pre versus post</th>
<th>T</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I like to eat vegetables.</td>
<td>-0.23</td>
<td>0.216</td>
<td>0.625</td>
</tr>
<tr>
<td>2</td>
<td>I think vegetables taste good.</td>
<td>0.305</td>
<td>1.29</td>
<td>0.461</td>
</tr>
<tr>
<td>3</td>
<td>There are plenty of vegetables to eat at my home.</td>
<td>0.432</td>
<td>7.505</td>
<td>0.225</td>
</tr>
<tr>
<td>4</td>
<td>I always eat vegetables at lunch time.</td>
<td>0.354</td>
<td>1.189</td>
<td>0.621</td>
</tr>
<tr>
<td>5</td>
<td>I always eat vegetables with my dinner.</td>
<td>0.508</td>
<td>0.281</td>
<td>0.948</td>
</tr>
<tr>
<td>6</td>
<td>I eat vegetables as snacks.</td>
<td>0.333</td>
<td>1.257</td>
<td>0.826</td>
</tr>
<tr>
<td>7</td>
<td>Vegetables taste good plain, without anything added to them.</td>
<td>-0.054</td>
<td>0.098</td>
<td>0.333</td>
</tr>
<tr>
<td>8</td>
<td>My favorite way to eat vegetables is when they are raw.</td>
<td>-0.078</td>
<td>0</td>
<td>0.929</td>
</tr>
<tr>
<td>9</td>
<td>My favorite way to eat vegetables is when they are cooked.</td>
<td>0.204</td>
<td>0.001</td>
<td>0.92</td>
</tr>
<tr>
<td>10</td>
<td>I like to try new vegetables.</td>
<td>0.751</td>
<td>0.185</td>
<td>0.432</td>
</tr>
<tr>
<td>11</td>
<td>I like to learn about how vegetables grow.</td>
<td>0.298</td>
<td>0.42</td>
<td>0.925</td>
</tr>
<tr>
<td>12</td>
<td>I think vegetables are important to eat every day.</td>
<td>0.576</td>
<td>1.973</td>
<td>0.336</td>
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<tr>
<td>13</td>
<td>I think I need to eat vegetables to be healthy.</td>
<td>0.757</td>
<td>26.855</td>
<td>0.097</td>
</tr>
<tr>
<td>14</td>
<td>I think I could still be healthy without eating vegetables.</td>
<td>-0.351</td>
<td>0.438</td>
<td>0.195</td>
</tr>
</tbody>
</table>

Table 3.3. Vegetable buffet (vegetables taken, pre versus post)

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Measure</th>
<th>Mean difference (pre to post)</th>
<th>T</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrots</td>
<td>pieces</td>
<td>5.150</td>
<td>6.444</td>
<td>0.385</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>pieces</td>
<td>-0.783</td>
<td>1.619</td>
<td>0.361</td>
</tr>
<tr>
<td>Broccoli</td>
<td>pieces</td>
<td>-1.283</td>
<td>2.750</td>
<td>0.244</td>
</tr>
<tr>
<td>Peas</td>
<td>nearest 1/4 cup</td>
<td>-0.417</td>
<td>2.073</td>
<td>0.033</td>
</tr>
</tbody>
</table>
Table 3.4. Vegetable buffet (vegetables *eaten*, pre versus post)

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Measure</th>
<th>Mean difference (pre to post)</th>
<th>T</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrots</td>
<td>Pieces</td>
<td>6.617</td>
<td>6.167</td>
<td>0.248</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>Pieces</td>
<td>-0.067</td>
<td>0.170</td>
<td>0.878</td>
</tr>
<tr>
<td>Broccoli</td>
<td>Pieces</td>
<td>-0.117</td>
<td>0.232</td>
<td>0.855</td>
</tr>
<tr>
<td>Peas</td>
<td>Nearest 1/4 cup</td>
<td>-0.204</td>
<td>6.514</td>
<td>0.252</td>
</tr>
</tbody>
</table>
CHAPTER 4

THE ROLE OF SENSORY-BASED, VEGETABLE-THEMED EDUCATION IN INCREASING VEGETABLE PREFERENCE AMONG ELEMENTARY SCHOOL CHILDREN

Abstract

Background Obesity is a leading cause of death in the United States. Research indicates that increased vegetable consumption may play a critical role in obesity prevention. Traditional educational interventions alone are only moderately effective in increasing vegetable consumption.

Objectives To determine the effectiveness of sensory-based, vegetable, themed curriculum on vegetable consumption and preference in elementary school-aged children. The vegetable-themed curriculum focused on four vegetables (carrots, peas, cauliflower, broccoli) and included three 30-minute lessons on each target vegetable. Lessons included information on how the target vegetable tastes, where it grows, and what it looks, feels, sounds, and smells like. Lessons were taught once per week for three weeks each month over four months.

Methods Children ages 5-11 enrolled in an after-school program at one elementary school were invited to participate (n=27 number invited to participate). The amount of vegetables consumed by participants during a designated snack occasion was observed pre- and post-intervention (n = 20, 12 respectively). Participants also completed pre-and post-intervention surveys on attitudes and behaviors related to vegetable consumption. Results from the pre- and post-intervention measures were analyzed using independent samples t-tests.
**Results** The intervention was associated with increased consumption of carrots (p value =0.001) and peas (p-value=0.003) but not cauliflower or broccoli. There was no change in vegetable-related attitudes or behaviors post-intervention.

**Conclusion** The results of the current study support the use of sensory-based, vegetable-themed education to increase vegetable consumption among children. Future studies should involve a larger sample size and should consider the feasibility of in-school rather than after-school education.

**Introduction**

Increasing fruit and vegetable intake may reverse current disease trends more so than any other dietary recommendation (1). An increased intake of fruits and vegetables has been associated with a decreased incidence and mortality from the following diseases: cardiovascular diseases, stroke, hypertension, diabetes, obesity, and certain types of cancer (1-4).

Inadequate vegetable consumption is seen in children. In the *Report Card on the Diet Quality of Children Ages 2-9* it is estimated that only 22% of children ages 7 to 9 eat 3 servings per day; only 19 percent of children ages 4 to 6 and 35% of children ages 2 to 3 meet this guideline, respectively (5). It is notable that vegetable consumption decreases with age and may be correlated with increased consumption of snack foods (5). Overall, the dietary quality of children ages 2 to 9 is less than optimal. Research generally indicates the decline of both childhood and adulthood vegetable consumption, suggesting that population vegetable intake habits continue into adulthood. Repeated food choices create momentum for similar food selections in the future (6). This may suggest that as individuals age, food choices are more predictable. Patterns of fruit and vegetable
consumption adopted in childhood persist into adulthood; intervention efforts are appropriately directed to children (7) and are more likely to maximize health benefits (8).

Many nutrition interventions are education-based, including interventions aimed at increasing vegetable consumption (9). Although education seems a logical intervention approach for children because 90% of children in the U.S. attend public schools and thus such education would be received by most children in society, nutrition education is at best moderately effective at increasing vegetable consumption among children. Additionally, schools are an attractive venue for nutrition education because they offer many services that impact health and wellness including physical education, foodservice (school breakfast and lunch programs), and also provide after-school care, all of which are avenues to create and reinforce dietary change. Of the 20 nutrition education research studies reviewed by Baranowski et al. (10) that assessed BMI as the outcome of interest, seven resulted in the desired changes; thirteen did not. While some nutrition education is part of the core curriculum in schools in all states, a main characteristic of six of the successful studies is that staff trained and educated outside of the school system conducted the educational portion of the studies. Chances are that teachers who administer the intervention have difficulty implementing it as intended, which results in an ineffective intervention. Baranowski’s review also suggests that interventions are more effective in older children (middle and high school age) who are more mature and can understand the intervention and have more control over their own food choices (10).

Mendoza (11) reviewed 57 research studies on nutrition education and concluded that nutrition education was not effective; only four of the 57 studies showed any
positive change as a result of nutrition education (11). Knowledge about diet and health has not generally been found statistically significant (11), suggesting that changing knowledge change dietary behaviors (12). A more sustainable method is needed to increase consumption by first increasing preference for target foods.

It may be assumed that general nutrition education methods can be extrapolated to vegetable education methods. As to the effectiveness of current reigning methods of increasing vegetable consumption specifically, classroom curriculum in conjunction with school foodservice cooperation and parent/home initiatives is the most effective (9). While multi-directional interventions seem to be the answer, critical components continue to be ignored. Interventions should be tailored to the specific determinants of vegetable aversion in order to have an effect (9). There are both environmental and personal determinants of vegetable consumption and while the current intervention model addresses some, it does not address other influential factors (9). Blanchette and Brug suggest that multi-component, school-based interventions deliver good results (9). Elements that should be included in the classroom component are “asking skills” to improve the accessibility and availability of fruits and vegetables at home and the teaching of skills involved in the preparation of simple and tasty fruit and vegetable recipes (9).

Wardle et al. (13) researched the difference between parent-led exposure versus parent knowledge on the consumption of vegetables in the household. Parents were instructed to give their children a taste of red pepper every day for 14 days (13). In the information intervention group parents were given a pamphlet about increasing fruit and vegetable consumption, and a third group received no intervention. The vegetable to
which preference was to be increased was determined by ranking of six vegetables by the child. The vegetable ranked number three was chosen as the exposure vegetable. The percentage of children in the exposure group who voluntarily consumed the selected vegetable increased from 47% pre-intervention to 77% post-intervention. In contrast, the information intervention group increased only from 45% to 60% and the control group decreased from 55% to 50%. The increase in willingness to eat the vegetable was only significant for the exposure intervention group. This is significant particularly because it was a “real world” situation in which parents led the exposure rather than a laboratory-type setting (13). It is notable that the provision of nutrition information had such little impact on a change in vegetable consumption (13). This research suggests that greater nutrition knowledge held by parents or children does not predict an increase in the consumption of healthy foods (13).

Reduction in neophobia through exposure to one food generalizes to similar foods. For example, repeated exposure to a carrot may transform an initially neophobic child into a child more accepting of carrots in particular and vegetables in general (14). The neophobic trend declines in older childhood. Neophobia may be more easily overcome as they are able to associate new foods with familiar tastes through “flavor principles” or the ability to correlate taste information they know about similar foods to the food which they have not tasted (15). Children’s dislike for vegetables is consistent across cultures; vegetables are consistently ranked at the bottom of food preference lists demonstrating the universal preference of food with high fat and sugar content (16). The foods that children prefer most are not typically foods of high nutritional value being high
in both fat and sugar. In a survey of four to sixteen year-olds, vegetables were rated lowest and sugary foods were rated the highest (17).

Providing opportunities to experience flavor properties of a food has more impact on increasing food preference than telling a child that the food is beneficial for his/her health (18); including this component in education would make it more effective than traditional informative education.

In Silberman’s book entitled *Active Learning: 101 Strategies to Teach Any Subject*, he describes the importance of hands-on, active learning:

Learning is not an automatic consequence of pouring information into a student’s head. It requires the learner’s own mental involvement and doing. Explanation and demonstration, by themselves, will never lead to real, lasting learning. Only learning that is active will do this. What makes learning “active”? When learning is active, students do most of the work. They use their brains… studying ideas, solving problems, and applying what they learn. Active learning is fast-paced, fun, supportive, and personally engaging. Often, students are out of their seats, moving about and thinking aloud… To learn something well, it helps to hear it, see it, ask questions about it, and discuss it with others. Above all, students need to “do it”—figure things out by themselves, come up with examples, try out skills, and do assignments that depend on the knowledge they already have or must acquire. (19)

Silberman continues by describing the scientific need for the active learning approach. It’s difficult for students to concentrate for a sustained period of time as minds wander and attention decreases. Johnson et al. (20) found that lecture-based learning is generally ineffective. The learner experience decreased attention with time; the format of lecturing appeals only to auditory learners and neglects those who are visual or experiential learners; lecturing promotes lower-level learning of factual information; and, students do not enjoy lecture format.

Adding pictures to lecture increases comprehension; however, pictures and lecture are still lacking in comprehension. Rather than just hearing and accepting information,
the brain processes incoming information and questions it based on what they already know: where does the information fit in? Have they seen or heard it before? Silberman states, “Without the opportunity to discuss, ask questions, do, and perhaps even teach someone else, real learning will not occur.” It takes several and different kinds of exposures to material to comprehend it (19).

A study by Benware and Deci (21) examined whether students who learned actively would be more motivated to learn and would learn more than students who learned passively. The active situation was created by having subjects learn material with the expectation of teaching it to another student; the passive situation was created by having subjects learn the same material with the expectation of being tested on it. Subjects who learned in order to teach were more motivated and had higher learning scores (21). Hands-on learning with an exposure component may be the most effective way of increasing vegetable consumption.

The objectives of this study were to assess the effectiveness of the *Viva Vegetables!* sensory-based, vegetable-themed curriculum in increasing vegetable consumption and positive attitudes about vegetables among elementary school-aged children. The *Viva Vegetables!* curriculum differs from traditional nutrition education in that it incorporates active learning principles with less of a focus on nutrition and more of a focus on enjoying the vegetable through the five senses which are taste, smell, sound, touch, and sight.
Subjects and Methods

Study Participants

Participants for this intervention were recruited from an elementary after-school program in Northern Utah in Cache County School District (CCSD) (n=27 invited to participate). The school was chosen based on higher levels of student participation in the after-school program and geographic location in relation to the University.

Methods

The methods and procedures of this study were reviewed and approved by the Utah State University (USU) Institutional Review Board, CCSD, and the Boys and Girls Club after-school program to ensure the protection of all participants. All participants and participant parents/guardians were informed of potential risks and benefits associated with participating in the study through a letter of information sent home with the students (Appendix). Parents were asked to sign and return the form if they wished to exclude their child from the data collection associated with the research without penalty. Data were collected from February to May of 2008.

Intervention – Viva Vegetable! Curriculum

Children were educated using the Viva Vegetables! curriculum once a week. Educators were not the children’s regular classroom teachers but students from the University dietetics program who had been instructed how to administer the intervention. Lesson plans were distributed to dietetics program students to study prior to the day of the lesson. Questions were answered by the research designer as to the implementation of the curriculum. The larger group of after-school program children was broken down
into a minimum of two groups to maximize teacher-student interaction with a maximum child-to-teacher ratio of 10:1.

Educational methods included in the Viva Vegetables! Curriculum focused on the five senses used to experience vegetables. Each vegetable was taught in three modules presented to children once per week for three consecutive weeks. For example, if the vegetable theme for February was cauliflower, children were taught three different sensory-based modules about cauliflower. The modules titled *A Tasty Little Vegetable* emphasized the taste properties of vegetables, the difference between different types (i.e., cooked vs. non, canned vs. store-bought vs. locally garden-grown) and the mouth feel of vegetables. Children learned positive adjectives to associate with the mouth properties of vegetables. The modules titled *Exploring Vegetables with the Senses* helped children use all of their senses to experience vegetables. They discussed how vegetables feel, sound, smell and what vegetables look like. They connected sensory experiences to already familiar experiences to solidify the new information in their knowledge base. The modules titled *How It Grows* helped children understand how vegetables get from the garden to their plate. They expressed an understanding of one reason that the specific vegetable was healthy for them to eat and what part of the plant the vegetable was (root, stem, leaf, flower, fruit, or seed). Copies of all modules for each of the four vegetables is provided in the appendix at the end of this thesis document.

**Observation of self-selected vegetable intake**

Prior to the intervention, after-school program participants were invited to select and eat vegetables provided to them in buffet style as their after-school snack. The vegetable buffet consisted of raw cauliflower, peas, carrots, and broccoli. None of the
vegetables were pre-portioned with the exception of peas, which were portioned in small cups in the amount of \( \frac{1}{4} \) cup. Students were instructed to take and eat as many vegetables as they wanted. Students could return for multiple portions. Plates were photographed both before and after each child’s visit(s) to the vegetable buffet. The same method was used for the post-intervention vegetable buffet, which was conducted after the *Viva Vegetable!* nutrition education interventions were complete. Dietetics students were trained on the methods and supervised during the study while photographing the plates. Amounts of vegetables consumed were counted from the photographs by at least three individuals; the median number was used for the statistical analysis. Pieces were counted based on the nearest “whole” piece or the nearest \( \frac{1}{4} \) cup in the case of peas.

**Attitude and behavior survey**

All participants were given a baseline survey to evaluate their attitudes and behaviors regarding vegetable consumption. The survey included 14 questions about attitudes and behaviors regarding vegetables in addition to and an evaluation of the child’s awareness of 31 different vegetables. Color pictures of the 31 vegetables were provided if children desired clarification or were of a younger age. Children were taken in groups of no more than three into a room separate from other participants to minimize distraction. Two proctors administered the survey to the small group and were available to help each child one-on-one as needed. Upon survey completion, children returned to the larger group. Student desks during the survey were separated for minimal eye contact and peer influence between students.
Statistical Analysis

Vegetable buffet consumption amounts at baseline were compared to amounts at post-intervention to assess effectiveness. Independent samples t-tests were used to examine differences between the pre- and post-intervention attitudes and behaviors and amount of vegetables selected and consumed. Paired t-tests were not run because there were many children who were present for the baseline testing but not the post-test and vice versa. Pearson correlations were run on the amount of change in vegetables taken and eaten versus the number of classes attended by a participant. All data SPSS (SPSS, Chicago, IL, USA) software package was utilized for data analysis.

Results

Analysis of the survey results indicated no significant positive or negative change in vegetable-related behaviors and attitudes as measured by the survey (See Table 4.1). This data suggests that the sensory-based education intervention was neither beneficial nor detrimental in the development of attitudes and behaviors in regards to vegetables.

Results of the analysis of the amount of vegetables selected by children using independent sample t-tests indicate that there was a significant increase in the amount of carrots selected (p-value= <0.001); there were no increase or decrease in the amount of broccoli, cauliflower, or peas selected (see Table 4.2). Comparatively, children increased their intake of both carrots (p-value=0.001) and peas (p-value=0.003) after the sensory-based, vegetable-specific education. There was no significant change in the amount of broccoli (p-value=0.175) or cauliflower (p-value=0.436) consumed (see Table 4.3).

Pearson Correlations were run, comparing the number of classes to the difference in vegetables taken pre- versus post-intervention and the vegetables eaten pre- versus
post-intervention for each student that participated in both pre- and post-intervention vegetable buffets (n=11). There were no significant positive or negative correlations between the number of classes attended and the change in vegetables taken or consumed (see Table 4.4).

**Discussion**

Teaching children about vegetables using the sensory-based vegetable-themed *Viva Vegetables!* curriculum had no significant positive or negative effect on the vegetable-related behaviors and attitudes of elementary school-aged children. Results of this study do not provide enough data to determine what amount of sensory-based, vegetable-themed education is needed to cause attitude and behavior change and/or elicit an increase in consumption of vegetables in children. However, there was an increase in consumption of peas and carrots from pre- to post-intervention. It is of interest that the significant increases in vegetable consumption occurred in traditionally sweet vegetables, peas and carrots. This study provides some evidence that whole-food themed education may be beneficial for increasing consumption and preference for vegetables in children rather than nutrient-focused education. A themed curriculum provides consistency for children and reinforces learning principles that are being emphasized in schools including vocabulary building, critical thinking, and assimilating new concepts into a framework of what has already been learned.

Providing opportunities to experience flavor properties of a food has more impact on increasing food preference than telling a child that the food is beneficial for his/her health (18); including this component in education would make it more effective than traditional informative education. Anywhere from 5 to 10 exposures of a food item is
required to increase preference of that food in young children (14); if lessons include the exposure component, they may be increasing effective. The age of a child at the time of exposure correlates with his/her extent of food neophobia in the future; earlier intervention is more beneficial and therefore appropriate in the elementary school population.

The participants in the study were benefited by a small student to teacher ratio and that fact that they were taught by individuals who were trained specifically on teaching the curriculum rather than their typical classroom teachers who may not have been able to implement it as intended.

A reason that correlation may not have been seen between the number of classes and the change factor in vegetables taken and consumed may be due to the small sample size (n=11). A larger sample size would provide more data from which to accurately assess trends. Additionally, because the sample size was not diverse in terms of race or age, it is unknown to what extent education would have an impact on individuals of different cultures or ages. Additionally, diurnal changes in preference for foods based on how much and what had been eaten earlier in the day may have affected the amount of vegetables taken and consumed. Snacks as provided in the after-school program are typically comprised of milk and an additional item such as cereal, crackers, or other sweet or salty snacks.

Future studies utilizing this curriculum would be effective if studying a control group versus an intervention (Viva Vegetables!) group or a group receiving “traditional” nutrition education that focuses primarily on nutrients versus the Viva Vegetables! curriculum. An in-school educational setting as opposed to an after-school education
setting would best benefit learners and reflect true benefits as the children will already possess an attitude of learning. Additionally, they may be more focused with the education presented as part of the school day and not during a time that is considered “play” time. However, individuals trained to implement the curriculum outside of the classroom should still be utilized to maximize the effect of the curriculum. Incorporating a parent piece as recommended by Blanchette and Brug to reinforce what the children are learning may also be beneficial.

**Conclusion**

Teaching children about vegetables using the sensory-based vegetable-themed *Viva Vegetables!* curriculum had no significant positive or negative effect on the vegetable-related behaviors and attitudes of elementary school-aged children. A positive effect may be seen with a larger sample size, more opportunities for exposure, and an in-school teaching setting rather than an after-school teaching setting.

**References**


Table 4.1. Comparison of survey results as differences between pre and post

<table>
<thead>
<tr>
<th>#</th>
<th>Question</th>
<th>Mean difference between pre versus post</th>
<th>T</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I like to eat vegetables.</td>
<td>0.630</td>
<td>6.431</td>
<td>0.323</td>
</tr>
<tr>
<td>2</td>
<td>I think vegetables taste good.</td>
<td>-0.180</td>
<td>0.341</td>
<td>0.660</td>
</tr>
<tr>
<td>3</td>
<td>There are plenty of vegetables to eat at my home.</td>
<td>-0.090</td>
<td>0.531</td>
<td>0.873</td>
</tr>
<tr>
<td>4</td>
<td>I always eat vegetables at lunch time.</td>
<td>0.180</td>
<td>0.205</td>
<td>0.777</td>
</tr>
<tr>
<td>5</td>
<td>I always eat vegetables with my dinner.</td>
<td>-0.640</td>
<td>1.751</td>
<td>0.446</td>
</tr>
<tr>
<td>6</td>
<td>I eat vegetables as snacks.</td>
<td>0.000</td>
<td>2.647</td>
<td>1.000</td>
</tr>
<tr>
<td>7</td>
<td>Vegetables taste good plain, without anything added to them.</td>
<td>0.730</td>
<td>0.301</td>
<td>0.353</td>
</tr>
<tr>
<td>8</td>
<td>My favorite way to eat vegetables is when they are raw.</td>
<td>0.540</td>
<td>1.927</td>
<td>0.490</td>
</tr>
<tr>
<td>9</td>
<td>My favorite way to eat vegetables is when they are cooked.</td>
<td>0.540</td>
<td>0.125</td>
<td>0.941</td>
</tr>
<tr>
<td>10</td>
<td>I like to try new vegetables.</td>
<td>-0.910</td>
<td>4.931</td>
<td>0.181</td>
</tr>
<tr>
<td>11</td>
<td>I like to learn about how vegetables grow.</td>
<td>-0.820</td>
<td>21.594</td>
<td>0.104</td>
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<tr>
<td>12</td>
<td>I think vegetables are important to eat every day.</td>
<td>0.000</td>
<td>No change</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>I think I need to eat vegetables to be healthy.</td>
<td>0.000</td>
<td>No change</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>I think I could still be healthy without eating vegetables.</td>
<td>0.180</td>
<td>0.745</td>
<td>0.808</td>
</tr>
</tbody>
</table>

Table 4.2. Vegetable buffet (vegetables taken, pre versus post)

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Measure</th>
<th>Mean difference (pre vs. post)</th>
<th>T</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrots</td>
<td>pieces</td>
<td>15.950</td>
<td>4.052</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>pieces</td>
<td>2.100</td>
<td>2.005</td>
<td>0.117</td>
</tr>
<tr>
<td>Broccoli</td>
<td>pieces</td>
<td>4.370</td>
<td>24.366</td>
<td>0.064</td>
</tr>
<tr>
<td>Peas</td>
<td>nearest 1/4 cup</td>
<td>0.120</td>
<td>0.698</td>
<td>0.575</td>
</tr>
</tbody>
</table>
Table 4.3. Vegetable buffet (vegetables *eaten*, pre versus post)

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Measure</th>
<th>Mean difference (pre vs. post)</th>
<th>T</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrots</td>
<td>pieces</td>
<td>9.050</td>
<td>3.685</td>
<td>0.001</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>pieces</td>
<td>0.380</td>
<td>0.419</td>
<td>0.436</td>
</tr>
<tr>
<td>Broccoli</td>
<td>pieces</td>
<td>1.530</td>
<td>7.279</td>
<td>0.175</td>
</tr>
<tr>
<td>Peas</td>
<td>nearest 1/4 cup</td>
<td>0.520 cup</td>
<td>11.977</td>
<td>0.003</td>
</tr>
</tbody>
</table>

Table 4.4. Correlations between number of classes and vegetables taken and eaten

<table>
<thead>
<tr>
<th></th>
<th>Took</th>
<th>Ate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>carrot</td>
<td>cauli</td>
</tr>
<tr>
<td>Pearson correlation</td>
<td>0.091</td>
<td>0.435</td>
</tr>
<tr>
<td>Significance</td>
<td>0.791</td>
<td>0.181</td>
</tr>
</tbody>
</table>
CHAPTER 5
SUMMARY AND CONCLUSIONS

Summary

The intention of this thesis project was to gain knowledge in the field of nutrition, particularly related to methods of increasing vegetable consumption among children. The literature on trends of vegetable intake and barriers and benefits of consumption of vegetable was reviewed. The literature review effectively summarized that most chronic diseases can be linked to dietary habits and may be effectively avoided or ameliorated by including vegetables in the diet (1-12). The review also demonstrated that American adults and children alike do not consume enough vegetables. In addition, two intervention studies were planned and executed and the efficacy of this intervention to increase preference for and intake of vegetables among children was examined.

The first intervention was a flavor-flavor conditioning method. The aim of this project was to examine the effectiveness of flavor-flavor conditioning by replicating a previous study (13) but adding an additional conditioning day, incorporating preference ratings and rankings and testing the effect of whole vegetable in addition to vegetable purees. The second intervention was the development and implementation of sensory-based, vegetable-themed curriculum with a focus on the senses and active learning practices. The effectiveness of both interventions was measured using a vegetable buffet plate waste and attitude/behavior survey both pre- and post-intervention. The vegetable buffet plate waste method was developed to provide a real-world observation of selection and consumption of vegetables among children. The results of these studies demonstrate that flavor-flavor conditioning is not generally effective and does not elicit a change in
whole vegetable consumption or preference. The only component of the flavor-flavor conditioning intervention that was significant was the exposure aspect, not the sweetening of vegetable flavors. This is consistent with previous literature that confirms that exposure is an effective method of increasing preference (14-18). The sensory-based education intervention demonstrated some beneficial effects but was limited by a small sample size. The idea of sensory-based education to influence food behavior among children should be implemented and examined in a larger population in order to obtain more significant results. Additionally, the after-school program is not an effective venue for nutrition education administration.

These approaches are applicable to nutrition educators and families. Nutrition educators may consider adopting sensory-based, whole food-themed educational approaches as they desire resilient positive dietary change in their students. Families can adopt a whole foods approach and recognize that vegetable consumption can be increased through mere exposure to vegetables and other whole foods and does not need to be scientifically complicated. The principle parents can gain is that pairing something unfamiliar with something familiar and preferred may effectively increase preference for that food item.

The *Viva Vegetables!* curriculum could be effective if implemented in statewide, federally-funded nutrition education programs such as Utah State University Food $ense (Supplemental Nutrition Assistance Program-Education). This program, through certified nutrition education assistants, teaches low-income individuals how to select, prepare, and store vegetables and other healthy foods. The curriculum could also be implemented in elementary schools locally and nationwide as the activities and objectives
correspond to core curriculum requirements. If the approach is validated in a larger population, the curriculum could be implemented on a national level for the program.

The flavor-flavor concept is appropriate if implemented in a whole foods perspective and individual taste preferences are considered but it may not be necessary to expand research in this avenue. It is very time-intensive and requires ongoing work and development whereas the educational approach can be done multiple times after the initial work of curriculum development is complete.

**Conclusion**

Much of the American population suffers from chronic disease, including overweight and obesity; vegetables can help children and adults alike obtain and maintain proper weight and may be an integral factor in disease prevention and management. Increasing preference for vegetables can be done effectively through exposure or education with the optimal time for intervention being in childhood, especially when such interventions include both school and home environments.

**References**


Consent forms
Letter of Information

Viva Vegetables – after school program

Introduction/Purpose  Dr. Heidi Wengreen in the Department of Nutrition and Food Sciences at Utah State University (USU) is conducting a research study to find ways to help children to eat more vegetables. All children participating in after school programs in the Cache County School District, including your child, are invited to participate.

Procedures  If you agree to let your child participate and he/she also agrees to do so, the following will occur. Your child will be asked to select and consume food from a snack buffet during the after school program at his/her school. Researchers will take a digital photograph of his/her plate after they have made their selections, and again just after they finish eating but before they dump their plate. In addition, your child will be asked to sample vegetable purees with and without added sugar and to rank them according to their taste preference. Finally, your child will be asked to complete two brief surveys about vegetables. The snack buffet assessments and vegetable surveys will take place twice during the school year, once during February and once during May. The taste preference activity will take place in mid-February and again in March. Researchers will make sure that children participating in this study do not have a food allergy of any known vegetable.

In addition, you will be asked to complete a pre-assessment questionnaire about vegetables which will be sent home with your child. After you complete the questionnaire please return it to school with your child.

Risks  The risks of your child participating in this research are minimal. There is a risk of others gaining access to personal information but this is unlikely because of the measures to protect you and your child’s privacy and confidentiality.

Benefits  There may not be any direct benefits to you or your child from this research at this time. The researchers, however, may learn more about how to make vegetables more appealing to children and how to best provide vegetables to children in schools. This may lead to positive changes throughout the Cache County School District that help improve the nutrition status of many children.

Explanation & offer to answer questions  If you have other questions or concerns regarding this research, you may reach Dr. Heidi Wengreen at 435-797-1806 or hwengreen@cc.usu.edu.

Voluntary nature of participation and right to withdraw without consequence  You and your child’s participation in this research is entirely voluntary. You and your child may refuse to in this study at anytime or you may withdraw at anytime from this research without consequence or loss of benefits.
Letter of Information
Viva Vegetables – after school program

Confidentiality  Research records will be kept confidential, consistent with federal and state regulations. The Boys and Girls Club personnel will assign each family an ID number for this study. Researchers will not have access to the ID number and will not be able to identify those involved in this study. Only authorized Boys and Girls Club personnel will have access to identifying data, which will be kept in a locked file cabinet in a locked room. The ID number will be kept for no more than three years. After that time, it will be destroyed.

IRB Approval Statement  This research project has been reviewed by the Institutional Review Board for the protection of human participants at USU and the Cache County School District. If you have any questions or concerns about your rights, you may contact the IRB at (435) 797-1821.

Investigator Statement  “I certify that the information contained in this form is correct and that we have provided trained staff to explain the nature and purpose, possible risks and benefits associated with taking part in this study and to answer any questions that may arise.”

Heidi Wengreen, Ph.D.
Principal Investigator
(435) 797-1806
8700 Old Main Hill
Logan, UT  84322-8700
hwengreen@cc.usu.edu

Signature of Parent/Guardian  Your child will automatically be included in this study unless you wish to withdraw him or her. If you do not want your child to participate in this research for any reason, please check the box below, fill in your child’s name, sign where indicated, and return this form to Heidi Wengreen at the address listed above or return to the Boys and Girls Club program facilitators.

Please withdraw ___________________________ (your child’s name) from this research study.

____________________________  ______________________
Parent/Guardian Signature       Date
Attitude/behavior survey
Viva Vegetable—after-school program
Student Assessment

ID#: _______________________

Are you a boy or a girl? _____

How old are you? _____

What grade are you in? _____

Instructions: Please mark the choice that best describes you using the following scale:
(big smiley face) I strongly agree, (smiley face) agree, (blank face) neither agree nor disagree, (frowning face) disagree, (big frowning face) strongly disagree

<table>
<thead>
<tr>
<th>Statement</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>I like to eat vegetables.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>I think vegetables taste good.</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>There are plenty of vegetables to eat at my home.</td>
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<td>I always eat vegetables at lunch-time.</td>
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<td>I eat vegetables as snacks.</td>
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<td>Vegetables taste good plain, without anything added to them.</td>
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<tr>
<td>My favorite way to eat vegetables is when they are raw.</td>
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<td></td>
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<tr>
<td>My favorite way to eat vegetables is when they are cooked.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>I like to try new vegetables.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>I like to learn about how vegetable grow.</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I think vegetables are important to eat everyday.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I think I need to eat vegetables to be healthy.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I think I could still be healthy without eating vegetables.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What is your favorite vegetable to eat? _________________________________
Please circle yes, no, or don’t know this vegetable when shown the pictures of the following vegetables.

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Yes</th>
<th>No</th>
<th>I don't know this vegetable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asparagus</td>
<td>Yes</td>
<td>No</td>
<td>I don't know this vegetable</td>
</tr>
<tr>
<td>Beans</td>
<td>Yes</td>
<td>No</td>
<td>I don't know this vegetable</td>
</tr>
<tr>
<td>Beets</td>
<td>Yes</td>
<td>No</td>
<td>I don't know this vegetable</td>
</tr>
<tr>
<td>Broccoli</td>
<td>Yes</td>
<td>No</td>
<td>I don't know this vegetable</td>
</tr>
<tr>
<td>Brussels Sprouts</td>
<td>Yes</td>
<td>No</td>
<td>I don't know this vegetable</td>
</tr>
<tr>
<td>Cabbage</td>
<td>Yes</td>
<td>No</td>
<td>I don't know this vegetable</td>
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<tr>
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<tr>
<td>Zucchini</td>
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Ranking and rating preference forms
Puree

Which flavor do you like the best?

A B C D

A B C D

A B C D

A B C D

I like this the most

I like this the least
Whole piece

Which flavor do you like the best?

ABCBA

I like this the most

I like this the least
Whole piece
How much do you like each flavor?

Participant Number:

Very much

Not very much

A  B  C  D

Flavor rating
Participant Number:

Puree
How much do you like each flavor?

Very much

Not very Much

A B C D

Flavor rating
Nutrition education lesson outlines
Viva Vegetables

presents

Broccoli
The goal of *A Tasty Little Vegetable* lesson is to give children an opportunity to taste broccoli. Some may think they don’t like broccoli because they have never tasted it at all, or have never tasted it in season. By tasting broccoli, they can broaden their taste experience and think about eating broccoli in different ways. If children realize that broccoli can taste different or have special appeal depending on how it is prepared, they may be more inclined to taste it!

**Objectives:**
1. Children will use positive adjectives to describe the taste of broccoli.
2. Children will understand how to incorporate broccoli into mealtimes.
3. Children will make and eat a simple, nutritious snack using broccoli.

**Total Time:** 25 minutes

**Materials**
- 1 large drawing pad
- 1 black marker
- 1 copy of “Broccoli Hunt” sheet (preferably green) per group
- Copies of the “Broccoli Word Bubbles” sheet, enough for one complete set of bubbles per group.
  - There are 2 sets of words per sheet.
- Copies of the “Veggie Tasters Award” sheet, enough for one per child. There are 2 awards per sheet.
- Tape
- Napkins
- Small paper plates for snack
- Recipe handout (1 per child)
- Broccoli will be used twice during the activities
  - Broccoli heads for pre-activity, or enough so each student can taste 1 floret of both cooked/raw
  - Broccoli heads for the snack, or enough so each student can make a broccoli forest
  - Remaining snack ingredients according to amount to be served
Preparation Required

- Cut out the broccoli word bubbles. Put tape on the back of the word bubbles and hide them throughout the room or wherever space allows. (Be sure to not hide the word bubbles in completely obvious places or the game may be finished sooner than intended).
  - Note: If you plan on conducting this activity more than once, it may be beneficial to laminate the copies of the "broccoli hunt" sheet and the word bubbles so they may be used multiple times.
- Cut "Veggie Tasters Award" sheet into single awards and sign them. To save time, you may want to sign the original copy of the award and then make copies for the students.
- Wash and cut the broccoli heads. Save one broccoli head to show during the pre-activity.
- Boil or steam the broccoli to be used for the pre-activity. Do not overcook!
- During the activity, it may be best to send another person to begin plating the snack.

Viva Vegetables: A Tasty Little Vegetable
Broccoli
LESSON PLAN

Objective 1: Children will use positive adjectives to describe the taste of broccoli

Activity: Experience taste and mouth feel of cooked broccoli, scavenger hunt

Time: 20 minutes

- Prepare a large piece of paper with 2 columns labeled “raw” and “cooked.” You will have four rows labeled:
  o Taste or Feel
  o Sound when chewing
  o Juicy?
  o Something similar

- Pass around the broccoli head you set aside. Ask the children to share some words that they used to describe how the stem and florets feel. Show them how the stem of the broccoli is smooth and how the top of the broccoli is bumpy and velvety when it is touched.

- Hand out one steamed and one raw broccoli floret on a napkin to each child. Let the children examine and touch their broccoli before tasting it.

- Have the children close their eyes and direct them to eat their steamed broccoli floret. Tell them to move it around in their mouth and feel it with their tongue and chew very slowly. Ask the following questions while they taste their broccoli:
  o What is one word you would say to describe the taste or feel of the steamed broccoli in your mouth? (tender, soft, stem feels smooth, florets feel velvety)
  o What sound does cooked broccoli make when you chew it?
  o Is the cooked broccoli juicy? (yes)
  o Have you tasted something like cooked broccoli before?

- Have the children close their eyes again and direct them to eat their raw broccoli floret. Tell them to move it around in their mouth and feel it with their tongue and chew very slowly. Ask the following questions while they taste their broccoli:
  o What is one word you would say to describe the taste or feel of the raw broccoli in your mouth? (crisp, crunchy, stem feels smooth)
  o What sound does raw broccoli make when you chew it?
  o Is the raw broccoli juicy? (yes)
  o Have you tasted something like raw broccoli before?

Activity: Scavenger Hunt

Divide the children into groups of no more than 5 to 6 children. (Make sure you have enough sets of word bubbles and “Broccoli Hunt” sheets as you have groups). If you are working with different age groups, put younger children and older children together. Give each group one copy of the “Broccoli Hunt” sheet. Explain the following instructions:

- There are words hidden throughout the area on little green circles. You are to find, as a group, five different words and stick them to the head of your broccoli. The words are listed on your “Broccoli Hunt” sheet if you forget which words you need to find.

- You may want to discuss some of the words:
  o Bumpy
  o Crunchy
  o Savory
  o Tender
• Juicy
  • If you find a word you have already found, leave it there so another group can find it!
  • The first group to find all of their words wins. After you have found your words, your broccoli picture should look extra bumpy!
  • Remember to search for the words as a group and to not leave anyone behind.

When they return from their word hunt, have each group present their broccoli and pick their favorite descriptive word. Make sure they found all of the right words.

**Objective 2: Children will understand how to incorporate broccoli into mealtimes**

**Activity:** Idea sharing and discussion  
**Time:** 5 minutes

Ask the students what some yummy ways are that they like to eat broccoli. Ask them some ways that they would like to try eating broccoli. Add the following ideas if the children don’t come up with them on their own:

- Broccoli can be eaten raw and dipped in a yummy sauce like lemon juice, peanut sauce etc.
- Broccoli can be cooked to make a yummy side dish
- Sprinkle a little cheddar cheese on top of cooked broccoli to add extra flavor
- Add broccoli to salads or soups
- Be creative!

**Objective 3: Children will make and eat a simple, nutritious snack using broccoli.**

**Activity:** Food demonstration and snack—“Wonderful Peanut Sauce”  
**Time:** 5 minutes

- Explain the recipe to the students briefly (use ingredient bottles to make it like a cooking show)
- Give each student a few broccoli florets, a celery stick and some peanut sauce
- Instruct them to make a broccoli forest on their plate and show you their creation before they eat
- Give the students the “Veggie Tasters Award” after they have tasted the snack
- Give students a copy of the peanut sauce recipe to take home and share with their parents

**Conclusion: Discussion and summary**  
**Time:** 2-3 minutes

- Regroup and have each student tell one new word they learned to describe broccoli.
- Ask them what their favorite part of the lesson was.
- Ask them how they are going to ask their parents to make them broccoli tonight.
Broccoli Word Bubbles

CRUNCHY

JUICY

SAVORY

TENDER

BUMPY

TENDER

BUMPY

SAVORY

CRUNCHY

JUICY
BROCCOLI HUNT

Make sure that when you are done, your broccoli looks extra bumpy! Your whole team should help in deciding what your favorite word is.
Wonderful Peanut Sauce

Adapted from
The Vegetable Dishes I Can’t Live Without by Mollie Katzen

1 cup smooth peanut butter
3 T honey
1 cup hot water
2 T low-sodium soy sauce

Mix all ingredients together and enjoy with your favorite vegetable! Store in the fridge up to 1 week if you have leftovers.
VEGGIE TASTERS AWARD

This certificate is awarded to YOU
For tasting and learning about broccoli.

__________________________  __________
Teacher Signature           Date

VEGGIE TASTERS AWARD

This certificate is awarded to YOU
For tasting and learning about broccoli.

__________________________  __________
Teacher Signature           Date
Exploring Vegetables with the Senses

broccoli

Brought to you by Viva Vegetables
A Utah State University Extension and Nutrition and Food Sciences Department campaign

The goal of the Exploring Vegetables with the Senses lesson is to help children use ALL of their senses to experience broccoli. If they build a more involved, sensory relationship with broccoli and associate positive things with broccoli, then they may acquire a more positive attitude about eating broccoli!

Objectives:
1. Children will understand how broccoli relates to four of their five senses (taste is a separate lesson):
   a. How does broccoli feel?
   b. How does broccoli sound?
   c. How does broccoli smell?
   d. What does broccoli look like?
2. Children will connect sensory experiences to what they already know:
   a. Does the feel of the broccoli remind them of something?
   b. Does the sound of the broccoli remind them of something?
   c. Does the smell of the broccoli remind them of something?
   d. Does the shape or color of the broccoli remind them of something?
3. Children will understand that eating broccoli is an experience that can involve all of the senses.

Total Time: 25 minutes

Materials
- “Mystery bucket” (5 gallon ice cream bucket with hole in lid with tube sock attached)
- Raw bunch of broccoli (1 bunch)
- Raw pieces of broccoli, enough for each student to have 1 piece
- Cooked fresh broccoli cut in small pieces, enough for each student to have 1 piece
- Drawing pad (11 X 14 medium weight—use like flipchart)
- Black marker
- Napkins & wet wipes
- Cartoon picture of Bud Broccoli (attached)

Preparation Required
- Create mystery bucket by cutting a hole in the lid of a 5 gallon ice cream bucket and attaching a tube sock in the hole so that children can feel inside the bucket without seeing inside of it
- Put a head of broccoli in bucket prior to class
- Cook enough broccoli for each child to have 1-2 florets
- Make color copy of Bud Broccoli picture

This material was funded by USDA Food Stamp Programs. The Food Stamp Program results without assistance to states with
their own evaluation capability. See 7 U.S.C. 2021 for more information. To obtain a copy of this document, call 1-866-255-0156 (in Ohio) or (1-866-255-0157 or 513-861-5215 (in all other states).

Viva Vegetables: Exploring Vegetables with the Senses

Broccoli

1 Page
LESSON PLAN

Introduction: “Mystery Bucket”
Time: 5 minutes
Tell the kids that they have a mystery to solve. Let them know that they are going to pretend to be detectives to find out what vegetable they will learn about today.
- Ask them what the 5 senses are and write out the 5 senses (sight, touch, smell, hear, taste)
- Reiterate the senses by telling them they need to use their eyes to see, nose to smell, ears to listen and hands to touch.
- Pull out the “mystery bucket” and have them feel in the bucket to find out what the surprise vegetable is.
- Direct the students to keep it a secret to themselves until everyone has had a chance to guess and while they are feeling it, have them think about what they feel.
- After everyone has felt the broccoli, commend the students for their guesses and then pull out the broccoli. Ask if anyone thought it was something different and why.

Objective 1: Children will understand how broccoli relates to four of their five senses (taste is a separate lesson):
   a. How does broccoli feel?
   b. How does broccoli sound?
   c. How does broccoli smell?
   d. What does broccoli look like?

Activity: Writing out sensory words
Time: 5 minutes
Display the broccoli from the bucket and the pieces of raw and cooked broccoli. Give each child a piece of both types of broccoli on a napkin. Have the children describe the broccoli and write their descriptive words on a drawing pad to refer to later (for objective 3, the AND THEN story). Worksheet is provided for older children to use during this lesson.
   - FEEL
     o Have them rub it on the side of their cheek or back of hand
     o How is the trunk different than the top?
     o Rough, smooth, soft, hard, fuzzy, etc.
   - LOOK
     o What if it was a different color?
     o What if it was really big?
     o How is the stem different than the top?
     o Color, shape, texture, size
   - SMELL
     o Avoid negative words like “stinky”
     o Use words like “earthy”
   - SOUND
     o Rub fingers over head of broccoli and hear how it sounds

Objective 2: Children will connect sensory experiences to what they already know:
   a. Does the feel of the broccoli remind them of something?
   b. Does the sound of the broccoli remind them of something?
   c. Does the smell of the broccoli remind them of something?
d. Does the shape or color of the broccoli remind them of something?

Activity: Broccoli comparison (worksheet or discussion)

Time: 5 minutes

To help children internalize the concepts of what they learned about broccoli while using their senses, compare broccoli to similar items (these are ideas, can use others from previous descriptions) using the attached worksheet. If the children are young and unable to do the worksheet, a verbal exercise is adequate.

- Green like ________ (grass)
- Rough like ________ (carpet)
- Shaped like ________ (a tree)
- Blooms like ________ (flowers)

Objective 3: Children will understand that eating broccoli is an experience that can involve all of the senses.

Activity: AND THEN story

Time: 10 minutes

- Have the children sit in a circle and tell an “And Then” story about a day in the life of broccoli.
- Instruct the children to use the descriptive words from earlier. Display a picture of cartoon broccoli (attached to this lesson) and begin the story:
  
  Bud broccoli woke up this morning and because he got hot in the night, his rough, bumpy hair became smoother and moved around a lot more than it usually did...AND THEN (have each child in the circle add 1-2 sentences to the story using descriptive information about broccoli, previously discussed. Each student should add “AND THEN” at the end of their part.)

Conclusion: Regroup and discussion

Time: 3 minutes

- Regroup and have each child tell one new word they can use to describe broccoli.
- Conclude the lesson by saying: Next time you see broccoli in the store, in the lunch line, or at home on the table, remember broccoli is not an ordinary vegetable, but can be fun to eat.
Exploring Broccoli with the Senses

Use your senses to interact with the raw and cooked broccoli. Write descriptive words about both the Raw and Cooked broccoli on the lines below.

Example:
Broccoli is green like my front lawn.
Broccoli sounds rumbly like my stomach when I'm hungry.

RAW
Broccoli feels __________ like __________.
Broccoli smells __________ like __________.
Broccoli sounds __________ like __________.
Broccoli looks __________ like __________.

COOKED
Broccoli feels __________ like __________.
Broccoli smells __________ like __________.
Broccoli sounds __________ like __________.
Broccoli looks __________ like __________.

Do you like cooked or raw broccoli better?

Why do you like it better?
How It Grows
broccoli

Brought to you by Viva Vegetables
A Utah State University Extension and Nutrition and Food Sciences Department campaign

The goal of the How it Grows lesson is to help children understand how broccoli gets from the garden to their plate. If they have an idea of where broccoli comes from, they may gain an interest in or appreciation of what it takes for it to get to the store or market. This may encourage children to taste broccoli.

Objectives:
1. Children will understand one reason broccoli is healthy for them to eat.
2. Children will understand what part of the plant the broccoli is (root, stem, leaf, flower, fruit, or seed).
3. Children will understand the story of broccoli from the garden to their plate (including stages of growth of broccoli).

Total Time: 25 minutes

Materials
✓ Broccoli that has gone to flower. To do this:
  - Pick a bunch of broccoli at the store that has a fairly loose head and looks like some of the florets may start to sprout.
  - Cut about an inch off of the stem of broccoli.
  - Place the broccoli in water in a place where it can get direct sunlight. Replace the water every day.
  - The broccoli will turn yellow and then brown.
  - The broccoli will flower after about 2 or 3 weeks.
✓ Broccoli pieces for kids to eat (1 head of broccoli should feed about 5 kids)
✓ Poster/handout of vegetable parts (attached)
✓ Pictures of broccoli from seed to flower
✓ Story book Topp and Bottoms by Janet Stevens
✓ Copies of broccoli pictures and arrow sheet, enough for each individual, group, or one for the teacher if he/she is explaining the process of broccoli growth
✓ Tape

Preparation Required
- 2 or 3 weeks ahead of time, prepare broccoli to go to flower.
- Chop enough broccoli so all children have some to eat.
- Prepare pictures of broccoli by cutting them out and also cutting out the arrows.
LESSON PLAN

Introduction: Clue game
Time: 1-2 minutes
Read these clues aloud and have the children guess what vegetable it is. Have them raise their hands when they think they know it, whether it's the first clue or the last. Stop when all children have their hands raised.
1. It takes 55-60 days for me to grow from seed to harvest.
2. I am from the Brassica family.
3. I am related to the cabbage.
4. I am green.
5. I have big bluish green leaves
6. My cousin is the cauliflower.
7. I look like a little tree.
8. My name starts with a “B”.

Objective 1: Children will understand one reason broccoli is healthy for them to eat.
Activity: Nutritional fact discussion
Time: 2-3 minutes
Most children know that vitamin C is in citrus fruits like oranges and grapefruits. It might be interesting for them to see that vitamin C can be found in a green vegetable, too. Most children have heard of vitamin C, so depending on what they know, you can make this a very short discussion.
- Ask class why broccoli is good for them. Some answers may include:
  - Broccoli has fiber.
  - Broccoli is green and green vegetables are healthy.
  - It has lots of vitamins.
- Commend the students for their guesses.
- Explain that broccoli (also) has vitamin C.
  - Ask the class if anyone knows what vitamin C does
  - Explain that it helps with immunity. Immunity is the army in your body that fights disease and sickness, like a cold. When germs get in your body, vitamin C gives your body the extra power to fight them. So eating broccoli is like eating an army!

Objective 2: Children will understand what part of the plant the broccoli is (root, stem, leaf, flower, fruit, or seed).
Activity: Making a broccoli growth cycle, examining broccoli that has gone to flower
Time: 10 minutes
- If you are doing this activity in individuals or groups, pass out broccoli pictures and arrows to each individual/group. Instruct them not to use them yet.
- Explain that all vegetables are edible parts of a plant.
- Show the poster or handout of the parts of a plant and have a volunteer child point to the part of the plant he/she thinks the broccoli is. The answer would be the FLOWER.
- As you tell the children the following, have them put the pictures in a circle on their desk. It should look like a cycle. If you are doing the presentation, put the pictures in a cycle on the board with tape and ask a child to help you with each of the steps.
  - Broccoli grows similar to cabbage because they are both in the same family called “Brassica”.

Viva Vegetables: How it Grows
Broccoli
2 | Page
- Broccoli grows from a seed, and all seeds come from flowers. Display the broccoli seed picture. Put up an arrow after this picture to point to the next picture.
- The seed starts by growing leaves. The leaves start very small and are green. Display the baby broccoli plants picture. Put up an arrow after this picture to point to the next picture.
- As the plant grows, the leaves are huge and blue-green in color. Display the bigger broccoli picture. Put up an arrow after this picture to point to the next picture.
- In the middle of the leaves, a head of broccoli grows from a long stem. Display the broccoli appears picture. Put up an arrow after this picture to point to the next picture.
- The broccoli part we eat is the FLOWER. When we eat broccoli, it's the kind of broccoli that hasn't made flowers yet. The tiny flowers are still closed. Broccoli is harvested by hand. There are machines that can harvest broccoli, but because broccoli isn't ready all at the same time, the field has to be harvested by hand several times, otherwise plants that are not ready will be picked too soon. Display the broccoli harvested by hand picture. Put up an arrow after this picture to point to the next picture.
- If you let broccoli stay on the plant, the little flowers will open up and those flowers have seeds. After a while the seeds will be let loose to make broccoli plants somewhere else. Display the broccoli flowers picture. Add an arrow to point to the first picture you displayed. This should complete the cycle.

- Ask the children if they have any questions.
- Show children the flowered broccoli and an unflowered broccoli and compare them.

**Objective 3: Child will understand the story of broccoli from the garden to their plate (including stages of growth of cauliflower).**

**Activity:** Reading story *Tops and Bottoms* by Janet Stevens

**Time:** ~10 minutes

- Hand out raw broccoli for the kids to munch on during the story.
- Read the story *Tops and Bottoms* and have the kids shout out “I spy broccoli” when they see broccoli in the illustration.
- After the story, discuss which vegetables we eat are tops and which vegetables we eat are bottoms; have them identify whether carrots, cauliflower and peas are tops or bottoms.

**Conclusion: Summary and regroup**

**Time:** ~2-3 minutes

Ask a few children to share a new thing they learned about how broccoli grows or a fun fact they will share with a friend.
Broccoli seeds come from yellow broccoli flowers.

The seeds grow into baby broccoli plants with blue-green leaves.
the baby broccoli plants grow a bit bigger.

As the broccoli plant grows bigger, a broccoli appears.
The broccoli is harvested by hand.

If the broccoli is not picked, it grows little yellow flowers. Remember that broccoli is the flower part of the plant.
ARROWS SHEET FOR CYCLE ACTIVITY

Each child or group needs a copy of this sheet with their pictures. If you are going to do this on the board as a demonstration for the class, you will only need one copy.
Brought to you by Viva Vegetables
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The goal of A Tasty Little Vegetable lesson is to give children an opportunity to taste carrots. Some may think they don’t like carrots because they have never tasted them. By tasting carrots, they can broaden their taste experience and think about eating carrots in different ways. If children realize that carrots can taste different or have special appeal depending on how they are prepared, they may be more inclined to taste them!

Objectives:
1. Children will use positive adjectives to describe the taste of carrots.
2. Children will understand how to incorporate carrots into mealtimes.
3. Children will make and eat a simple, nutritious snack using carrots.

Total Time:

Materials
- Baby carrots for the pre-activity.
- Regular-sized carrots for lesson and snack.
- Vegetable peeler.
- Knife.
- Cutting board.
- Ingredients for snack according to amount to be served (see attached recipe).
- Copies of Veggie Tasters Award sheet. There are two awards per sheet. You may want to sign them before copying.
- Copies of the carrot picture (attached).
- Crayons, colored pencils, or markers for the coloring activity.
- Small paper plates for the snack.
- Plastic forks for the snack.

Preparation Required
- Wash the carrots to be used in the pre-activity and snack.
- Prepare the snack and keep warm until serving time or have another person prepare the snack during the activities.
- Peel all of the regular carrots to be used in the pre-activity and cut each of the regular carrots into fourths. Leave one of the regular carrots unpeeled and uncut.
• Cut Veggie Tasters Award into single awards.
• Set up for the carrot pre-activity.
LESSON PLAN

Objective 1: Children will use positive adjectives to describe the taste of carrots.

Activity: Tasting regular and baby carrots

Time: 15-20 minutes

- Show the children the baby carrots and the unpeeled, uncut regular carrots and allow the children to examine the differences between the carrots.
- Take the unpeeled, uncut carrot and show the children how to peel the carrot and some different ways of cutting the carrot:
  - Discs
  - Sticks
  - Dicing
- Pass out one baby carrot and one of the peeled and cut sections of the regular carrots.
- Ask the children to taste their carrots and ask them these questions:
  - What is one word you would say to describe the taste or feel of the carrot in your mouth?
    - Crisp
    - Hard
    - Smooth
  - Can you taste a difference between the baby carrot and the regular carrot?
    - Baby carrots have a milder flavor than regular carrots.
  - What sound does the carrot make when you bite it?
    - Snap
    - Crunch
    - Like the sound of a twig breaking
  - Is the carrot juicy?
    - Yes
  - Have you tasted something like a carrot before?
  - What do you think the carrot tastes like when it is cooked?
    - Savory
    - Hearty

Activity: Make a carrot superhero

- Divide the children into small groups. Pair younger and older children.
- Give each group one copy of the carrot picture sheet and coloring utensils. Have the children color and create a superhero out of the carrot picture and a slogan for their superhero based on how the carrot tastes and feels in the mouth.
  - Example: Crunchy Carrotman. He’s crisp, he’s crunchy, he’ll be there in a “snap”, he’s Carrotman!
- Have each group present their superhero and slogan to the other students in the class.

Objective 2: Children will understand how to incorporate carrots into mealtimes.

Activity: Mealtime experience discussion

Time: 5 minutes

- Ask the children how they have eaten carrots before. Answers may include:
  - Raw
  - Cooked
  - Grated on salad
  - In a stir-fry
Objective 3: *Children will make and eat a simple, nutritious snack using carrots.*

Activity: Eat *Carrot Pennies*

Time: 5 minutes

- Tell the children how the carrot pennies were made.
- Pass out the carrot pennies for the children to eat.

Conclusion:

- Ask the children if there is anything new they learned about carrots they would like to share with the class.
- What is one new way you would like to try carrots at home?
CARROT PENNIES

Recipe adapted from PRETEND SOUP by Mollie Katzen and Ann Henderson

2 medium-long, thin carrots, sliced into thin rounds
1 teaspoon butter (more or less)
3 shakes of salt
1 squeeze lemon juice (from a small wedge)
1 teaspoon sesame seed
1 tablespoon brown sugar
1/4 cup water

1. Boil or steam carrots until tender but not mushy.
2. Add all ingredients to the pan. Turn the heat to medium.
3. Cook and stir over medium heat until the carrots are nicely coated with syrup. Add more sugar and/or water depending on how syrupy you like it.
4. Transfer to plates and serve to the children. This snack may be better eaten with a fork to avoid sticky fingers.
Exploring Veggies with the Senses

Brought to you by Viva Vegetables
A Utah State University Extension and Nutrition and Food Sciences Department campaign

The goal of the Exploring Vegetables with the Senses lesson is to help children use ALL of their senses to experience carrots. If they build a more involved, sensory relationship with carrots and associate positive things with carrots, then they may acquire a more positive attitude about eating carrots!

Objectives:
1. Children will understand how carrots relate to four of their five senses (taste is a separate lesson):
   a. How do carrots feel?
   b. How do carrots sound?
   c. How do carrots smell?
   d. What do carrots look like?
2. Children will connect sensory experiences to what they already know:
   a. Does the feel of the carrots remind them of something?
   b. Does the sound of the carrots remind them of something?
   c. Does the smell of the carrots remind them of something?
   d. Does the shape or color of the carrots remind them of something?
3. Children will understand that eating carrots is an experience that can involve all of the senses.

Total Time: 25 minutes

Materials
- "Mystery bucket" (5 gal ice cream bucket w/ hole in lid with tube sock attached)
- Raw carrots-full length (4)
- Raw baby carrots (in clear container) (1/2 #)
- Cooked carrots (in clear container) (1/2 #)
- Drawing pad (11 X 14 medium weight-use like flipchart)
- Black marker
- Pen
- Napkins & wet wipes

Preparation Required
- Put carrots in the mystery bucket
LESSON PLAN

Introduction: “Mystery Bucket”
Activity: Stick hand inside the mystery bucket
- Explain to the children that they have a mystery to solve. They are going to pretend to be detectives to find out what vegetable they will learn about today. They will need to use all the senses, eyes to see, nose to smell, ears to listen and hands to touch.
- Pull out the “mystery bucket” to find out what the surprise vegetable is.
- Have each child feel inside the bucket and describe how it feels (rough, smooth, soft, hard, etc.)
- After every child has had a chance to touch the vegetable, have them guess what it is.
- After they have guessed correctly, pull the carrots out of the bag and continue with the lesson.

Objective 1: Children will understand how carrots relate to four of their five senses (taste is a separate lesson):
  a. How do carrots feel?
  b. How do carrots sound?
  c. How do carrots smell?
  d. What do carrots look like?
Activity: Writing out sensory words
- Display the carrots from the bag, a clear container of baby carrots and a clear container of cooked carrots.
  Give each child a piece and have the children describe the different types of carrots:
  - FEEL (rough, smooth, soft, hard, etc.).
  - LOOK (orange, round, long, short, etc.).
  - SMELL
  - SOUND (break large carrots in half for “crack”)
- Write their descriptive words on a drawing pad or the board to refer to later.

Objective 2: Children will connect sensory experiences to what they already know:
  a. Does the feel of the carrots remind them of something?
  b. Does the sound of the carrots remind them of something?
  c. Does the smell of the carrots remind them of something?
  d. Does the shape or color of the carrots remind them of something?

Objective 3: Children will understand that eating carrots is an experience that can involve all of the senses.
Activity: Carrot comparison
Time: 5 minutes
Compare carrots to similar items (these are ideas, can use others from previous descriptions).
- Orange like (basketball)
- Round like (finger)
- Long like (sugar cone)
- Cracks like (tree branch)
- Hard like (rock)

Activity: Read the story, “The Gnomes Who Loved Carrots”
Read the story, “The Gnomes Who Loved Carrots”. Before reading the story allow children to choose parts out of a hat or basket and have them act out what the story is describing. Also, put steamed carrots in a paper sack and put regular carrots in a paper sack.

Parts (6-12 individuals):
- Grandmother = ____________________________
- Holly = ____________________________
- Eddie = ____________________________
- Woodcutter = ____________________________
- Gnomes (3-4 or how many children who are left who want to participate.)
  - ____________________________
  - ____________________________
  - ____________________________
- Mr. Gnome = ____________________________

When the story is completed, review the similarities and differences between cooked and raw carrots and any other of the descriptors used earlier.

Conclusion:
Tell the children that next time they see carrots in the store, in the lunch line, or at home on the table, they can think about how they aren’t just ordinary carrots, but a favorite food of the gnomes, too. Ask the children to share a new fact about carrots that they learned.
The Gnomes Who Loved Carrots

Whenever the story talks about steamed/cooked carrots, use the cooked carrots in the container. Whenever it talks about raw carrots/picking them from the field, etc., use the regular raw carrots.

"A long time ago in the lands beneath the earth there lived a race of little people called gnomes, and if there were any treasure to be found buried in the rocks and soil, the gnomes would know where to find it..." the grandmother's fairy tale began.

Her young granddaughters were all ears as the voice they loved told them a tale of how once upon a time a poor woodcutter mistakenly left his bundle behind in the forest, and in that bundle was his lunch of steamed carrots. The gnomes found the bundle and tried the carrots - and loved them so much that to thank him they tied a gold ingot up in the bundle, and left it on the very same spot. The next day the woodcutter returned for his bundle and was very surprised! Suddenly he was rich man! Overcome by greed, he used the gold to buy a huge field and planted it all with carrots. For a whole year he took bundles of carrots to the forest, hoping that again they would be mysteriously replaced with gold ingots, but they always turned out empty, for the forest creatures were just as happy as the gnomes to enjoy the tasty treat.

"And to this day foolish people take bags of carrots to the forest in the hopes of becoming rich, but alas, they never find anything in them."

With these words the grandmother finished her story. After all had been kissed goodnight, a sleepy Maria asked her sister, "What do you think gnomes are like?"

Her sister laughed. "They must be pretty special if they get to live in fairy tales."

All night Maria thought about the gnomes, and the next day she asked her grandmother to steam some carrots for lunch. After the heaping bowl was set on the table, Maria waited anxiously until her grandmother was looking the other way, and then slipped a few into her pocket. After lunch she tied them into a bundle and set it off for the woods.

It was a little scary to be in the woods all by herself, but she wanted so badly to see a gnome that she forgot all about being frightened. She stopped in a thicket of bilberries beneath a tall pine tree, took out the bundle of carrots and set it on the ground. Above it she hung a sign that read: "Dear gnomes, please help yourselves. I don't want your gold, but I really want to see you."

The next day Maria could hardly contain herself when she opened the bundle and found a little gem-bag and a note written on green paper. Trembling with excitement, she read the words: "Dear Maria, thank you for the delicious carrots. If you want to see us, squeeze one eye shut and look into this bag with the other."

Holding her breath, Maria closed one eye as tight as she could, and brought the little bag up to the open one. Inside she saw an old, red-faced little man wearing a green shirt that fell almost to his feet. He was peering carefully into a delicate silver-framed mirror and combing his long beard.

"Is that you, Maria? Let me introduce myself. I'm the chief woodsman of the gnomes," he explained, bowing slightly in a friendly manner.

"Hello," Maria replied in a voice that was just as warm and friendly as his. "Tell me, please, why are you wearing such a long shirt?"
"Well, now, Maria, that's my nightshirt. I spent the whole night gathering strawberries from our woodland plantations and now I'm getting ready for bed."

"Please, stay up and talk to me, if only for a minute," Maria hurriedly asked the gnome. "Tell me why you like carrots so much?"

"Like them? My goodness, that's hardly the word. To tell you the truth, hm, well, the thing is that gnomes grow very slowly. We're lucky to put on two or three inches in a thousand years. Carrots help us grow faster, you see. Do you know about the carrot's secret treasure, carotene? No? Well, no sooner does it get inside your stomach than it turns into a vitamin that makes you grow. And if you don't get enough of it, you get what we call "chicken-eyes", you can't see so well in the dark. And there's nothing worse for a gnome - we live below the ground, you know," he explained, for he saw that Maria was looking a bit puzzled. "Also carrots are very good for colds, for headaches and for wounds, if you cut yourself, for example. Ouch!" The gnome smiled. "And if you want rosy-cheeked, eat a carrot every day. Just look at me now that I've feasted on your wonderful gift!"

Maria was delighted with her new friend.

"Tell me, please, too, Mr. Gnome, do you only eat steamed carrots?"

"Oh my, no, gnomes eat raw carrots, too, but for my old teeth the soft steamed ones are a lot easier to handle. I'm nearly 800, you know. And speaking of time, it's time for my rest," the gnome said, and with that he disappeared.

Later that day Maria got the rest of the leftover carrots from her grandmother and took them out into the woods. Three times she returned to the old pine tree, carrying bunches of fresh carrots she had secretly pulled from her grandmother's garden. Her grandmother was quite upset when she discovered the vegetables were missing, but she blamed the neighbors' boys - certainly Maria couldn't have taken them!

When it was already starting to get dark, Maria again raised the little bag to her eye. This time her gnome-friend was dressed in a green caftan with scarlet trim, and on his head he wore a green cap with a tassel. He was even more striking than before, but not nearly so friendly.

"Good evening, did you like my carrots?" she asked.

The gnome wrinkled his face and looked very stern.

"Maria, you pulled those carrots out of your grandmother's garden without asking, and she blamed those boys. If we wanted to we could have borrowed into her garden ourselves, or into any other garden in the world, carrots grow everywhere, you know. But no gnome would ever touch something that wasn't his."

"Dear gnome, I'm sorry, please forgive me. I'll tell granny, and next year I'll plant carrots myself." She brightened. "If you like I can bring you some carrot seeds, and you can grow your own carrots here in the woods."

Now the old wood gnome smiled.

"Don't worry, Maria, we're not angry with you. True, you stole the carrots, but it wasn't for yourself. You only wanted to help us. And thank you for your kind offer of the seeds, but in the woods the carrots would soon go wild, and though a wild carrot is still good for you, it's got no carotene."

The next year Maria planted her own carrots, just as she'd promised, and took them to the gnomes. Always she remembered to share with them. Even when she grew up and studied all about vegetables and grew all sorts of..."
wonderful kinds of carrots, she would always take the very brightest orange ones to the gnomes, since the orange the carrot, the more carotene it has. And the gnomes were especially happy in their underground homes when she brought Vitamin carrots, which have twice as much carotene as any other kind.

http://www.lindzbook.com/booksvegs.htm

Excerpts from the book *The Fairy-Tale Stories About Vegetables* by Lopatina A. Serebtsova M.

The goal of the How it Grows lesson is to help children understand how carrots get from the garden to their plate. If they have an idea of where carrots come from, they may gain an interest in or appreciation of what it takes for them to get to the store or market. This may encourage children to taste carrots.

Objectives:
1. Children will understand one reason carrots are healthy for them to eat.
2. Children will understand what part of the plant the carrot is (root, stem, leaf, flower, fruit, or seed).
3. Children will understand the story of carrots from the garden to their plate (including stages of growth of carrots).

Total Time: 25 minutes

Materials:
- Potted carrot with green stem attached
- Potter flower plant
- Carrot sticks for children to eat while watching movie
- Movie The Carrot Highway
- Poster of vegetable parts (attached)
- One of each of the following for each group of children:
  - Carrot seed packet
  - Small carrot with hairy roots still attached
  - Carrot with green stem
  - Baby carrots

Preparation Required
LESSON PLAN

Introduction: Joke
Time: 1-2 minutes
Q: How do you know that carrots are good for your eyes?
A: Have you ever seen a bunny with glasses?

Objective 1: Children will understand one reason carrots are healthy for them to eat.
Activity: Nutritional fact discussion
Time: 2-3 minutes
- Ask the children why they think carrots are good for them. Commend them for any answers they share.
- Explain that carrots (also) have vitamin A.
  - Ask the class if anyone can explain what vitamin A does.
  - Explain that it helps build the cells in your eyes. Vitamin A is like a construction worker for the eye, it helps to build the different parts of your eye that make it work.

Objective 2: Children will understand what part of the plant the carrot is (root, stem, leaf, flower, fruit, or seed).
Activity: Comparing the carrot plant to a potted flower plant
Time: 10 minutes
- Explain that all vegetables are edible parts of a plant.
- Show the picture of the parts of a plant and have a few volunteers point to the part of the plant that he/she thinks the carrot is (the answer is the root).
- Show children the pictures of carrots from start to finish.
- “Plant” a carrot with the green still attached in a glass jar or other see-through pot. Pull the carrot out of the pot and have the children compare the carrot to a potted plant.
- Ask the children to share their observations about the similarities and differences between the potted flower and the carrot plant.

Objective 3: Child will understand the story of carrots from the garden to their plate (including stages of growth of carrots).
Activity: Put carrots in order of stage of development after watching a small segment of the video Carrot Highway
Time: ~10 minutes
- The movie Carrot Highway is available from the Ag in the Classroom program, www.agclassroom.org/lt
- Ask the children if they know where a baby carrot comes from
- Pass out the baby carrots as a snack for the children to eat while watching segments of the video
- Ask the children where the baby carrot comes from again after the video and discuss what they learned from the movie.
- Separate the class into small groups and pass out the carrot pictures and have the children put them in order. Have all students in the group raise their hands when their group is finished putting them in order. The first group to finish gets a packet of carrot seeds to take home.
Conclusion: Summary and regroup
Time: ~2-3 minutes
Ask the children to share one new thing they learned about carrots with the rest of the class.
Viva Vegetables presents Cauliflower
The goal of A Tasty Little Vegetable lesson is to give children an opportunity to taste cauliflower. Some may think they don’t like cauliflower because they have never tasted it at all, or have never tasted it in season. By tasting cauliflower, they can broaden their taste experience and think about eating cauliflower in different ways. If children realize that cauliflower can taste different or have special appeal depending on how it is prepared, they may be more inclined to taste it!

Objectives:
1. Children will use positive adjectives to describe the taste of cauliflower.
2. Children will understand how to incorporate cauliflower into mealtimes.
3. Children will make and eat a simple, nutritious snack using cauliflower.

Total Time: 25 minutes

Materials
- 4-oz. cups (1 per child)
- Tape
- Copies of “Cauliflower Popcorn” snack label sheet to tape around the snack cups (1 label per cup). There are six copies of the labels per sheet.
- Copies of “Veggie Tasters Award” sheet (1 per child). There are two awards per sheet. You may want to sign the awards before you make copies.
- Enough cauliflower for each activity. Cauliflower will be used three different times: pre-activity, food demo, and snack. One head of cauliflower will likely provide about 24 florets
- Ingredients for the recipe in classroom size-adjusted amounts (recipe attached, “Cauliflower Popcorn”)
- Props for the main activity: camcorder (can be brought from home and does not need to work) and other props you may have that are applicable to the activity.

Preparation Required
- Begin preparing the cauliflower popcorn for the snack one hour before the snack is to be served. Be sure that someone is available to turn the cauliflower throughout the cooking time.
- Cut up 1-3 heads of cauliflower for the pre-activity. Be sure to have enough cauliflower so that each child may have one floret. One head of cauliflower will likely provide 24 florets of cauliflower.
- Cut out “Cauliflower Popcorn” labels and tape on small plastic cups.
- Cut “Veggie Tasters Award” sheet into single awards and sign them if you haven’t already.
- Gather ingredients for food demo and set up for demonstration. The amount of ingredients needed for the food demo will be the same as the original recipe (see below). Note: Will not be cooking the cauliflower popcorn prepared during the food demo. This is a simple demonstration to show how the snack is prepared so the children can take this idea home.
LESSON PLAN

Introduction: Word challenge
Time: ~2 minutes
- Write the word "cauliflower" on the board.
- Ask the children to make as many words as they can out of the word "cauliflower" in 30 seconds. Have them raise their hands when they want to share a word. Words may include:
  - Flow
  - Flower
  - Few
  - Low
  - Cow
  - Life
  - Role
- Tell the children you will be talking about cauliflower today.

Objective 1: Children will use positive adjectives to describe the taste of cauliflower.
Activity: Taste-testing
Time: ~5 minutes
- Gather the children for the pre-activity and food demo and give each child a floret of cauliflower. Let the children eat their cauliflower floret and invite them to discuss how the cauliflower tastes and feels in their mouth.
- Ask the children the following questions:
  - How does it feel in your mouth? Spongy, etc.
  - It is crunchy or soft? Crunchy, etc.
  - What do you think it would feel and taste like in your mouth if it was cooked? Soft, savory, etc.
  - If it was roasted in the oven? Sweeter, etc.
  - Is it juicy?
  - Does it taste like something you have tasted before? Milky, nutty, etc.

Objective 2: Children will understand how to incorporate cauliflower into mealtimes.
Objective 3: Children will make and eat a simple, nutritious snack using cauliflower.
Activity: Food demonstration and meal discussion
Time: ~5 minutes
There are two options for this instructional section:
1. Prepare the cauliflower up to step 3 of the recipe. Once the cauliflower is coated you may spread it onto a cookie sheet or, to avoid a mess, just have a cookie sheet to show the children and explain how it is used to roast the cauliflower.
2. Bring all the ingredients of the recipe but don’t actually put it together. Discuss the steps of the recipe with the children.

After the food demo, ask the children if they have tasted cauliflower and in what ways. Answers may include:
- In soups or salads
- Raw or dipped in a tangy sauce
- Steamed and sprinkled with salt and pepper
- Roasted into "cauliflower popcorn"
Activity: Commercial
Time: 15 minutes
- Divide the children into groups with 4-5 children in each group. If a larger group of students are present, you may want to include more children per group. Give each group a prop.
- Have the children make-up a commercial using the following scenario:
  A local supermarket has just received a new shipment of cauliflower and would like your help in advertising the cauliflower in a commercial. The grocer would like his commercial to be based on how cauliflower tastes and feels in your mouth. Remember how cauliflower tasted to you and the facts you discussed during the tasting activity about how cauliflower tastes and feels in your mouth (ex. cauliflower is soft when it is cooked). Use the prop you have been given to describe the taste and mouth feel of cauliflower in your commercial.
- Give the children approximately 5-8 minutes to prepare their commercial. Use the camcorder as a prop to pretend-record their commercial if available. The commercial does not need to be longer than 1-2 minutes. Have the children present their commercial to the other students.
- While the children are preparing their commercials, have a few people (not children of course!) put the roasted cauliflower in the snack cups.
- The children may eat their cauliflower popcorn while watching each others commercial. Serve the cauliflower popcorn for the children to eat during the presentations. Be sure to remind the children how roasting cauliflower makes it taste sweet.

Conclusion: Summary and Regroup
Time: 2 minutes
- Ask the children what they learned about cauliflower that is new to them.
- What way do they want to try cauliflower at home?
- Thank the children for participating.
- Distribute tasting certificates.
CAULIFLOWER POPCORN

1 head cauliflower or equal amount of pre-cut commercially prepared cauliflower
1 tablespoons olive oil
1 teaspoon salt to taste

1. Preheat oven to 425°.
2. Trim the head of cauliflower, discarding the core and thick stems; cut florets into pieces about the size of ping-pong balls.
3. In a large bowl, combine the olive oil and salt. Whisk, then add the cauliflower pieces and toss thoroughly.
4. Line a baking sheet with parchment for easy cleanup (you can skip that if you don’t have any) then spread the cauliflower pieces on the sheet and roast for 15 minutes. Turning 3 or 4 times, until most of each piece has turned golden brown. The browner the cauliflower pieces turn, the sweeter they’ll taste. Be careful not to burn it.
VEGGIE TASTERS AWARD

This certificate is awarded to YOU
For tasting and learning about cauliflower.

_____________________________  ________________
Teacher Signature               Date

VEGGIE TASTERS AWARD

This certificate is awarded to YOU
For tasting and learning about cauliflower.

_____________________________  ________________
Teacher Signature               Date
The goal of the Exploring Vegetables with the Senses lesson is to help children use ALL of their senses to experience cauliflower. If they build a more involved, sensory relationship with cauliflower and associate positive things with cauliflower, then they may acquire a more positive attitude about eating cauliflower!

Objectives:
1. Children will understand how cauliflower relates to four of their five senses (taste is a separate lesson):
   a. How does cauliflower feel?
   b. How does cauliflower sound?
   c. How does cauliflower smell?
   d. What does cauliflower look like?
2. Children will connect sensory experiences to what they already know:
   a. Does the feel of the cauliflower remind them of something?
   b. Does the sound of the cauliflower remind them of something?
   c. Does the smell of the cauliflower remind them of something?
   d. Does the shape or color of the cauliflower remind them of something?
3. Children will understand that eating cauliflower is an experience that can involve all of the senses.

Total Time: 25 minutes

Materials
- "Mystery bucket" (5 gal ice cream bucket w/hole in lid with tube sock attached)
- Raw cauliflower head (1)
- Raw cauliflower cut in pieces, enough for one piece per child
- Cooked cauliflower cut in pieces, enough for one piece per child
- Drawing pad (11 X 14 medium weight—use like flipchart)
- Black marker
- Napkins & wet wipes
- Lyrics to children’s rhymes (attached)
Preparation Required

- Create Mystery Bucket by cutting a hole in the lid of a 5 gallon ice cream bucket and attaching a tube sock in the hole so that children can feel inside the bucket without seeing inside of it
- Put a head of cauliflower in bucket prior to class
- Cook enough cauliflower for each child to have 1-2 florets
- Make copies of songs, attached, one per group
LESSON PLAN

Introduction: “Mystery Bucket”
Time: 5 minutes
Tell the kids that they have a mystery to solve. Let them know that they are going to pretend to be detectives to find out what vegetable they will learn about today.

- Ask them what the 5 senses are and write out the 5 senses (sight, touch, smell, hear, taste)
- Reiterate the senses by telling them they need to use their eyes to see, nose to smell, ears to listen and hands to touch.
- Pull out the “mystery bucket” and have them feel in the bucket to find out what the surprise vegetable is.
- Direct the students to keep it a secret to themselves until everyone has had a chance to guess and while they are feeling it, have them describe what they feel.
- After everyone has felt the cauliflower, commend the students for their guesses and then pull out the cauliflower. Ask if anyone thought it was something different and why.

Objective 1: Children will understand how cauliflower relates to four of their five senses 
(taste is a separate lesson):

  a. How does cauliflower feel?
  b. How does cauliflower sound?
  c. How does cauliflower smell?
  d. What does cauliflower look like?

Activity: Writing out sensory words
Time: 5-10 minutes

- Display the cauliflower from the bucket and the pieces of raw and cooked cauliflower.
- Give each child a piece of both cooked and raw cauliflower.
- Have the children describe the cauliflower. Write their descriptive words on the board or drawing pad to refer to later. Worksheet is provided for older children to use during this lesson.
  - **FEEL**
    - Have them rub it on the side of their cheek or back of hand
    - Rough, smooth, soft, hard, fuzzy, etc
  - **LOOK**
    - What if it was a different color
    - What if it was really big
    - How is the stem different than the top
    - Color, shape, texture, size
  - **SMELL**
    - Avoid negative words like “stinky”
  - **SOUND**
    - Rub fingers over head of broccoli and hear how it sounds

Objective 2: Children will connect sensory experiences to what they already know:

  a. Does the feel of the cauliflower remind them of something?
  b. Does the sound of the cauliflower remind them of something?
  c. Does the smell of the cauliflower remind them of something?
d. Does the shape or color of the cauliflower remind them of something?

Activity: Verbal comparison

Time: 3 minutes

To help children internalize the concepts of what they learned about cauliflower while using their senses, compare cauliflower to similar items (these are ideas, can use others from previous descriptions)

- White like ________ (snow)
- Round like ________ (rock)
- Bumpy like ________ (carpet)

Objective 3: Children will understand that eating cauliflower is an experience that can involve all of the senses.

Activity: Cauliflower Sensory Song

Time: 15 minutes

- Split the main group into 2-3 groups (so there are about 4-5 children in each group).
- Have each group make up a song about cauliflower choosing a song from the attached list and changing the words but using the same tune. They should use the words and comparisons from the previous descriptions about the cauliflower.
- Give each group about 10 minutes to make up their song; have one person in each group write it down on a piece of paper.
- Have each group perform their song.

Conclusion: Regroup and Summary

Time: 3 minutes

- Regroup and have each child tell one new word they can use to describe cauliflower.
- End by saying: Next time you see cauliflower in the store, in the lunch line, or at home on the table, remember cauliflower is not an ordinary vegetable, but can be fun to eat.
Children’s Songs for Objective 3

“Mary Had a Little Lamb”
Mary had a little lamb,
Little lamb, little lamb,
Mary had a little lamb,
Its fleece was white as snow.

And everywhere that Mary went,
Mary went, Mary went,
 Everywhere that Mary went,
The lamb was sure to go.

“Yankee Doodle Dandy”
Yankee Doodle went to town
A-riding on a pony
Stuck a feather in his hat
And called it macaroni.

Yankee Doodle, keep it up
Yankee Doodle dandy
Mind the music and the step
And with the girls be handy.

There was Captain Washington
Upon a slapping stallion
A-giving orders to his men
I guess there was a million.

Yankee Doodle, keep it up
Yankee Doodle dandy
Mind the music and the step
And with the girls be handy.

“Litsy Bitsy Spider”
The litsy bitsy spider
Crawled up the water spout

Down came the rain
And washed the spider out
Out came the sun
And dried up all the rain
And the litsy bitsy spider
Crawled up the spout again.

“Old Macdonald Had a Farm”
Old Macdonald had a farm, E-I-E-I-O
And on his farm he had a cow, E-I-E-I-O
With a “moo-moo” here and a “moo-moo” there
Here a “moo” there a “moo”
Everywhere a “moo-moo”
Old Macdonald had a farm, E-I-E-I-O

Old Macdonald had a farm, E-I-E-I-O
And on his farm he had a pig, E-I-E-I-O
With a (snort) here and a (snort) there
Here a (snort) there a (snort)
Everywhere a (snort-snot)
With a “moo-moo” here and a “moo-moo” there
Here a “moo” there a “moo”
Everywhere a “moo-moo”
Old Macdonald had a farm, E-I-E-I-O

Old Macdonald had a farm, E-I-E-I-O
And on his farm he had a horse, E-I-E-I-O
With a “neigh, neigh” here and a “neigh, neigh” there
Here a “neigh” there a “neigh”
Everywhere a “neigh-neigh”
With a (snort) here and a (snort) there
Here a (snort) there a (snort)
Everywhere a (snort-snot)
With a “moo-moo” here and a “moo-moo” there
Here a “moo” there a “moo”
Everywhere a “moo-moo”
Old Macdonald had a farm, E-I-E-I-O

“On Top of Spaghetti”
On top of Spaghetti, all covered with cheese,
I lost my poor meatball when somebody sneezed.

It rolled off the table, and onto the floor,
And then my poor meatball rolled out of the door.

It rolled down the garden, and under a bush,

Viva Vegetables: Exploring Vegetables with the Senses

Cauliflower

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And then my poor meatball was nothing but mush!
The mush was as tasty, as tasty could be,
And then the next summer it grew into a tree.
The tree was all covered, all covered with moss,
And on it grew meatballs, all covered with sauce.
So if you have spaghetti, all covered with cheese,
Hold onto your meatball, 'cause someone might sneeze.

"Twinkle, Twinkle, Little Star"
Twinkle, twinkle, little star,
How I wonder what you are;  
Up above the world so high,
Like a diamond in the sky,
Twinkle, twinkle, little star,
How I wonder what you are!

When the blazing sun is gone,  
When he nothing shines upon,  
Then you show your little light,  
Twinkle, twinkle, all the night.  
Twinkle, twinkle, little star,  
How I wonder what you are!

Then the traveler in the dark
Thanks you for your tiny spark;  
He could not see which way to go,  
If you did not twinkle so.
Twinkle, twinkle, little star,  
How I wonder what you are!

In the dark blue sky you keep,  
While you thru my window peep,  
And you never shut your eye;  
Till the sun is in the sky,  
Twinkle, twinkle, little star,  
How I wonder what you are!

"Three Blind Mice"
Three blind mice,  
Three blind mice  
See how they run,  
See how they run!

They all ran after  
The farmer's wife  
She cut off their tails  
With a carving knife  
Did you ever see  
Such a sight in your life  
As three blind mice
EXPLORING CAULIFLOWER WITH THE SENSES

Use your senses to interact with the raw and cooked cauliflower.
Write descriptive words about both the Raw and Cooked cauliflower on the lines below.

Example:
Cauliflower is white like snow.
Cauliflower sounds snappy like a branch breaking.

**RAW**
Cauliflower feels __________________ like __________________________.

Cauliflower smells___________________ like ________________________.

Cauliflower sounds___________________ like ________________________.

Cauliflower looks___________________ like ________________________.

**COOKED**
Cauliflower feels __________________ like __________________________.

Cauliflower smells___________________ like ________________________.

Cauliflower sounds___________________ like ________________________.

Cauliflower looks___________________ like ________________________.

Do you like cooked or raw cauliflower better?

Why do you like it better?
The goal of the How it Grows lesson is to help children understand how cauliflower gets from the garden to their plate. If they have an idea of where cauliflower comes from, they may gain an interest in or appreciation of what it takes for it to get to the store or market. This may encourage children to taste cauliflower.

Objectives:
1. Children will understand one reason cauliflower is healthy for them to eat.
2. Children will understand what part of the plant the cauliflower is (root, stem, leaf, flower, fruit, or seed).
3. Children will understand the story of cauliflower from the garden to their plate (including stages of growth of cauliflower).

Total Time: 25 minutes

Materials
✓ Coloring utensils
✓ Paper, one piece per child
✓ Poster of plant parts, attached
✓ Pictures of cauliflower from seed to flower, attached

Preparation Required
- Make copies of pictures to show children
- Read over lesson to be able to explain how cauliflower grows
- Obtain required materials
LESSON PLAN

**Introduction: Clue Game**

**Time: 5 minutes**

Read these clues aloud and have the children guess what vegetable it is. Have the children raise their hands when they think they know it, whether it’s the first clue or the last. Stop when all children have their hands raised.

1. It takes 55-60 days for me to grow from seed to harvest.
2. I am from the Brassica family.
3. I am related to the cabbage.
4. I am white.
5. I have big green leaves.
6. Broccoli is my cousin.
7. Farmers sometimes call me a curd when I am in the field.
8. My name starts with C.

Commend children for their guesses and explain that you are going to be talking about how cauliflower grows.

**Objective 1: Children will understand one reason cauliflower is healthy for them to eat.**

**Activity: Nutritional fact discussion**

**Time: 2-3 minutes**

Ask the class why cauliflower is good for them. Commend the students for their guesses. After children have made a few guesses, explain that cauliflower (also) has something called folate:

- Ask class if anyone knows what folate does.
- Explain that there is a secret code called DNA that makes your body work. Folate helps make the secret code so that your body can grow. If you didn’t eat cauliflower, or folate, your body would stay the same size.
  - Ask the children for a good way to remember that cauliflower has folate.
  - Have a child explain what folate does in their own words.

**Objective 2: Children will understand what part of the plant the cauliflower is (root, stem, leaf, flower, fruit, or seed).**

**Activity: Identification of cauliflower on the plant parts poster**

**Time: 3-4 minutes**

Explain that all vegetables are edible parts of a plant

- Show poster of plant parts and have a volunteer child point to the part of the plant of which he/she thinks cauliflower is.
- Have the child explain why they chose that part of the plant.
- The answer would be that cauliflower is the flower part of the plant.

**Objective 3: Child will know what the different stages of maturity are from field to store**

**Activity: Drawing a cauliflower cooling machine**

**Time: 10 minutes**

- Show pictures of a cauliflower plant from start to finish.
- Ask kids how they think large fields of cauliflower are harvested and taken to stores.
• Explain that cauliflower is harvested by hand, so men and women pick the cauliflower heads off of the plants.
• The workers then put the cauliflower on a machine that is in the field with them. The machine cools the cauliflower and packs it in bins and boxes for transport.
• Have kids draw a machine that cools cauliflower using crayons.
• When all children are finished choose a few children to show the class how their machine works.

Conclusion: Regroup and Summary
Time: 2 minutes

Regroup and have each child go around in a circle telling one new thing they learned about how cauliflower grows. Tell them that they can’t repeat something that anyone else has said. When they have gone around the circle once remind them of how cauliflower grows and thank them for participating.
Cauliflower is cut off the plant by hand and then placed on machines in the field that cool the cauliflower and pack it into bins and boxes so it is ready for washing and packing.
These pictures show cauliflower seedlings, or baby cauliflower plants.

These bottom pictures show cauliflower being covered from the sun so it stays white. Some cauliflower plants do it themselves and others require people to tie the leaves together.
PICTURES OF CAULIFLOWER PLANTS
PARTS OF A PLANT
PARTES de una PLANTA
(English/Spanish words are provided.)

Blossom/Flor

Fruit/Fruta

Stem (Stalk)/Tallo

Leaf/Hoja

Roots/Raices
Viva Vegetables

presents

Peas
The goal of *A Tasty Little Vegetable* lesson is to give children an opportunity to taste peas. Some may think they don’t like peas because they have never tasted them. By tasting peas, they can broaden their taste experience and think about eating peas in different ways. If children realize that peas can taste different or have special appeal depending on how they are prepared, they may be more inclined to taste them!

**Objectives:**
1. Children will use positive adjectives to describe the taste of peas.
2. Children will understand how to incorporate peas into mealtimes.
3. Children will make and eat a simple, nutritious snack using peas.

**Total Time:** 25-30 minutes

**Materials**
- Green balloons
- Copies of "Veggie Tasters Award" sheet.
- 1 plate per child for snack
- 1-2 oz. cup per child for pre-activity
- 1-2 oz. cup per child for snack
- Peas will be used twice during the activities:
  - Green peas (likely frozen and will need to be thawed) for the pre-activity. If possible, obtain at least one snow pea for the pre-activity.
  - Sugar snap peas for the snack (at least 4 per child)
- Remaining snack ingredients according to amount to be served
- 1 copy of the recipe for each child

**Preparation Required**
- Place 2 tablespoons of green peas for the pre-activity in the small plastic cups. If the peas are frozen, make sure they are thawed thoroughly. Canned peas are NOT recommended.
- Set aside one sugar snap pea and, if possible, a snow pea to show the children for the pre-activity.
- Make a dip for the snack. During the activity, have someone plate the dip and the sugar snap peas.
• Cut “Veggie Tasters Award” sheet into single awards and sign them. You may want to sign the original and then make copies to save time.

• Blow up the green balloons and tie them shut. The balloons just need to be blown up with air and not with helium.
LESSON PLAN

Objective 1: Children will use positive adjectives to describe the taste of peas.
Activity: Sensory Experiment
Time: ~7 minutes
- Gather the children and show them the different types of peas you have (the green peas, the sugar snap peas, and the snow peas if possible). Explain how the pods on the sugar snap peas and the snow peas are edible. Pass out the green peas in the plastic cups so that each child has one. Let the children taste their peas and ask the following questions:
  o What is one word you would say to describe the taste of the pea in your mouth? Peas have a delicate, sweet flavor.
  o What does the pea feel like in your mouth? Soft.
  o What does the pea sound like when you bite into it? Do the peas make any sound when you chew them? Raw peas are soft and burst in your mouth when you eat them
  o Are the peas juicy or dry? Juicy.
  o Have you tasted something like a pea before?
  o What do you think the pea tastes like when it is cooked?
- Point out to the children that sugar snap peas are peas that can be eaten in the pod. The pods are plump and juicy and filled with small, tender peas.

Objective 2: Children will understand how to incorporate peas into mealtimes.
Activity: Recipe idea discussion
Time: ~3 minutes
- Ask the children how they have eaten peas before.
- Ask the children what their favorite way to eat peas is.
- Ask the children what ways they would like to try peas.
- Answers may include, or you may share the following:
  o Peas can be eaten raw or added to a salad
  o Peas can be steamed or boiled to make a tasty side dish to any meal
  o Peas can be added to soups or be the main ingredient in soup (split pea soup!)
  o Try eating frozen peas for a quick easy snack
  o Snow peas and sugar snap peas have edible pods that can make a great scoop for a yummy dip.

Activity: Pea relays
Time: 10-15 minutes
- Divide the children into groups of 5 children per group. Be sure to mix-up the age of the children in each group so that the older children can help the younger children. Give each group a balloon. Have each group pretend their balloon is a pea and discuss how the balloon is soft and squishy like a real pea. Play the following games and relays with each team competing against one another:
  o Have each group stand in a circle with their arms down to their sides (as if they were a pea pod). Have each team compete to see how long they can keep their balloon off the ground without using their arms.
- Have one member of the team jump across the room and back with the balloon between his/her legs and then give the balloon to the next player until every member of the team has had a chance to go. The first team finished wins.
- Have all the team members lie on the floor and try and keep their balloon off the ground. The last team to keep their balloon off the ground wins.
- *Play as many games as time permits but allow enough time to play the game below. Be sure that with each game, all team members keep their hands down to their sides (as if they were a pea pod!).*
- For the last game, have each team compete against one another by seeing which team can sit on their balloon and pop it the fastest. Remind the children how a pea “bursts” in your mouth when you eat it but without the loud noise or force.

**Objective 3: Children will make and eat a simple, nutritious snack using peas.**

**Activity:** Food demonstration and snack  
**Time:** 5 minutes  
- Show the children how to make the vegetable dip, either by showing them containers of ingredients or doing a food demonstration.
- Distribute peas and vegetable dip to the children.
- Give the children the “Veggie Tasters Award” after they have tasted the snack.

**Conclusion: Summary and regroup**  
**Time:** 3 minutes  
- Regroup and have each child go around in a circle telling one new thing they learned about how peas taste.
- Tell them that they can’t repeat something that anyone else has said.
- Thank the children for participating.
Cottage Cheese Dip

1 cup cottage cheese
¼ tsp. garlic powder
¼ tsp onion powder
½ tsp. parsley flakes
½ tsp. dill weed

Mix all ingredients together and chill. Serve with fresh vegetables.

Yield: 8 servings

FROM Food Sense CURRICULUM Recipes
Exploring Vegetables with the Senses

Brought to you by Viva Vegetables
A Utah State University Extension and Nutrition and Food Sciences Department campaign

The goal of the Exploring Vegetables with the Senses lesson is to help children use ALL of their senses to experience peas. If they build a more involved, sensory relationship with peas and associate positive things with peas, then they may acquire a more positive attitude about eating peas!

Objectives:
1. Children will understand how peas relate to four of their five senses (taste is a separate lesson):
   a. How do peas feel?
   b. How do peas sound?
   c. How do peas smell?
   d. What do peas look like?
2. Children will connect sensory experiences to what they already know:
   a. Does the feel of peas remind them of something?
   b. Does the sound of peas remind them of something?
   c. Does the smell of peas remind them of something?
   d. Does the shape or color of peas remind them of something?
3. Children will understand that eating peas is an experience that can involve all of the senses.

Total Time: 30 minutes

Materials
- Raw peas in pods (3-4 lg. handfuls)*if available, 1 per child
- Frozen, thawed peas, about 1 Tbsp in a cup, one per child, labeled “raw”
- Cooked (from fresh or frozen) peas, about 1 Tbsp in a cup, one per child, labeled “cooked;” be careful not to overcook
- Drawing pad (11 X 14 medium weight--use like flipchart)
- Black marker
- Napkins
- Wet wipes
- Green circles (6-8 inch diameter) (for “places” during game if no chairs) & tape
Preparation Required

- Labels with five different adjectives about peas with enough for each child to have 1 label.
- List of the five adjectives used on the labels.
LESSON PLAN

Objective 1: *Children will use positive adjectives to describe the taste of peas.*
Activity: Sensory Experiment
Time: ~7 minutes
- Gather the children and show them the different types of peas you have (the green peas, the sugar snap peas, and the snow peas if possible). Explain how the pods on the sugar snap peas and the snow peas are edible. Pass out the green peas in the plastic cups so that each child has one. Let the children taste their peas and ask the following questions:
  - What is one word you would say to describe the taste of the pea in your mouth? *Peas have a delicate, sweet flavor.*
  - What does the pea feel like in your mouth? *Soft.*
  - What does the pea sound like when you bite into it? *Do the peas make any sound when you chew them? Raw peas are soft and burst in your mouth when you eat them.*
  - Are the peas juicy or dry? *Juicy.*
  - Have you tasted something like a pea before?
  - What do you think the pea tastes like when it is cooked?
- Point out to the children that sugar snap peas are peas that can be eaten in the pod. The pods are plump and juicy and filled with small, tender peas.

Objective 2: *Children will understand how to incorporate peas into mealtimes.*
Activity: Recipe idea discussion
Time: ~3 minutes
- Ask the children how they have eaten peas before.
- Ask the children what their favorite way to eat peas is.
- Ask the children what ways they would like to try peas.
- Answers may include, or you may share the following:
  - *Peas can be eaten raw or added to a salad*.
  - *Peas can be steamed or boiled to make a tasty side dish to any meal*.
  - *Peas can be added to soups or be the main ingredient in soup (split pea soup!)*
  - *Try eating frozen peas for a quick easy snack*.
  - *Snow peas and sugar snap peas have edible pods that can make a great scoop for a yummy dip*.

Activity: Pea relays
Time: 10-15 minutes
- Divide the children into groups of 5 children per group. Be sure to mix-up the age of the children in each group so that the older children can help the younger children. Give each group a balloon. Have each group pretend their balloon is a pea and discuss how the balloon is soft and squishy like a real pea. Play the following games and relays with each team competing against one another:
  - Have each group stand in a circle with their arms down to their sides (as if they were a pea pod!). Have each team compete to see how long they can keep their balloon off the ground without using their arms.
• Direct the children to do the same with the cooked peas and the peas in a pod.

Objective 2: Children will connect sensory experiences to what they already know:
   a. Does the feel of peas remind them of something?
   b. Does the sound of peas remind them of something?
   c. Does the smell of peas remind them of something?
   d. Does the shape or color of peas remind them of something?

Activity: Fill in the blanks
Time: 3 minutes

Compare peas to similar items (these are ideas, can use others from previous descriptions). Write these phrases on the board with the blanks so that children can come up with ideas. Write those ideas in the blanks.
   • Green like __________ (grass).
   • Round like __________ (marbles).
   • Soft like __________ (flower).

Objective 3: Children will understand that eating peas is an experience that can involve all of the senses.
Activity: Pea Pod Explosion
Time: 15 minutes

• Have the children sit in a circle (use chairs if they are available). If there are not chairs available, tape green circles to the ground to mark spots.
• Using 3-4 (you want at least 3 people with each “name”) of the words used to describe the peas (for example: soft, round, green, etc.), go around the circle and assign each child a “name” and give them the corresponding label to put on their shirt so they don’t forget which word they are.
• Pick one child to go first and stand in the middle of the circle (fill in their spot). There should always be one fewer places than there are children.
• The children on the outside of the circle say all together, “What kind of peas do you like?”
• The person in the middle says, “I like peas that are ___________” and calls out a “name” and everyone with that “name” has to move to a different spot in the circle. The person in the middle tries to get one of the empty spots before someone else. The person left without a chair is the next one to call out a “name”.
• Sometimes you can call “Pea Pod Explosion” and everyone has to change spots.

Conclusion: Summary and Regroup
Time: 2 minutes
• Regroup and have each child tell one new word they can use to describe peas.
• What did they learn that they didn’t know before?
• End by saying: Next time you see peas in the store, in the lunch line, or at home on the table, remember peas are not an ordinary vegetable, but can be fun to eat.
The goal of the How it Grows lesson is to help children understand how peas get from the garden to their plate. If they have an idea of where peas come from, they may gain an interest in or appreciation of what it takes for them to get to the store or market. This may encourage children to taste peas.

Objectives:
1. Children will understand one reason peas are healthy for them to eat.
2. Children will understand what part of the plant the peas are (root, stem, leaf, flower, fruit, or seed).
3. Children will understand the story of peas from the garden to their plate (including stages of growth of peas).

Total Time: 30 minutes

Materials:
- Picture of plant parts (attached)
- Poster of pea vine (to play "pin the pea on the vine") or yarn to create a pea vine and paper to make flowers, snow peas, and pea pieces or paper to draw peas on
- Tape
- Ziploc bag
- Damp paper towels
- Beans that will sprout (lima beans will probably work best)
- Paper for kids to make a log book out of for their bean growth
- Bandana or something to blindfold the students one at a time
- Pea seed packet for a prize

Preparation Required
- Draw the pea vine
- Cut out peas to put on the vine
- Print pea dissection sheet
- Read through lesson plan
LESSON PLAN

Introduction: Joke
Time: 1 minute
Q: What do vegetables wish for, more than anything else in the whole world?
A: Peas (peace) on earth.

Q: Why do vegetables want this so much?
A: Because it will give them peas (peace) of mind!

Objective 1: *Children will understand one reason peas are healthy for them to eat.*
Activity: Nutrition fact discussion
Time: 2-3 minutes
- Ask the class why the think peas are good for them. Answers may include:
  - Fiber
  - Vitamin K
  - Vitamin C
  - Pretty much any answer will do for a guess
- Commend the children for their answers
- Explain that peas (also) have fiber
  - Ask the class if anyone knows what fiber does.
  - Explain that fiber helps food move through our body after we eat. Fiber acts like a garbage man that pushes all the waste out of your body. The “fiber garbage man” helps to keep your intestines nice and clean.

Objective 2: *Children will understand what part of the plant peas are (root, stem, leaf, flower, fruit, or seed).*
Activity: Pin the pea on the vine
Time: 10-15 minutes
- Explain that all vegetables are edible parts of a plant.
- Tell the class that a plant has six parts and point to them on the poster as you say them: root, stem, leaf, flower, fruit, and seed
  - On the poster of plant parts, have a few volunteers point to the part of the plant that they think peas are (the answer would be the fruit. Fruit is anything that carries seeds).
- Explain that you are going to play a game called “Pin the Pea on the Vine.”
  - Depending on the number of children, create a few posters of a pea plant and draw a few flowers on the plant (or create a vine with string and put a paper flower on it).
  - Blindfold each child during his/her turn and have him/her try to “pin” (with tape) the pea onto the flower. You can either draw peas or use flat snow peas to tape on the board.
  - The winner gets a seed packet to grow their own peas.
  - Depending on the group size, you may need to split the class into groups and have the group with the most peas on the flowers win.

Objective 3: *Child will understand the story of peas from the garden to their plate (including stages of growth of peas).*
Activity: Pea pod dissection
Time: 10 minutes
- Show children the pictures of the pea plant in different stages of growth. Have a child come to the front and hold each picture.
  - A pea plant starts out as a seed. The seeds are planted in small gardens or on big pea farms.
  - It starts to sprout into a little plant and grows into a big plant.
  - Soon, peas start to grow on the plant.
  - When the peas are ready, they are either picked by hand or by harvesting machines.
- Remind the children that the seed to grow the pea is actually inside the pea pod.
- Bring different types of peas (snow, sugar snap, etc.) and have them dissect them and discuss the differences between all the different types of pea pods and pea seeds.

Conclusion: Summary and regroup
Time: 3 minutes
- Ask the children to share one interesting fact that they learned about peas.
- Thank the children for their participation.
PARTS OF A PLANT
PARTES de una PLANTA
(English/Spanish words are provided.)

- Blossom/Flor
- Fruit/Fruta
- Stem (Stalk)/Tallo
- Leaf/Hoja
- Roots/Raíces
Pea Plants, Sprouts, Pods and Flowers
Pea farms and gardens
PLACE THE SEEDS (OR PEAS) OF THE PEA POD IN THIS CIRCLE.

REMOVE THE ENTIRE STEM IF YOU CAN AND PLACE IT ON THIS ARROW.

PLACE THE POD INSIDE OF THIS RECTANGLE.