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Sensory Exploration of Seasonally and Locally Available Vegetables and its Effects on Vegetable Consumption of Western Massachusetts Head Start Children

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SENSORY EXPLORATION OF SEASONALLY AND LOCALLY AVAILABLE VEGETABLES AND ITS EFFECTS ON VEGETABLE CONSUMPTION OF WESTERN MASSACHUSETTS HEAD START PRESCHOOL CHILDREN

A Thesis Presented

by

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DEDICATION

I dedicate this to my husband, Bryan. You give me strength, and your love and support guide me each day. I am truly blessed. You are my best friend, the love of my life, and my soul mate. Thank you for always believing me, and helping me to believe in myself.

I also want to dedicate this to my family. To my parents for loving and supporting me throughout my life and for always encouraging me. You have given me faith in myself because of the faith that you have always had in me. I wouldn't be who I am today without you both. And also to my brother and his wife. my new sister. You have both been such important sources of love and inspiration for me. Thank you.

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ABSTRACT

SENSORY EXPLORATION OF SEASONALLY AND LOCALLY AVAILABLE VEGETEBLES AND ITS EFFECTS ON VEGETABLE CONSUMPTION OF WESTERN MASSACHUSETTS HEAD START PRESCHOOL CHILDREN

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The current exploratory study is part of the Massachusetts Farm Fresh (MAFF) research project. Eating a wide variety of fruits and vegetables provides micronutrients and phytochemicals. Guided by the Social Cognitive Theory and utilizing a pre- post- study design we: 1) examined the effect sensory attributes (i.e. sweet taste profile, color, shape, texture, growth pattern) of the target vegetables have on Head Start pre-school children's *willingness to explore* and *consumption* and 2) compared these outcomes for: facilitator-guided exploration (FG), vs. children's self-guided (SG) exploration

Between September-October 2011, we conducted a 6-week multi-sensory nutrition education intervention with Western Massachusetts Head Start preschoolers (3-5 years of age; n=94 children). Vegetables were paired during intervention weeks: sugar snap peas-green beans, carrots-parsnip, beets-radishes, and broccoli-cauliflower. Children's willingness to explore the vegetables and taste was recorded by observers using a willingness rating scale. Consumption of the target vegetables was calculated from measured pre- post weights. Data were analyzed using SPSS version 20.0. Results are reported here for 50 children with complete data at both baseline and follow-up.

Willingness to explore the vegetables improved from baseline (40-50% of children = SCORE O) to follow-up (20-40% = SCORE 0) for all eight vegetables Willingness scores (1) increased for the “lower-sugar” vegetables (broccoli, cauliflower, green bean, radish) (p=.013) (2) were lower for white vegetables (cauliflower and parsnip) than those for the other three color categories (red, green and orange) and (3) were higher for both pod (sugar snap peas and green beans) and long-root (carrot and parsnip) versus root vegetables (beet and radish).

Pre-post mean (SE) consumption (g) increased for carrots (p=.013) (2.45+/-.39 vs. 3.49+/-.43) and radishes (p=.023) (.90+/-.22 vs. 1.45+/-.29). Follow-up consumption of “higher-sugar” vegetables was higher (p=.000).   At follow-up, carrot-parsnip pair was higher than broccoli-cauliflower (mean difference 1.49+/-.51) (p=.005) and beet-radish1.01+/-.55) (p=.071) pairs. No differences in outcomes were noted between FG and SG approaches.

Overall, children’s willingness and consumption varied by sensory attributes of the vegetables. The multi-sensory approach successfully activated the children’s senses while providing exposure to a variety of local vegetables in the Head Start setting.

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INTRODUCTION

1.1 Statement of the Problem

Obesity and other diet-related diseases continue to affect both adults and children. Children who are obese commonly have high blood pressure and high cholesterol, two important risk factors for cardiovascular disease; breathing problems such as asthma; and insulin resistance and type 2 diabetes (CDC). Children who are obese also have a higher likelihood of becoming obese as adults (CDC). Obesity during adulthood is associated with increased risk of developing other chronic diseases including heart disease, type 2 diabetes and cancer (CDC). Currently, 37% of the U.S population has cardiovascular disease, 11% have type 2 diabetes and 41% will be diagnosed with cancer in their lifetime. (Dietary Guidelines 2010). The health care costs of obesity in the United States are reported to be up to $147 billion dollars annually (Trogdon 2010). These numbers will continue to rise unless changes are made in the diets and lifestyles of Americans.

According to (Table 1), nearly 17% of children between the ages of 2 and 19 are obese, as defined by a body mass index above the 95th percentile (Ogden 2010). More than 10% of 2 to 5 year old children in the United States are obese, an increase from 5% from 1976-1980 data. Based on this data, *Healthy People*

2020 named a reduction in the prevalence of child and adolescent obesity one of its goals.

Table 1. Prevelance of Obesity Among U.S Children and Adolescents aged 2-19, for selected years 1963-1965 through 2007-2008 (Ogden, 2010)

Age (in years)[1]	NHES 1963–1965 1966–1970[2]	NHANES 1971–1974	NHANES 1976–1980	NHANES 1988–1994	NHANES 1999–1900	NHANES 2001–2002	NHANES 2003–2004	NHANES 2005–2006	NHANES 2007–2008
Total	(3)	5.0	5.5	10.0	13.9	15.4	17.1	15.5	16.9
2–5	(3)	5.0	5.0	7.2	10.3	10.6	13.9	11.0	10.4
6–11	4.2	4.0	6.5	11.3	15.1	16.3	18.8	15.1	19.6
12–19	4.6	6.1	5.0	10.5	14.8	16.7	17.4	17.8	18.1

[1]Excludes pregnant females starting with 1971–1974. Pregnancy status not available for 1963–1965 and 1966–1970.
[2]Data for 1963–1965 are for children aged 6–11; data for 1966–1970 are for adolescents aged 12–17, not 12–19 years.
[3]Children aged 2–5 were not included in the surveys undertaken in the 1960s.

Children from low-income families are of particular concern because 1 in 7 low-income preschool aged children are obese (CDC). Data from the Pediatric Nutrition Surveillance System (PedNSS), which tracks the nutritional status of low-income children attending federally-funded nutrition programs, indicate that in 2009, 14.7% of children between 2 and 4 years old were obese, compared to 10.4% of all pre-school-aged children, and 16.4% were overweight. Limited access to healthy food and the high cost of fresh produce are major barriers for low-income families to eat a balanced diet that includes fruits and vegetables (PedNSS). These factors make it difficult for low-income families to maintain a healthy weight and get adequate nutrients, particularly from fruits and vegetables (PedNSS), and this may lead to deficiencies.

Fruits and vegetables are high in a variety of vitamins and minerals including potassium, fiber, folate and vitamins A and C; nutrients that are an essential part of a healthy diet and ones that are important for child growth and development. Vitamins A and C are of particular importance for eye health, wound healing, healthy teeth and gums, and cognition. Fruits and vegetables have been shown to reduce the risk of many chronic diseases including cardiovascular disease as well as cancer in adults. These foods can also help maintain a healthy weight (State Indicator 2009, Dietary Guidelines 2010). Eating a wide range of colors and varieties of fruits and vegetables is the best way to obtain the various vitamins and minerals children and adults need for overall health (fruitsandveggiesmorematters). Color plays a role in children's liking and disliking of foods, particularly vegetables (Baxter, 2000) and may also impact assessment of sweetness of foods in both adults and children (Lavin, 1998). Nutrition education programs such as *Color Me Healthy,* implemented by North Carolina State University's Extension, use color as one of their main themes to teach young children about healthy eating and exercise (Dunn 2004, Witt 2012). Color is also the focus of the Academy of Nutrition and Dietetics 2012 National Nutrition Month theme, "Eat Right with Color" (eatright.org). The pigments that color fruits and vegetables (ex. flavonoids, carotenoids) are categorized as phytochemicals. These non-nutritive compounds exhibit antioxidant properties and are found to have health benefits, namely for cancer and disease prevention (Brown 2008).

Despite the known benefits and preventative effects of fruits and vegetables, most Americans are not getting the recommended amounts of these foods. According to the Dietary Guidelines for Americans, most recently released in 2010, the recommendation for child fruit and vegetable consumption among children aged 2-5 are 1 to 1.5 cups fruits and 1.5-2.5 cups vegetables per day depending on their calorie needs (Dietary Guidelines 2010). Recommendations for adults are based on their age, gender and activity level. Men and women between 20 and 50, who need approximately 2000-3000 calories, are recommended 2 to 2.5 cups of fruit and 2.5 to 4 cups of vegetables per day (Dietary Guidelines 2010). The usual adult intake for vegetables is 1.6 cups per day and 1.0 cups for fruit (Dietary Guidelines 2010). In Massachusetts in 2009, only about 29% of adults were consuming 3 or more servings of vegetables per day (State Indicator Report 2009). Data was not available for children.

Increasing both fruit and vegetable consumption among Americans is an objective set forth by the Dietary Guidelines. It is also one of the objectives set by *Healthy People 2020,* to "increase the variety and contribution of vegetables to the diets of the population aged 2 years and older" (healthypeople.gov). Although many children age 2-3 are consuming the recommended servings of fruit per day, according to the Dietary Guidelines 2010, children 4 and older are not eating the recommended amount of vegetables.

Fruits tend to be more widely liked by children (Blanchette and Brug 2005). In an effort to increase children's liking of vegetables, the focus of the proposed research is on them. We used a sensory-based approach to expose children to a variety of vegetables (including different colors and shapes). Sensory exploration is the foundation for the intervention activities in order to increase children's willingness to try and consumption of the target vegetables. Others have used sensory-based education in their studies with children (Reverdy 2008, Mustonen 2009, 2010), but to our knowledge, this approach has not been used in the United States. Our approach is also unique in that it puts the focus on the vegetables themselves and allows the children to have immediate interaction with the foods through sight, touch and taste. Unfamiliar foods (Tuorila 2001), and also unfamiliar vegetables (Wardle 2003a), have been used in studies with children and adults. In their 2001 study, Tuorila et al. looked at food neophobia of Finnish adults. A variety of foods, 20 in total, unfamiliar and familiar of both plant and animal origin were used and participants answered food stimuli questions as well as filled out a food neophobia scale. Wardle et al evaluated exposure alone versus reward plus exposure models to assess child vegetable preferences. Sweet red bell pepper, a food determined novel and disliked by children through preliminary tests, was the target vegetable. Consumption and liking were outcome measures. Though we did not specifically assess familiarity of the vegetables presented in our study prior to implementation, we gained insight from the coordinating Head Start nutritionist regarding children's typical exposure to our target vegetables in the Head Start setting. The vegetables we present are a combination of those which children are more frequently exposed (ex. carrots, broccoli) and those which are not (ex. parsnip, radish). To the best of our knowledge, we are the first to expose children to eight different (familiar and unfamiliar) raw vegetables, in a Head Start setting.

1.2 Specific Aims and Hypotheses

The overall goal of our research is to develop and implement a multisensory intervention and promote the consumption of seasonally available vegetables among Head Start children in select Western Massachusetts sites using a sensory-based classroom approach. We also developed a parent component that exposes Head Start parents to child-friendly recipes highlighting the same vegetables in order to promote parent consumption of these vegetables and the incorporation of these vegetables into meals at home.

Specific Aim 1:

Examine the effect the different sensory attributes (i.e. taste profile, color, shape, texture and growth pattern) of the target vegetables have on children's willingness to try and consumption of these vegetables throughout the sensory-based exploration program.

The objectives of aim 1 are: 1) To assess the differences in willingness to try those vegetables that are categorized as "sweet tasting" with those vegetables that are "less-sweet-tasting" at baseline and at follow-up; 2) To compare the change in consumption of those vegetables categorized as "sweet tasting” with those vegetables that are “less-sweet-tasting” from baseline to follow-up; 3) To determine differences in willingness to try and consumption at baseline and at follow-up of the target vegetables across 4 color categories: red (beet, radish), orange (carrot), green (broccoli, green beans, snap pea pods) and white (parsnip, cauliflower); and 4) To compare the differences in consumption between the 4 vegetable pairings (peas-beans, carrot-parsnip, beet-radish, broccoli-cauliflower).

We hypothesize that children will show a preference for the sweet tasting vegetables over the less-sweet tasting vegetables at both time points, and will therefore be more willing to try and consume these vegetables. Children have an innate propensity for sweet flavors and those foods with satiating effects (Birch, 1999). A preferred liking for sweet tastes was found by Havermans and Jansen (2006). They investigated whether using a flavor-flavor learning technique would increase children’s liking and preference for a given vegetable taste. Pre-and post-tests were the same and involved children sampling purees of 6 vegetable flavors (zucchini, pumpkin, peas, cauliflower, broccoli and carrots). The children then ranked their preference for the taste. Those flavors ranked as 3 and 4 (which differed by child) were used for conditioning. After the pre-test, children were given pairs of the 2 ranked tastes; one sample was unsweetened (CS-) and the second was sweetened with dextrose (CS+). The children then received a post-test, again with 6 unsweetened vegetable flavors to sample. Analysis for the 13 children who completed the experiment (i.e. pre-test, conditioning and post-test) showed that there was a significant increase in preference for CS+ at post-test, but not for CS- These results indicate that children favor sweet tastes versus un-sweet, and that one's liking of an initially less-preferred flavor can be increased through a learned association with a highly-preferred flavor. Although not all of our pairings included one sweet and one less-sweet vegetable, we can infer that when grouping vegetables by taste, we will see a difference between them.

When comparing across the four color categories, we hypothesize that we will see increased willingness and consumption for "red" and "orange" vegetables (i.e. beets, radishes and carrots) over those vegetables that are white and green (i.e. cauliflower, parsnip, broccoli, snap peas and green beans). Children may create color-flavor associations, which could result in them relating certain colors, specifically those in the red and yellow spectrum (or in our case red and orange categories) with sweetness. Based on what has been established in the literature about sweet tastes being preferred by young children (Birch 1999, Havermans 2006), we expect that the vegetables in the red and orange color groups will be associated with higher outcome measures.

When assessing the children's consumption of the vegetable pairs, we expect to see differences based on the varying shapes and textures represented by each pairing. Texture was the most important characteristic responsible for liking and disliking foods, as reported by 4-5 year olds in a study conducted in 2007 by Zeinastra et al. In 2010, Zeinstra et al. examined the effect preparation method had on children's vegetable liking. The children liked the boiled and steamed preparations best, and this preference was related to the crunchy texture of the vegetables (among other attributes). All of the vegetables presented in our study are raw. Though there are some similarities in texture (degree of crunchiness), the texture is not the same between the pairs.

Specific Aim 2:

Investigate the effects of classroom-based sensory exploration of vegetables (which will include touching and viewing the different colors, textures and shapes as well as tasting) on Head Start children's willingness to try and consumption of the target vegetables within a classroom setting. This will include a comparison of these outcomes in children for two approaches: facilitator-guided sensory-exploration by the children and children's self-guided sensory-exploration.

The objectives of aim 2 are to examine changes in the children's acceptance measures (i.e. willingness to try and consumption) for the target vegetables from baseline to follow-up for two groups of children: one group who will experience facilitator guided sensory exploration of vegetable A (of each vegetable pairing) and self-guided sensory exploration of vegetable B (of each vegetable pairing), and another group who will experience facilitator guided sensory exploration of vegetable B and self-guided sensory exploration of vegetable A. We will: 1) Assess willingness to try the target vegetables, at baseline and at follow-up for each group of children**;** and 2) Compare the changes in consumption of the target vegetables, from baseline to follow-up between the two groups of children.

We hypothesize that facilitator-guided sensory exploration of locally and seasonally available vegetables will result in a greater positive change in consumption from baseline to follow-up compared with children's self-guided sensory exposure and exploration of the target vegetables. Observational learning is one of the main constructs of the Social Cognitive Theory. The use of both peer and adult modeling has been tested in studies involving children and intake of a variety of foods (Hendy 2000, Hendy 2002, Horne 2004, Lowe 2004). Peer modeling videos featuring "Food Dudes" were used in 2 studies involving 5-11 year olds (Horne, 2004) and 12-13 year olds (Lowe 2004). Videos were shown to the children in which the models eat and enjoy fruits and vegetables, and promote the consumption of these foods. Consumption of fruits and vegetables was then measured at lunch and snack time at school as well as at home. Results overall showed that for both studies, consumption increased during the intervention from baseline. Furthermore, Lowe et al reported an increase in children's liking of a variety of fruits and vegetables.

When looking at teacher modeling, Hendy et al first questioned teachers themselves which model they thought would be most effective for increasing children's food acceptance. Teacher modeling received the highest ranking. They compared "silent" with "enthusiastic" teacher modeling and found the former to be ineffective. The latter however did prove to be effective in helping children accept new foods presented to them.

Based on the effectiveness of teacher modeling, we expect that the slightly adapted method of facilitator-guided exploration we developed similarly will have a positive influence on children’s willingness to explore and try the vegetables in our study as well as consume them in higher amounts than if children explore the vegetables on their own (self-guided approach).

1.3 Head Start Setting

Head Start, established in 1965, is a national program whose purpose is to, “promote school readiness by enhancing the social and cognitive development of children through the provision of educational, health, nutritional, social and other services to enrolled children and families” (Office of Head Start). The program is available to low-income families with children between the ages of three and five. Early Head Start, which began in 1995, is available for children from birth to three years as well as pregnant women and their families.

1.4 Significance and Innovation

Obesity rates have reached epidemic levels with approximately two-thirds of the U.S. population considered to be overweight or obese, a problem not specific to only adults. Childhood obesity is at a rate of 17% in the United States, putting children and adolescents at risk for several chronic health conditions including type 2 diabetes and heart disease (CDC).

Data from the 2009 State Indicator Report on Fruits and Vegetables indicates that less than 30% of adults in Massachusetts are getting the recommended 3 or more daily servings of vegetables (data were not available for children or adolescents). Long-term evidence has established that a diet rich in fruits and vegetables is important for disease prevention and growth and development in children and there is an increasing body of research focused on nutrition interventions with children (Ciliska 2000, French 2003, Blanchette 2005, Gaines 2009, Witt 2012). Nutrition interventions are commonly conducted in school-based settings and have proven successful (Jamelske 2008) due to the amount of time children spend at school and because children are consuming a significant amount their daily intake here (Brug 2008).

We have chosen to conduct our research with Head Start pre-school-aged children because 1 in 7 children from a low-income family is obese (CDC), and because limited access to healthy foods is a major barrier for low-income families. Eating habits develop in early childhood (Aldridge 2009) and can track into adulthood (Wardle 2003a, French 2003, Brug 2008). Food neophobia, i.e. the fear of new foods, is common in young children, starting after infancy through early childhood (Birch 1999), and eventually decreases during adolescence into adulthood (Birch 1999). Targeting children when they are young can help to lessen food neophobic behaviors (Cooke 2007) and increase liking for more healthy foods, particularly vegetables (Cooke 2007) since children typically have a greater dislike for them over fruits. Our study design developed based on ideas used by Kannan et al (2011) in previous work with Head Start children through the Fruitzotic project (Kannan 2011) and the Classroom Garden Project (Kannan 2012). Other programs, such as *Food Friends* (Young 2004, Bellows 2006) have also attempted to try to increase willingness to try novel foods in a Head Start setting. The “try new foods” theme of this 12-week program is highlighted in both their educational materials for parents and the nutrition education activities in the classroom. Programs like this, which encourage a “play” approach and use developmental learning skills including sensory evaluation (Young 2004) that helped to provide a framework for our research.

A growing number of studies supporting the use of sensory-based interventions are being conducted or implemented. Both Mustonen (2009, 2010) and Reverdy (2008, 2010) tested the use of the French sensory education program*, Classes du gout*. These studies were done in Finland and France with 8-11 year olds. Reverdy et al. reported an increase in food neophilia as well as a positive influence on willingness to try new foods, though this effect of the sensory program was not lasting (Reverdy, 2008). In a second paper, Reverdy et al. revealed that the sensory education lead to liking and preference of more complex food variants (Reverdy, 2010). For Mustonen et al., sensory education improved odor identification, and though it wasn’t significant, the program also improved taste identification (Mustonen, 2009). In their second paper, they found that the program decreased food neophobia scores, and this effect was stronger in the younger children.

To our knowledge, the sensory-based approach has not been utilized extensively in the United States with young children. Although other studies have been similar in that they used the senses in their sensory education lessons (Reverdy 2008, Mustonen 2009, 2010), this method was used with older children (7-11 year olds). Children in our study will learn to use their senses to explore vegetables without the use of props or rewards (Wardle 2003a, Horne 2004, Lowe 2004). What is most unique about our study design is the use of two different intervention approaches that have not been used in previous research. Our study is exploratory in nature and is evaluating a design that has not been tested. Many interventions also are conducted with school-aged children (6 and older) in a larger school setting. Our intervention, on the other hand, is with younger children (3-5 year olds) at the classroom level. Head Start classrooms are a much different environment that a school cafeteria. The ratio between children and teachers/facilitators is much higher, allowing for more individualized attention.

CHAPTER 2

LITERATURE

2.1 Determinants of Fruit and Vegetable Intake

Children and adults alike are not meeting the recommendations for fruit and vegetable (F & V) intake. To meet the goal set by *Healthy People 2020* of increasing F & V consumption in children, it is important to gain insight into the reasons behind their food choices. Young children themselves do not purchase their own food, so there are clearly other factors involved in why children eat certain foods over others and why they are not getting enough F & V. Some potential contributors to children's F & V consumption include *preferences and liking, sensory attributes, exposure, availability/accessibility, environment and parental and/or peer influences,* among others (Pollard 2002, Blanchette 2005, Cooke 2007, Brug 2008). In the following sections of the proposal, each of these determinants is described.

2.1.1 Preference and Liking

"Preference" can be defined as the "selection of one item over another" (Birch 1999). Early childhood is a key time to influence a child's intake because this is the period during which food preferences develop (Aldridge 2009). Preferences and liking are among the most important personal (i.e. versus environmental) determinants affecting a child's fruit and vegetable consumption (Blanchette 2005, Brug 2008) and may be formed as early as the age of six

(Byrne 2002). Preferences and food habits may track throughout childhood and adolescence, and even into adulthood (Wardle 2003a, French 2003, Lowe 2004, Brug 2008).

The affinity for some foods over others is both learned and unlearned (Brug 2008). The unlearned or innate preferences can be explained in part by the “wisdom of the body theory”. This theory says that children may be programmed to like certain foods, specifically those that are high-energy, sweet, salty, and high in fat (Birch 1999, Blanchette 2005, Brug 2008). Researchers have found that one’s affinity for those programmed foods and not others can be altered and replaced by learned behaviors through exposure and changes in environment (Blanchette 2005). Exposure can increase familiarity of foods and familiarity has been linked to the formation of food preferences (Aldridge 2009). What are of greater concern are those foods (especially fruits and vegetables) that are may not familiar. There is research with children that has explored exposure to novel or unfamiliar vegetables (Wardle 2003a, Addessi 2005, Reverdy 2008), but to our knowledge there is no research that has investigated exposure to multiple vegetables using a sensory-based classroom approach with preschoolers.

2.1.2 Sensory Attributes

One’s senses and what sensory appeal food brings are major determinants of a person’s food choices (Pollard 2002). It is well known that children are predisposed to prefer certain tastes (sweet, salty) over others (bitter, sour) and to reject novel foods (Birch 1999). Liking the taste of vegetables is significantly associated with daily vegetable intake (Brug 2008). However, perhaps the more typically bitter taste of many vegetables makes them less preferred. Some research has examined flavor-conditioning such as flavor-flavor learning to increase liking of vegetables (Havermans 2007). This procedure pairs a neutral flavor with one that is highly favored (i.e. sweet), and it creates an association between the two flavors which leads to an increased preference for the neutral flavor alone (Havermans 2007). Twenty-one children (mean age=5.2 years) participated. In the pre- and post-test, children tasted 6 vegetables flavors and ranked their liking. The two flavors for each child ranked 3 and 4 during the pre-test were then presented during conditioning in pairs. The flavor pairs consisted of one sample (of each flavor) left unsweetened (CS-) and then the second was sweetened with dextrose (CS+). The post-test presented the same 6 unsweetened vegetable flavors as pre-test. At post-test, children's preference for CS+ was significantly increased from baseline, though CS- was not (Havermans 2007). Although in our study, we will not be altering the natural flavors of the vegetables presented (all given to children raw), there will be a combination of sweet and less-sweet tasting vegetables. Perhaps the presence of those sweet tasting vegetables will enhance children's willingness to try those vegetables that are less-sweet.

Food neophobia (i.e. a reluctance to eat and/or rejection of novel foods (Pliner 1994), is higher in younger children (Birch 1987), and taste exposure may therefore be influenced by children's natural avoidance of certain foods. Many researchers have recently explored the use of visual exposure to increase children's liking of new foods and commonly rejected ones like vegetables.

Houston-Price et al. hypothesized that children's visual exposure of foods will enhance attitudes toward the appearance of those foods, and lead to increased willingness to taste them. Twenty toddlers (ages 21-25 months) participated in the study. Books highlighting both unfamiliar and familiar fruits and vegetables were read at home. Children then participated in a taste test of fruits and vegetables that used a 2 (fruit vs. vegetable) x 2 (exposed through book reading vs. non-exposed) x 2 (unfamiliar vs. familiar) design. Children tended to taste more exposed than non-exposed foods, though this was only true for the unfamiliar foods, and it was not significant ($p=.36$). The opposite effect was seen for familiar foods. Children were more willing to try non-exposed familiar foods than exposed (where willingness actually decreased), and familiar non-exposed foods were strongly preferred over unfamiliar non-exposed ($p=.008$) (Houston-Price 2009). These results do suggest the possibility that exposure to unfamiliar foods can increase children's willingness. In our study, we will be presenting preschoolers with a mixture of familiar and unfamiliar vegetables (as indicated by the Head Start nutritionist record of exposure in the classroom to the target vegetables). They will use a combination of all five senses to explore the vegetables. We expect that this multi-dimensional approach will increase familiarity and therefore willingness to try the vegetables.

A classic study by Birch compared the effectiveness of taste and visual exposure in 2-6 year old children (Birch 1987). "Taste" exposure included vision, taste and olfaction and "look" exposure included only vision and olfaction. After exposure, children made 2 types of judgments: one based on tasting the foods, and one based only on looking. Taste preference was enhanced for both exposure types, though visual preference increased only for visual exposure. Those foods that were tasted were consistently more preferred than those that were not. The relationship between exposure and preference/judgment was significantly correlated for both exposure types ($r=.94$, $p<.05$ for taste, $r=.91$, $p<.05$ for look) (Birch 1987). Birch concluded that taste exposure is a more effective method for increasing food preferences than looking, and this could be in part because it is a tri-modal approach versus a dual-modal. This idea of a multi-modal method provides support for our intervention incorporating all five senses. Overall, research that has investigated the role taste and taste exposure plays in children's food preferences has shown that this particular sense is a major determinant of acceptance and that neophobic behaviors can be reduced and preferences can be enhanced in young children.

Other researchers have applied a multi-sensory approach. Both Reverdy (2008, 2010) and Mustonen (2009, 2010) used the French *Classes du gout* sensory education program as a model for use in older (7-11 year old) children. The *Classes du gout* program introduces subjects to each of the five senses through "taste" lessons aimed to "teach young children how to become well-informed consumers who are aware of the quality and differences between foods through their sensory impressions" (Mustonen 2010). Reverdy et al, as part of the EduSens program in France, adapted the *Classes du gout* model. Children were assigned to either the education or control group. The education group received 12 lessons, focusing on the senses and their use during a variety of activities. They found an increase in willingness to try new foods as well as increased neophilia (or liking of new foods) among children in the education group (Reverdy 2008) compared with the control. The effects of the intervention were not permanent however (Reverdy 2008). Mustonen et al (2009, 2010) used a Finnish adaptation of *Classes du gout* where children performed various laboratory tests and received sensory lessons. Participants were divided into education and control groups. In their 2009 paper, Mustonen et al. saw an increase in children's ability to correctly identify tastes a slight increase in older children's willingness to try unfamiliar foods, and a significant increase in the number of words younger children used to describe certain foods. As with Reverdy et al, the effects were not sustained (Mustonen 2009). In their 2010 paper, Mustonen et al. reported a significant decrease in neophobia in younger children as a result of the sensory program ($p= .041$). Programs that introduce and encourage children to use their senses when eating foods may help increase children's knowledge and acceptance of a wider variety of foods, and vegetables in particular. These studies were done in Europe, and to our knowledge, a similar multi-sensory design has not been used in the United States. Nor has it been done within a Head Start classroom focusing only on vegetables. Recent nutrition education programs focusing on the use of all five senses have found that a multi-sensory approach is useful at increasing children's willingness to try new foods, decreasing food neophobia, and expanding children's knowledge and use of their senses in relation to food.

In our nutrition program, we also wanted to investigate whether there would be differences in willingness and consumption between vegetables based on their color. There is research that suggests color may play a role in food acceptance (Lavin 1998, Poelman 2011). The focus of Poelman et al. was to investigate (cooking) preparation methods and color typicality on vegetable acceptance. Three vegetables (sweet potato, cauliflower and French beans) were used and were presented using three cooking methods. The two colors (one typical and one atypical for each vegetable) were presented using the same preparation technique. Color, as results showed, had an effect on expected preferences, but not actual. This finding does have positive implications that color may play a role in acceptance, and more specifically, color may encourage children to try vegetables. Based on this, we can expect that color will have an influence on children's willingness to explore and try the vegetables during our program.

Programs have been developed and used in child care settings, including Head Start that focus on both eating and physical activity; one such program is *Color Me Healthy (CMH)*. This program uses color, music and sensory exploration to teach 4-5 year old children about the benefits (i.e. being fun) of healthful eating and exercise (Dunn, 2004). It utilizes the "train the trainer:" model and comes with a "toolkit" that includes such things as posters, a teacher guide and materials that emphasize the different colors of fruits and vegetables (Witt 2012). An evaluation of the program was done by Witt et al. in 2012. Seventeen classrooms were involved in the study; 10 received the CMH program while the other 7 served as comparisons. The program was implemented for six weeks. The aim was to evaluate whether exposure to *Color Me Healthy* would increase snack time consumption of fruits (pineapple, cantaloupe, strawberries and grapes) and vegetables (carrots, celery, broccoli and cherry tomatoes). The subject sample included two-hundred sixty-three 4-5 year olds. Data was collected at baseline (1-week prior to program implementation), at a 1-week follow-up 1-week and a 3-month follow-up. Consumption of fruits increased by about 30% and about 24% for vegetables in response to *Color Me Healthy* between baseline and 1-week follow-up. Between baseline and the three-month follow-up, children’s consumption increased by 20.8% for fruits and 33.1% for vegetables. This study did not look at any specific fruit or vegetable, nor did it assess the effectiveness between the use of one color over another. Our research helps determine if there are any differences in children’s willingness to try and consume vegetables based on their color as well as between the eight vegetables. The positive results seen in recent research using color as a major theme in nutrition education provides support that this particular sensory attribute may play an important role in children’s acceptance of certain foods over others.

2.1.3 Neophobia, Familiarity and Exposure

Food neophobia has been defined as the rejection or fear of new or novel foods, and is common in children (Birch 1999, Pollard 2002, Cooke 2007). In an adaptive sense, food neophobia is a protective response as new foods pose the possibility of causing serious harm, even death (Birch 1999). In our current culture however, this can be maladaptive (Russell 2008) and have a deleterious effect on a child's food preferences, ultimately limiting their intake of a variety of foods. If children are predisposed to like foods higher in fat and energy and be fearful of new foods including fruits and vegetables, their diets will suffer and they will be more prone to infection, illnesses, and in the future, chronic disease. Neophobia develops during and typically lasts throughout the preschool years and those children who exhibit higher neophobia have less diversified diets (Cooke 2007). A study conducted by Russell et al. (2008) examined the relationship between food neophobia and food preferences in 371 2-5 year old Australian children and what effect neophobia had on preference for different food types. Results showed that neophobia had a negative relationship with food preferences, and that the strongest correlation was seen with vegetables ($r= -.60$) (Russell 2008). Because of this known aversion for vegetables in pre-school-aged children we are interested in exposing young children to a range of locally grown vegetables instead of focusing our efforts on fruits, which research has shown are generally more preferred by children (Blanchette 2005).

However, food neophobic behaviors can be modified by increasing one's familiarity with of a variety of foods. Familiarity, or "knowledge gained through experiences" has been associated with food acceptance (Aldridge 2009). One's familiarity with a food can be obtained through both "mere exposure" and direct taste exposure (Aldridge 2009). Mere exposure or the simple offering of vegetables to children is an avenue through which a child's preferences for some foods can be changed by introducing them to and familiarizing them with new foods, which could affect their intake of vegetables (Wardle 2003a, Reinaerts 2007).

A study conducted by Reinaerts et al. in 4-12 year Dutch children investigated various potential determinants of fruit and vegetable consumption including social influence, availability/accessibility, parental FV consumption and exposure, among others. Exposure was assessed by asking children if they had ever tasted common fruits and vegetables. The vegetables that were included in the study were cooked cauliflower, broccoli, carrots, beans, cabbage, Brussel sprouts and spinach. Results showed that exposure contributed to vegetable consumption, even after controlling for preferences (Reinaerts 2007).

Exposure should happen early and frequently. Research shows that offering variety in the first 2 years is important and may predict future food behaviors (Skinner 2002, Cooke 2007). Experiencing repeated exposure to new foods has been shown to result in acceptance for and liking of these foods (Blanchette 2005, Cooke 2007). The number of exposures necessary to increase a child’s preferences for fruits and vegetables can vary: numbers between 5 and 10 exposures have been shown to be effective in eliciting changes in preferences (Birch 1999, Blanchette 2005).

In one study done by Wardle et al., children were randomized into one of three experimental groups: exposure alone, reward and control. Those children in the intervention groups attended eight treatment sessions where they were given pieces of sweet red pepper. Liking was rated and consumption was measured by counting the number of pieces eaten. The results were in favor of exposure alone. A significant linear trend was seen in both the liking ratings and consumption in the exposure group over the course of the eight treatment sessions. Where there was an increase in liking and consumption shown by the exposure group, liking actually declined in the reward group (Wardle 2003a). In another study by Wardle et al., children were randomized into one of three groups: taste exposure, health information or control. The study was conducted in the home and children were exposed to a target vegetable for fourteen consecutive days. Liking, preference and intake were measured. Although the results showed positive changes in all of the groups, there was a significant increase in all three outcome measures only in the exposure group. Parents were surveyed and seven out of ten from the exposure group expressed that ‘the intervention had had a lasting effect on their child’s liking for the target vegetable’ (Wardle 2003b).

Although others have found that repeated exposures to a food may be needed (Birch 1999), and because there isn’t research conducted using different varieties with young children, we are going to be testing the feasibility of this method over an exposure period of six weeks.

2.1.4 Environment, Availability and Accessibility

Environment, both physical (i.e. school or home) and social (i.e. peers, teachers, parents), plays an important role in determining a child’s food choices and dietary behaviors (Brug 2008). Social influences will be discussed in the next section, and the focus here will be on environmental influences including availability and accessibility. What foods are accessible and available in a person's environment are key determinants of what foods they consume. Limited access and availability to fruits and vegetables is considered a barrier to increasing consumption of healthful foods, even when the desire is present (Pollard 2002). This is especially true for young children because they have less autonomy over what they eat then older children and adults (Brug 2008). In a study conducted in 2005, Bere et.al aimed to identify predictors of future fruit and vegetable intake and whether future intake was predicted when controlling for intake in the past. They also looked at the changes in these predictors and if they were related to both future intake and change in intake over time. The study was conducted in Norway with 6th and 7th graders in a school setting. Both environmental (e.g. accessibility at home, accessibility at school, and modeling) and personal (e.g. intention, preferences, self-efficacy and awareness) factors as well as fruit and vegetable intake were measured using a validated questionnaire at baseline and follow-up. When looking at the cross-sectional correlates of fruit and vegetable intake, accessibility at home and preferences were most strongly correlated (Bere 2005). Changes in accessibility both at home and at school, and preferences correlated with changes in intake and explained some of the variance seen with follow-up intakes. The results indicate these factors as potential predictors of future fruit and vegetable intakes in children. It can be speculated that accessibility to fruits and vegetables is a key contributor of both preferences and actual intakes, and that higher levels of accessibility will be associated with higher preferences (Bere 2005).

Perceived access to fruits and vegetables in one's environment can also predict and influence food choices. Many studies have found that home availability of fruits and vegetables as reported by children is positively associated with child intakes of those foods (Rasmussen 2006). In 2009, Caldwell et al. investigated the association between community-level accessibility of fruits and vegetables and the change in consumption of fruits and vegetables of participants involved in a variety of community-based programs. Adult and youth participants completed surveys at the start and end of their program as well as at a 1-year follow-up. Measures included fruit and vegetable consumption and perceived access to fresh fruits and vegetables and assessments were conducted that looked at grocery store fruit and vegetable availability. The primary outcome measure was fruit and vegetable consumption. The results showed that the average number of fruits and vegetables eaten per week as well as the average number of fruit and vegetable servings per week significantly increased from the start of the program to the end and at follow-up. Greater perceived access to fruits and vegetables was associated with greater increases in fruit and vegetable consumption from the start of the program to the end, which reached statistical significance. There was also an association seen between grocery store availability of fruits and vegetables and an increase in consumption over time. Those participants with access to more varieties of produce in their grocery stores had higher increases in weekly fruit and vegetable servings. For this reason, we hypothesize that offering eight different vegetables in our study will result in a greater increase in willingness to try and greater consumption of these different vegetables within a classroom setting. It is also thought that exposing parents to different vegetables will increase their purchase of these vegetables and lead to increased exposure at home for themselves and their children.

2.1.5 Social and Parental Influences

Eating is social, particularly for children, and watching the eating behaviors of others can have an effect on the food choices children make for themselves (Brug 2008). Children are exposed to the eating behaviors in both the school and home environments. A large amount of a child’s time is spent at school and much of their food intake occurs here (Brug 2008). Observational learning, or modeling, in the school environment has been shown effective at increasing children’s fruit and vegetable consumption. Examples of models that have been shown to positively influence consumption include peers, mothers, unfamiliar adults, and teachers, among others (Lowe 2004). We are specifically interested in parent influences and literature indicates various ways in which parents can impact their child’s eating behaviors (Blanchette and Brug 2005, Rasmussen 2006, Reinaerts 2007, Busick 2008, Brug 2008, Vereecken 2010).

One important way that parents influence child consumption is by eating fruits and vegetables themselves. In a review by Rasmussen et al., eight out of nine papers showed a positive association between parent and child fruit and vegetable consumption. The aim of Reinaerts et al. in 2007 was to explain fruit and vegetable consumption in 4-12 year old Dutch children by looking at a variety of factors, including parental fruit and vegetable intake. They measured consumption using a validated questionnaire given to parents. Parental consumption was found to be correlated with child intake for both fruits and vegetables, showing that parents play an important part in shaping their children's dietary behaviors (Reinaerts 2007). Vereecken et al. also looked at parental consumption as well as parenting styles and parental feeding practices, which literature has also identified as predictors of child intake (Rasmussen 2006, Brug 2008). Specifically, eating behavior, general parenting styles (i.e. support, structure, positive discipline, psychological control and physical punishment) and parental feeding practices (i.e. verbal and physical strategies used to get preschoolers to eat, categorized into parent-centered and child-centered) were examined (Vereecken 2010). Participants were Belgian-Flemish children ages 2.5 to 3 years and their parents. Questionnaires were completed by parents that collected information on children's and parents' fruit and vegetable intakes, general parenting styles, parental feeding practices and child characteristics. They found that there was significantly higher consumption of fruits and vegetables among children who were less neophobic, with parents with a higher consumption of fruits and vegetables, and with parents who used more child-centered parenting practices. For child fruit consumption, parent's consumption had the most influence, and second was child food neophobia, which had a negative effect. For vegetable consumption, parent's consumption was second to child food neophobia. Finally, they found that specific parental feeding practices were more influential than general parenting style at predicting fruit and vegetable intake in children.

We will investigate parent food neophobia and exposure to novel vegetables and the effects they have on parental consumption and purchasing of vegetables for use and consumption at home. Food purchases determine what foods are available in the home for adults and children and affect child's willingness and consumption of vegetables. The findings of Busick et al. from their 2008 study indicate that the children of those parents who purchased the greatest amount of fruits and vegetables had increased exposure to these foods and were more willing to taste them.

Because of the well-established influence of parents on children's fruit and vegetable intake, it is important to include a parent-specific component in our study. Our aim by exposing parents to novel vegetables through our recipe-building activity is that the exposure will increase parents' willingness to try and consume as well as impact their intent to purchase and utilize more vegetables at home.

2.2 Theoretical Frameworks

2.2.1 Social Cognitive Theory

Learning theories have often been used in developing nutrition interventions (Resincow 1997, Reynolds 1999. Ma 2003, Gaines 2009). Albert Bandura's Social Cognitive Theory (SCT) is a framework often used when studying health behaviors as it, "offers both predictors and principles on how to inform, enable, guide, and motivate people to adapt habits that promote health" (Bandura, 2004) and has been used in studies that focus on fruit and vegetable intake in children (Gaines 2009). The SCT contains nine constructs that have been used in a variety of combinations in the literature. The constructs consist of environment, behavioral capacity, expectations, expectancies, self-control, observational learning, reinforcements, self-efficacy, and emotional coping. The constructs are defined in Table 1 as are their application in our study design.

2.2.2 Use of the SCT in Fruit and Vegetable Interventions

There have been some fruit and vegetable interventions that have utilized the SCT in their design. Perry et al. used the theory as the foundation for their '5-a-day Power Plus' program in St. Paul, Minnesota. The study was conducted in 20 elementary schools using 4^{th} and 5^{th} graders as their study participants. The SCT constructs incorporated were environment, behavioral capability, observational learning, reinforcement and self-efficacy. The program was comprised of 4 components: behavioral curricula, parent education and involvement, school food service changes and industry involvement and support. Skill-building and problem-solving activities were included as well as taste testing and snack preparation. Comic books served as role models for the children and prizes were used as incentives. Parental involvement was incorporated by using at-home information and activity packets. Data collection tools included 24-hour records and lunchroom observations by trained professionals, parent telephone surveys and health behavior questionnaires. Although conditions at home did not see significant changes (e.g. parent surveys, fruit and vegetable consumption), higher intakes of fruits and vegetables at lunchtime were seen in the intervention schools and positive health behavior changes (e.g. more usual daily servings of FV) were observed (Perry 1998).

Another study by Perry et al., ‘5-a-day Cafeteria Power Plus’ program, an extension of their previous ‘5-a-day Power Plus’ program also utilized the SCT. This intervention was targeting cafeteria-based changes in first through third graders in 26 Minnesota schools and incorporated the SCT constructs of environment, expectations, observational learning, reinforcement and self-efficacy. Their focus was on environmental versus personal factors influencing behavior. Daily activities that included increasing availability and attractiveness of fruits and vegetables were conducted. Food service staff verbally encouraged children to eat FV and praised them for doing so. Posters displaying FV characters served as role models. Children were able to sample FV in their cafeteria and a “challenge week” was also used to help increase consumption. The main outcome measure was fruit and vegetable consumption during lunchtime at school and was measured by observers recording intake and portion sizes. Intakes of fruit and vegetables (no potatoes), fruit and vegetables (no potatoes, no juice) and fruit (no juice) were significantly higher in the intervention schools compared with the controls (Perry 2004).

2.2.3 Current Application of the SCT

Our study utilizes the environment behavioral capacity, expectations, expectancies, observational learning, reinforcement and self-efficacy constructs. These constructs and how they are applied in the current study are shown in Table 2 and will be discussed one-by-one below.

We have applied the first construct listed, ‘environment’, defined as the physically external factors, in that we have increased the availability and accessibility of vegetables in the Head Start setting during our program and aim to makes changes to Head Start menus as well.

The second construct, behavioral capacity, is the skill to perform a behavior and is applied here through participation in sensory-based exploration activities which will lead to the ability to identify vegetables by name and other descriptors such as color, shape, size, and texture.

Expectations, construct three, are the anticipated outcomes of a behavior. Here taste testing occurred which was used along with our sensory-based exploration of vegetables to increase children’s willingness to try and consumption of vegetables and have a positive effect on children’s food neophobia. We expected that parent exposure to our recipe building has a positive effect on their intent to purchase, prepare and consume these same vegetable varieties.

Construct four, expectancies are those values that are placed on the given outcomes described above and applies to the children by highlighting the appealing taste of the vegetables as well as giving knowledge about where and how the foods and their different varieties are grown. Parents were given hand-outs that provide information regarding storing, cooking and buying as well as local availability and recipes.

Observational learning (our fifth construct) occurred by watching the behaviors of program facilitators, teachers and peers within the classroom setting during sensory exploration (children) and recipe building (parents) activities.

Reinforcements (construct six) was given to both children and parents to increase desired behaviors (i.e. increased willingness, preference and consumption; intent to purchase, prepare and consume) and their recurrence. Children were verbally praised for trying the vegetables during tasting and parents were offered a variety of incentives during the family night. Self-efficacy (construct seven) was achieved through participation in activities and trying the target vegetables.

Reciprocal determinism, the final construct listed in Table 2, is another important concept in the SCT. It is the “constant interaction …among the characteristics of a person, their behaviors, and their environment” (Gaines 2009). As mentioned previously, certain factors affect a person’s intake of specific foods. Some key influences of a child’s fruit and vegetable consumption include preferences and liking, exposure, availability and accessibility, self-efficacy and parent and peer influences. These personal and environmental factors are shown in Figure 1, adapted from Pajares, 2002 and Gaines and Turner, 2009.

Figure 1. Application of the Social Cognitive Theory (adapted from Gaines 2009 and Pajares 2002) to the Mass Farm Fresh Research Project

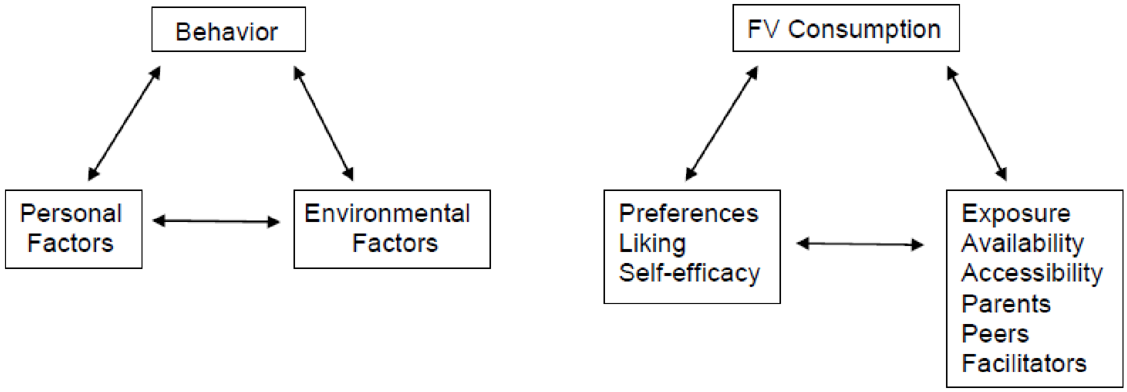


Table 2. Social Cognitive Theory Constructs (Gaines 2009) and Applications in the Mass Farm Fresh Research Project

Concept	Description	Application for Increasing Fruits and Vegetables in children
1. Environment	Factors that are external to the person	Increasing availability and accessibility in the classroom as well as incorporation of vegetables into Head Start menus; exposure to novel vegetable varieties
2. Behavioral Capability	Skill to perform a behavior	Participation in sensory-based exploration activities; describing vegetables by name, color, shape, texture, growth
3. Expectations	Anticipatory outcomes of a behavior	Taste testing; sensory exploration using 2 intervention approaches to increase willingness to try and consumption of target vegetables and have positive effect of food neophobia; parent exposure to recipe building activities increases their intent to purchase, prepare and consume vegetables and lessen food neophobia

4. Expectancies	Values placed on a given outcome	Highlighting sensory properties of vegetables; increasing knowledge of locality, growing of vegetables; parents provided with information regarding growing and facts about each vegetable, recipes, cooking and storing tips, local availability
5. Observational Learning	Acquired behaviors from observing the behaviors of others and outcomes of those behaviors	Facilitators, serve as role models during facilitator-guided exploration; peers were present during sensory exploration
6. Reinforcements	Responses to a person’s behaviors that increase or decrease the likelihood of recurrence	Parents offered recipes and take-home ingredient bags, encouraging incorporation of vegetables into family meals at home; children received verbal praise after trying vegetable
7. Self-Efficacy	Confidence in performing a behavior	Trying different vegetables gave confidence to try other novel foods and vegetables; parents gained cooking/preparation skills and knowledge of novel vegetable varieties which gives confidence to prepare more vegetables at home
8. Reciprocal Determinism	Dynamic interaction of a person, behavior and environment in which a behavior is performed	New skills and availability of vegetables as snacks in the classroom increases willingness to try and consumption of more vegetables

2.2.4 Transtheoretical Model: Stages of Change

The transtheoretical model (TTM) came about after research conducted by James Prochaska and colleges in the early 1980s. It is a model of behavioral change, more specifically intentional change (Prochaska, 1998). The model itself contains core constructs that include Stages of Change, Processes of Change, Decisional Balance and Self-Efficacy. Our focus will be with Stages of Change. Under this core concept are 6 more specific constructs listed and briefly described in Table 3, although much of the literature sites the use of only the first five stages (Ma 2003, Spencer 2007, Hildebrand 2009). The precontemplation stage is characterized by having no intention of change within the next six months. Those falling into this group may either have tried unsuccessfully to change in the past, are not well-informed about the behavior changes that need to be made, or are not yet ready to make the change. The contemplation stage describes those who are ready to make a change within the next six months. They are not ready for an immediate change and frequently weigh the pros and cons of the behavior change of interest. Those in the preparation stage have the intention to take action within thirty days, have a plan, and have even begun making some changes to their behavior. Those in the action stage have been making behavior changes for a period of less than six months, and those in the maintenance stage have been making changes for more than six months.

Table 3. Stages of Change constructs (Prochaska et al, 2008)

Precontemplation	No intention to take action within the next 6 months
Contemplation	Intends to take action within the next 6 months
Preparation	Intends to take action within the next 30 days and has taken some behavioral steps in this direction
Action	Changed overt behavior for less than 6 months
Maintenance	Changed overt behavior for more than 6 months
Termination	No temptation to relapse and 100% confidence

As demonstrated in the stages listed, the TTM sees change not as one distinct event or moment but instead a process (Prochaska 2008). A person does not necessarily progress through the stages in a linear manner, and can advance two or more stages as well as regress back to an earlier stage.

2.2.5 Use of the Transtheoretical Model in Recent Research

Spencer et al. conducted a review of the literature that focused on the application of the Transtheoretical Model to dietary behaviors. The review assessed population-based, intervention and validation studies, 64 in total. Of the 21 population studies reviewed, nine included fruit and vegetable intake assessments. Overall, there was greater consistency in the application of stages of change, something that was not seen in earlier reviews (Spencer 2007), and this was attributed to the focus on foods rather nutrients in study investigations. In light of the success of the model use, assessment tools and strategies among the studies did vary. Of the 25 intervention studies, 7 focused on fruit and vegetable assessment and 19 of the 25 supported the use of the stages of change model.

In 2009, the aim of Hildebrand and Betts's study was to "use the Transtheoretical Model of Behavior Change to assess the proportionate stage of change of low-income parents and primary caregivers of preschool-aged children for increasing FV accessibility to their young children". They also looked at decisional balance, self-efficacy and the use of processes of change. Study participants included low-income parents and primary caregivers (PPC) of preschool children between the ages of 1 and 5. PPC were also enrolled in a federally funded nutrition program such as WIC (Women, Infants and Children), EFNEP (Expanded Food and Nutrition Education Program), and FSNEP (Food Stamp Nutrition Education Program). Survey instruments served as data collection tools and measures included: demographics; intention to serve fruits and vegetables; pros and cons, which measured decisional balance; confidence, which measured self-efficacy; strategies for serving more fruits and vegetables, which measured processes of change; and FVFQ, fruit and vegetable frequency questionnaire, which measured intake. Overall, the results showed that the parents fell into different stages of change and those results were collapsed into three categories. 43% were in the precontemplation/contemplation (P/C) stage, 29% in the preparation (P) stage and 28% in the action/maintenance (A/M) stage. Those parents in A/M stage served significantly more fruits and vegetables to their children than did those in the P/C stage. Those in the A/M and P stages used more cognitive processes (e.g. role-model eating FV and consciousness raising) and behavioral processes (e.g. countering and stimulus control) than did those parents in the P/C stage. Parents in the A/M scored higher on the pro decisional balance scale and those in the P/C stage scored higher on the con scale. Finally, self-efficacy was lowest in the P/C stage and increased through the stages.

Investigation into parents' current stage of change is also of our interest since parental intake and availability/accessibility of FV at home are both such important determinants of child FV consumption and have shown strong correlations in the literature (Bere 2005, Reinaerts 2007). In our study, we determine parents' current stage of change. We determined this by assessing their intent to increase the number of servings of vegetables at home using a survey during our parent night. We also assessed their intent to purchase, prepare and consume vegetables at home by tallying the number of parents took home vegetable bags and other resources after recipe demonstrations. Although we will not be able to measure long-term changes, we are able to test the feasibility of the parent component through short-term effects. It is to be noted that the data from the parent events will be presented in future work and are not included in this thesis.

CHAPTER 3

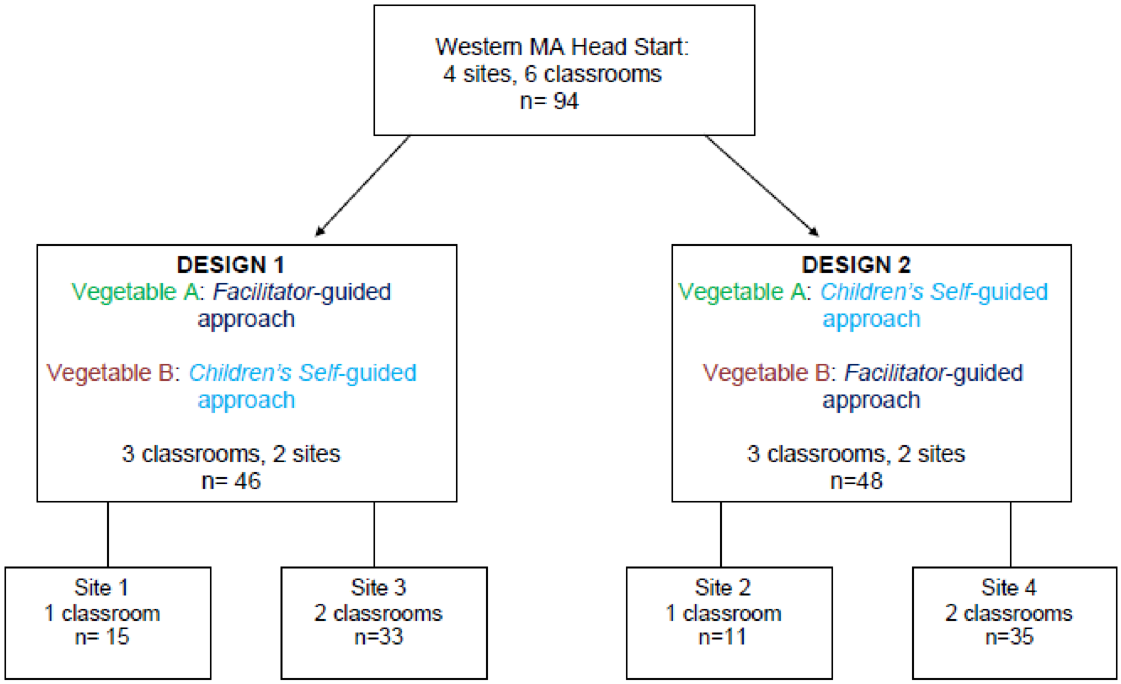
METHODS AND MATERIALS

3.1 Study Design

Our nutrition intervention took place over a total period of seven weeks, which included a baseline (week one), intervention weeks (weeks two-five) and follow-up assessment week (week six). The classroom components were followed by a post intervention parent night (week seven). The parent component also took place at the respective Head Start site but included only the parents of the children enrolled and were scheduled during each site's monthly parent meeting. The program occurred during the Fall of 2011, beginning the third week of September 2011 and lasting through the first week of November 2011. The parent nights occurred as a follow-up of the classroom component, during the month of December 2011.

Our approach used a combination of facilitator-guided and self-guided (by child) sensory-based exploration of 8 vegetables. The 8 vegetables were presented in 4 pairs (green beans-snap pea pods, carrots-parsnips, beets-radishes, broccoli-cauliflower), one pair during each of the four intervention weeks. Figure 2 shows the study design used for the classroom component.

Figure 2. Classroom Study Design for Child Component



3.2 Subjects

IRB consent was obtained from University of Massachusetts Human Subjects Participation in research and parental informed consent obtained for all children. Ninety-four children were recruited from three Head Start sites in Western Massachusetts. Each site consisted of one or two pre-school classrooms with an average of 14 children per classroom. The children ranged in age from 2.9 years to 5.0 years. Because the intervention was done within the classroom, we did not randomize the children into experimental and control groups.

3.3 Site Selection

Sites were selected based on recommendations from the Head Start nutritionist. These recommendations were based on the identified need of the Head Start sites for a nutrition education program emphasizing vegetable exposure. Sites were also chosen to represent diverse groups of children and were matched for classroom size to ensure that the two groups were equal for data analysis. . Site selection was also based on the power analysis conducted through the Mass Farm Fresh (larger research project) through which estimates were derived for a sufficient sample size to test the research hypotheses proposed in the study for Aims #1 and #2.

3.4 Target Vegetables

The eight target vegetables selected for the study include: sugar snap peas, green beans, carrots, parsnip, beets, radishes, broccoli and cauliflower. Vegetables for the study were selected first based on their availability year round in grocery stores, so that families were able to access these vegetables easily and at reasonable costs. All eight vegetables are able to be grown in Massachusetts, and can also be purchased seasonally at most farmers markets. This is in conjunction with the local theme of the Massachusetts Farm Fresh project. The vegetables were paired during the intervention weeks as follows: snap peas-green beans, carrots-parsnip, beets-radishes, and broccoli-cauliflower. The pairings were based on similarities in shape, texture, and growth pattern. The characteristics of each vegetable, including sensory and growth properties, are listed in Table 4.

Table 4. Sensory and Growth Properties of the Target Vegetables

Vegetable	Sensory Properties	Growth Properties
Snap Peas	• Sweet tasting; higher sugar content (with pod: 4g per 100g, without pod: 5.67g per 100g)[a] • Green color • Pod-shaped • Waxy texture on outside with softer peas inside	• Grow on a vine • Considered a pole plant • Peas grow in pods
Green Beans	• Less-sweet tasting; lower sugar content (3.26g per 100g)[a] • Green color • Pod-shaped • Waxy texture on outside with softer beans inside	• Grow on a vine • Considered a pole plant • Beans grow in pods
Carrots	• Sweet tasting; higher sugar content (4.26g per 100g)[a] • Orange color • Long and tapered, conical shape • Rough texture on outside, smoother and slippery on inside, crunchy	• Growth underground • Considered a root vegetable • Grow individually (versus in a bunch)
Parsnip	• Sweet-tasting; higher sugar content (4.80g per 100g)[a] • White color • Long and tapered, conical shape • Rough texture on outside, smoother on inside, crunchy	• Growth underground • Considered a root vegetable • Grow individually (versus in a bunch)
Beets	• Sweet tasting; higher sugar content (6.76g per 100g)[a] • Red color • Round, globe-shaped • Rough outer skin, with wet smooth texture inside, crunchy	• Growth underground • Considered a root vegetable • Grow individually (versus in a bunch)
Radishes	• Less-sweet tasting; lower sugar content (1.86g per 100g)[a] • Red color • Round, globe-shaped • Rough outer skin with wet texture inside, crunchy	• Growth underground • Considered a root vegetable • Grow individually (versus in a bunch)
Broccoli	• Less-sweet tasting; lower sugar content (1.70g per 100g)[a] • Green color • Tree-shaped	• Grow aboveground • Florets grow on a thick stalk • Considered the “flower”

	• Rough texture on top of florets, smooth stalk	of the plant
Cauliflower	• Less-sweet tasting; lower sugar content (1.91g per 100g)[a] • White color • Tree-shaped • Rough, bumpy texture on top of florets with smooth stalk	• Grow aboveground • Florets grow surrounded by large, green leaves • Considered the "flower" of the plant

[a] Sugar content for each vegetable obtained from USDA National Nutrient Database

3.5 Assessment Instruments

3.5.1 Willingness Rating Scale (WRS)

Children's willingness to try each of the eight target vegetables was be measured using a Willingness Rating Scale (WRS) The WRS scale has been adapted from a version used in similar work with Head Start preschool children by Kannan et al (2011). The scale used by Kannan et al (2011) was adapted from Johnson (2007). As shown in the Appendix, the WRS is a 5 category rating scale. The first rating categorizes the child as "no engagement" (given a rating of 0) and the final rating (of 4) categorizes the child as "swallowed one or more bites". The remaining ratings include "examined (looked, touched, smelled)", "licked only", and "spit out", and were used for assessing the children's extent of willingness to try for each vegetable. .

During the baseline and follow-up assessments and during the four intervention weeks, each child's name was written on the rating scale and an "X" was be used to signify the rating documented by trained nutrition student observers present in the Head Start classrooms. A copy of the WRS is accessible in Appendix.

3.5.2 Recorded Weights Form

All vegetables were washed, peeled (except for green beans and sugar snap peas), and chopped. Vegetables were weighed on a calibrated Denver Instrument digital scale measuring to one decimal point. A clean paper bowl was used on the scales for all weighing. Pre- and post-weights for all eight vegetables were documented by trained student research assistants, using a Recorded Weights Form, located in the Appendix. Post-weights were collected after return from the lesson implementation and documented on the same recorded weights form used for pre-weights. The students involved in the vegetable preparation and weighing wore surgical grade gloves at all times.

A MAFF pre-post weight form containing all children's names per classroom was used for to record the consumption data for each vegetable for each of the 6 weeks (including baseline, intervention and follow-up). Consumption of each vegetable was calculated in gram amounts using the equation: pre-weight (g) – post-weight (g) = consumption in grams.

3.5.3 Sensory Exploration Chart

During the sensory exploration classroom activities (described in detail in the Procedures section), trained student observers filled out a Sensory Exploration Chart. On the chart, observers wrote down children's responses to the questions asked during the sensory-guided segments (facilitator-guided and self-guided) of the intervention lesson plans. The chart included space for observers to write the classroom responses that related to the five senses (see, touch, hear, smell, taste) for the two vegetables during each lesson. A copy of the chart is in the Appendix.

3.5.4 Parent Surveys

Upon arrival at the parent night, at their respective Head Start site, each parent was provided a small packet of surveys. The questions on the surveys pertained to the following items: food neophobia for self as well as their child's food neophobia, assessed using 9 statements on each of the Child Food Neophobia Scale (CFNS) (Pliner 1994) and Adult Food Neophobia Scale (AFNS) (Pliner, 1994) ; confidence and willingness of the parent to prepare and serve the different vegetables featured in the classrooms and parent night event at home; the frequency of child consumption of each of the eight vegetables at home; and preparation method used for each of the eight target vegetables.

3.5.5 Parental Intent to Purchase and Use the Vegetables

To determine parent's intent to purchase and use the vegetable varieties at home in meals, the take-home vegetables (all eight vegetables were provided at the event) picked up by the parents at the end of the parent event were used as proxy indicators. In order to track what vegetables were taken by each family, this information was recorded by a trained student using a checklist of the vegetables after asking parents what vegetables were taken. We also counted and recorded the number of other resources taken by parents. Collectively, these take-home resources served as a proxy for parent's intent to purchase and use the vegetables featured in both the classroom setting and the family event. This approach for evaluating parent intent needs to be validated in future work.

3.6 Procedure

3.6.1 Child Component

An informed consent letter was sent home to the parents of each child to obtain permission for their child to participate in the classroom sensory-based program. The informed consent provided the study purpose, procedure and duration of the study. The consent document described what their child will experience during classroom participation on a weekly basis for all six weeks and at the three month follow-up (data not included here), data collection time points and procedures, and the risks, benefits, confidentiality and incentives provided to families for their participation in the MAFF family event. Child gender data were obtained during classroom visits. Children's ages and race and ethnicity information are being collected from the Head Start families and will be incorporated in future analysis. All children were pre-screened for ongoing food allergies by the Head Start Nutritionist.

3.6.1.1 Preparation of Vegetables for Baseline and Follow-up Assessments

Prior to the launch of the study, students underwent extensive training for vegetable preparation and weighing using standardized procedures. Students prepared and weighed the vegetables for their respective sites the evening prior to their site visit. Vegetables were bought at a local market and washed thoroughly. Students wore surgical grade gloves at all times when handling any vegetables. Carrots, parsnips and beets were all peeled after washing. Both carrots and parsnips were then sliced into circular coin-shapes for presentation to the children during the tasting. When the circles were very large, they were cut in half and presented as half circles. The very ends were not used when very tapered as the pieces would have been too small. Because the beets were much larger in diameter, they were cut into triangular pie-shaped pieces for presentation during the tasting. For radishes, the ends were cut off and they were sliced into circular coins. As with carrots and parsnips, those radishes that were larger in diameter were cut in half (to form half circles). Those vegetables that were sliced (carrots, parsnip, beets and radishes) were sliced to no more than 2mm thickness. For broccoli and cauliflower, small florets were cut from the larger stalks of the whole vegetable. Florets were no more than 2 inches tall by about 1-2 inches wide. The ends of both the green beans and snap pea pods were cut off. Green beans were cut into three pieces, with each piece being about 1-1.5 inches long. For the snap peas, pods were opened up to reveal the peas inside. Pods were cut so that each piece contained 2-3 peas each. Pods that did not have any peas attached were not used. All plastic bags and disposable paper bowls were labeled separately in a customized fashion with the child's first name (and last initial only if a classroom had two children with the same name) and site and classroom.

A calibrated Denver Instrument digital scale with a one-decimal-point measure was used for weighing. A blank bowl (no name/site/classroom) was used on the scale to ensure proper sanitation of the vegetables. Each vegetable was weighed out separately and placed in each child's bag for every lesson. A trained student research assistant recorded the pre-weight for each child using a Recorded Weights Form Three "extra" bags were also sent to each classroom in case there were any newly enrolled children that were not on our rosters which we had received from the Head Start Nutritionist at the beginning of our study. Once all of the weighing was completed, vegetable bags were stored in a refrigerator until leaving for the site the following morning. Vegetable preparation and weighing was done using similar standardized procedures during the follow-up week.

During baseline, and follow-up, each child received 7.0 grams (+/- 0.1 g) of each of the eight vegetables, for a total weight of approximately 56.0 grams per serving for all eight vegetables together. A typical serving size is approximately 1 ounce, or 28 grams. Because baseline and follow-up assessments included all 8 vegetables, a total of 28 grams per serving would not provide enough of each vegetable (only 3.5 grams per vegetable). It was therefore decided that 2 ounces, or 56 grams, would be a suitable serving size for baseline and follow-up time points.

3.6.1.2 Preparation of Vegetables for the Sensory Exploration and Tasting during Intervention Weeks

During the intervention weeks, vegetables were bought and prepared using the same standardized procedures as during baseline and follow-up as described above. Vegetables were presented in pairs during the intervention weeks (green bean-snap pea pod, carrot-parsnip, beet-radish, broccoli-cauliflower). Because only two vegetables were served during each tasting, the children received 14.0 grams (+/- 0.1 g) of each of the 2 vegetables for a total serving size of approximately 28.0 grams.

During the intervention weeks, children also explored the two vegetables highlighted during the sensory exploration lesson. Vegetables were prepared for the exploration the evening prior, using standardized procedures. The vegetables were washed and cut into equal pieces- one piece for each child. For snap peas and green beans, the children were given one whole pod. Carrots and parsnip were given to the children as sticks, unpeeled (so the children could see and feel the inside and outside of the vegetables). For beets and radishes, children were given one (cross-sectional) slice of each vegetable, unpeeled. Broccoli and cauliflower were given as florets to each child. These vegetables were not weighed, but were put in a separately labeled bag for the sensory exploration portion of the lesson. There was a separate bag for each vegetable for each classroom (a total of 4 bags, 2 bags per classroom). These vegetables were also refrigerated until transport to the site the following morning.

3.6.1.3 Classroom Implementation

The child focused classroom nutrition education intervention component took place in six pre-school classrooms within three Head Start sites in Western Massachusetts between September 2011 and November 2011. The sensory-based exposure and exploration activities occurred during each classroom’s circle time in the morning. Two classrooms were visited per day on Tuesday, Thursday and Friday during the baseline, intervention and follow-up weeks. The classroom facilitator was a University of Massachusetts (UMASS) Amherst graduate or undergraduate student trained in the implementation of the classroom component. In addition to the facilitator, there were also 2-3 observers, also trained UMASS student observers, in each classroom.

3.6.1.3.1 Baseline and Follow-up Lessons

Student teams arrived to their respect site 15 minutes prior to the lesson start time to set up. Upon arrival in each classroom, facilitators set up tasting bowls, matching up each child's bowl with their respective baggie containing the 8 vegetables. During both baseline and follow-up, teachers helped putting nametags on each child for identification purposes and 2 video cameras were set up on either side around the circle where the children were seated such that all children were in the camera view for obtaining sensory exploration data from the children. At baseline, no formal lesson was conducted prior to tasting. At follow-up, children participated in a passport activity. Each child was given a 1-page sheet containing a picture of each of the eight target vegetables. The facilitator gave children a sticker one at a time and the children were asked to place the sticker on its matching picture. Each sticker was different in order to represent the 8 vegetables (ex. green round sticker represented peas, green rectangle sticker represented green bean, orange round sticker represented carrot, orange rectangle represented parsnip, etc.).

Tasting bowls were passed out to each child, carefully matching the name on each bowl with each child's nametag. Children were told that they could "eat as much as they wanted of their vegetables". Facilitators and classroom teachers had a list of "standardized phrases" (ex. what vegetables did you try? what vegetables did you like?) for these lessons so as to not affect willingness or consumption with encouraging or rewarding phrases. Each child received approximately 56 grams in their tasting bowl, 7.0 grams (+/- 0.1 g) of each of the eight vegetables. They were given about 10 minutes to taste the vegetables. After the tasting period was up, the bowls were collected from each child and carefully matched with and put into their labeled baggie for transportation back to campus. Children were observed during the tasting using the Willingness Rating Scale. Because a full lesson was not conducted during baseline and follow-up, total time in each classroom was approximately 15-20 minutes.

3.6.1.3.2 Intervention Lessons

During the four intervention weeks, the total time in the classroom was 30 minutes: 20 minutes allotted for the sensory exploration activities (showing poster of growth cycle and whole vegetable props; use of magnifying glasses for visual exploration; breaking the vegetables and hearing what sound they makes; smelling the vegetables, describing what the vegetables feel like) and 10 minutes for tasting and data collection via Willingness Rating Scales and Sensory Vegetable Charts.

As with baseline and follow-up, student teams arrived at each site 15 minutes prior to the start of the lesson. Upon arrival the facilitators set-up lesson materials (vegetable props, growing cycle poster, vegetables for sensory exploration, magnifying glasses) and tasting bowls (as described above). Video cameras were set up on either side of the circle where the children would be sitting during the lesson as teachers put nametags on all of the children. Once all of the children were seated in the circle, the lesson began. A script was made for each lesson and memorized prior to classroom implementation.

Three classrooms (classroom A (n=15) and classroom B (n=16) (n=13)) receive facilitator-guided sensory exploration of vegetable A (ex. green bean) and self-guided sensory exploration of vegetable B (ex. pea pod) while the remaining three classrooms (classroom A (n=17) and classroom B (n=16) (n=11)) receive facilitator-guided children's sensory exploration of vegetable B (ex. pea pod) and child-self-guided sensory exploration of vegetable A (ex. green bean). Table 5 shows the lesson format for each classroom over the 4-week intervention period.

During the facilitator-guided sensory-based exploration, each child was given the first of the two vegetables of the day (vegetable A, or green bean using example above), and the student facilitator leading the lesson plan used a standardized series of sensory-based questions and prompts (e.g. what color is the vegetable? what does the vegetable smell like? use your magnifying glass to make the vegetable bigger, like this. touch the vegetable with your fingers. what does it feel like? break the vegetable apart. what does it sound like when you break it?) that guided the children through their exploration of that first vegetable for that lesson. The facilitator-guided segment lasted approximately 5 minutes.

During the child self-guided sensory exploration, which always followed the facilitator-guided segment for that day, the children were given the second vegetable of the day (vegetable B, or pea pod using example from above), and were allowed to explore the vegetable on their own, using their multiple senses. While the children explored the vegetable on their own (without the same guiding questions), there were a few background questions comparing the two vegetables (e.g. is this vegetable the same as the first vegetable? how is it the same? how is it different?) to help encourage the young children to actually explore the vegetable on their own. The self-guided segment also lasted about 5 minutes.

All other components of the lesson plans were the same across all classrooms. Each child had their own passport labeled with their first name. The passport activity asked the children to identify each of the two vegetables of the day by placing a colored and shaped sticker (i.e. green circle, green rectangle) on a picture of the respective vegetable in the passport. The five senses were introduced to the children by pointing out the body parts with which we use our senses (i.e. nose for smelling, eyes for seeing), and a “5 Senses Song” was sung. The growth cycle of each vegetable was explained using a poster with pictures showing the growth progression. During the entire sensory-based exploration portion of the lesson plans (facilitator- and self-guided), each child was given a magnifying glass to use to enhance their visual examination of the vegetables. Table 6 contains a brief description of all lesson materials. All lessons were videotaped using digital video cameras.

Table 5. Classroom Lesson Format

Classroom	Intervention Week 1	Intervention Week 2	Intervention Week 3	Intervention Week 4
Site 1	Facilitator-guided: GREEN BEAN Self-guided: SNAP PEA POD	Facilitator-guided: CARROT Self-guided: PARSNIP	Facilitator-guided: RADISH Self-guided: BEET	Facilitator-guided: BROCCOLI Self-guided: CAULIFLOWER
Site 2	Facilitator-guided: SNAP PEA POD Self-guided: GREEN BEAN	Facilitator-guided: PARSNIP Self-guided: CARROT	Facilitator-guided: BEET Self-guided: RADISH	Facilitator-guided: CAULIFLOWER Self-guided: BROCCOLI
Site 3 Classroom A	Facilitator-guided: GREEN BEAN Self-guided: SNAP PEA POD	Facilitator-guided: CARROT Self-guided: PARSNIP	Facilitator-guided: RADISH Self-guided: BEET	Facilitator-guided: BROCCOLI Self-guided: CAULIFLOWER
Site 3 Classroom B	Facilitator-guided: GREEN BEAN Self-guided: SNAP PEA POD	Facilitator-guided: CARROT Self-guided: PARSNIP	Facilitator-guided: RADISH Self-guided: BEET	Facilitator-guided: BROCCOLI Self-guided: CAULIFLOWER
Site 4 Classroom A	Facilitator-guided: SNAP PEA POD Self-guided: GREEN BEAN	Facilitator-guided: PARSNIP Self-guided: CARROT	Facilitator-guided: BEET Self-guided: RADISH	Facilitator-guided: CAULIFLOWER Self-guided: BROCCOLI
Site 4 Classroom B	Facilitator-guided:	Facilitator-guided:	Facilitator-guided: BEET	Facilitator-guided:

	SNAP PEA POD Self-guided: GREEN BEAN	PARSNIP Self-guided: CARROT	Self-guided: RADISH	CAULIFLOWER Self-guided: BROCCOLI

During the tasting portion of the lesson (which always followed the sensory-exploration activities), all classrooms were offered both of the vegetables discussed during the day's lesson in a tasting bowl. All of the vegetables were pre-cut, pre-weighed and labeled with each child's name prior to arrival at the site. The children received a total of 28 grams (14 grams of each of the 2 vegetables) in their bowl. The sample bowls were passed out to each child by carefully matching the name on the bowl with the child's nametag. The children were told that they "will now be able to taste the vegetables that they had just explored", and that they "can eat as much of the vegetables as they like". The tasting period lasted no longer than 10 minutes due to time constraints. Lessons were kept within a 30 minute timeframe, per the request of Head Start Nutritionist and teachers. Children were observed using both Willingness Rating Scales and a Sensory Exploration Chart.

Table 6. Description of Classroom Lesson Materials

Name of Lesson Material	Description of Material and Procedure Used	Purpose of Material
Passport and Stickers	Each child had a passport book with their first name on the cover. During each intervention lesson, passports were handed out. The children opened the passport to the 4 pages (containing one picture of each of the eight vegetables on the pages) for	Identification of vegetables by children prior to exposure and exploration

	that lesson. The children were given 2 stickers, one at a time, and asked to put the sticker (ex. green rectangle) on the appropriate vegetable (ex. green bean).	
Song	Before singing, the children were asked what body part is used for each of the 5 senses, one by one (ex. What do we use to see? What do we use to smell? etc). “5 senses, 5 senses We have them, we have them Seeing, hearing, touching Tasting, smelling There are 5, there are 5” Song was sung by facilitators first, then children were encouraged to sing along with facilitators while pointing to respective body parts (eyes, ears, fingers, mouth, nose)	Introduction to the 5 senses and how we use them
Poster	A poster was made for each of the eight vegetables during the intervention weeks. Each poster was individualized for each of the 8 vegetables and depicted (using hand-drawn pictures) the growth cycle of each vegetable, from a seed, to a plant to a vegetable ready for harvest.	Explanation of vegetable growth cycle, from seed to harvest.
Vegetable Props	During first the facilitator-guided (FG) and then self-guided (SG) exploration, children were given a piece of each vegetable to explore with either guided prompting phrases and questions (FG) or background questions (SG)	Sensory exploration using 4 of the 5 senses (sight, smell, touch, sound)
Magnifying Glasses	During the entire sensory exploration portion of each lesson (FG and SG segments) children were given magnifying glasses. Children were shown how to use them to view the vegetables.	Enhancement of visual exploration

3.6.2 Parent Component

The parent component took place after the classroom follow-up. One parent night per site was scheduled in the evening during each site's monthly parent meeting. As parents arrived to the event, they were given a clipboard and a series of forms to fill out, including the child and parent neophobia scales mentioned above, a parent entrance survey, a video release form and a demographic survey. Once all of the parents arrived and filled out their paperwork, an overview of the classroom component was given to the parents as an introduction. Next, in 3-4 groups, parents participated in a recipe-building activity. They were given a sample of each of the 8 target vegetables from the classroom component, a recipe and some kitchen tools (i.e. cutting board, grater, peeler, knife). The parents were given about 10 minutes to prepare the recipe, using any of the vegetables of their choice. Each group was able to then sample the recipe they prepared. The parents then had a meal provided to them that included all 8 vegetables in one of the three dishes. The recipes for the parent meal and recipe-building activity were adapted from SNAP-Ed Recipe Finder (USDA). Finally, the parents completed an exit survey before picking up take-home materials (information packets, gift cards, vegetable bags).

3.6.2.1 Parent Night Event Materials

3.6.2.1.1 Vegetable Bags and Intent Forms

For each of the eight target vegetables (green beans, pea pods, carrots, parsnip, beets, radishes, broccoli, cauliflower), a take-home bag was available at the parent night event. At the conclusion of the recipe building activity at the end of the parent night event, parents (X# parents x 8 vegetables = X# bags) were encouraged to pick up the vegetable bag(s) of their preference. Upon departure from the event, a trained student used a form tracking which of the 8 vegetables each parent took home.

3.6.2.1.2 Other Resources

There were other materials available for parents to pick up at the end of the parent event. A packet was provided highlighting the 8 target vegetables. One handout was prepared for each vegetable and included: where locally and when each vegetable can be purchased; storing tips for each vegetable including procedure for storing and information on shelf-life; fun facts about each vegetable, including a brief history of its origin and nutritional information; and two recipes per vegetable. Information was obtained from “Fruits and Vegetables, More Matters: Fruit and Vegetable of the Month”(CDC) and recipes were adapted from either SNAP-Ed Recipe Finder (USDA) or from “Fruits and Vegetables, More Matters: Fruit and Vegetable of the Month” (CDC). The packet also included information about nutrients related to child-nutrition and tips on getting children to eat more vegetables.

3.7 Data Collection

Informed consent forms were sent home to the parents (detailed above). Demographic data of both the parent(s) and child (child age, gender and ethnicity, family education level and household income) were obtained from the Head Start Nutritionist.

3.7.1 Classroom Component

3.7.1.1 Children's Willingness to Try Vegetables during Baseline, Intervention and Follow-up

Willingness to try the target vegetables was observed during the tasting portion of the baseline and follow-up visits (no formal lesson during these 2 weeks), and the tasting activity during the intervention weeks' lessons. Trained student observers assessed Willingness to Try using the Willingness Rating Scale (WRS). Each child's name was written on the forms. During observations, observers checked off all ratings that applied to each child (e.g. if child smelled and then licked a vegetable, the observer would check off ratings for both "examined (looked/touched/smelled)" and "licked only"). Vegetables were listed on the WRS prior to site arrival, and only those vegetables that would be tried were listed (i.e. all 8 vegetables were listed during baseline and follow-up and vegetable pairs during each intervention week).

3.7.1.2 Assessment of Children's Consumption of Vegetables during Baseline, Intervention and Follow-up

Child consumption was measured during the tasting portion of the lesson. For baseline and follow-up, there was not a formal lesson. During the intervention weeks, the tasting activity was done last, following sensory-exploration (FG and SG) segments. Paper bowls with pre-cut and pre-weighed portions (weighing 28 grams of vegetable per bowl during intervention, 56 grams per bowl during baseline and follow-up) were labeled with each child's name, site and classroom. The children were given their respective bowls and prompted by the facilitator to eat as much of the vegetables as they liked. The children were observed by the UMASS nutrition student facilitators in the classrooms as well as by teachers to ensure that each child was eating only his/her own sample and that no food was dropped or thrown away. Tasting activities lasted approximately 10 minutes. These sessions were videotaped with the intention of being able to reference and use to confirm what was recorded by the classroom observers. Videotaping has been used in other research studying children's eating behaviors (Addessi 2005, Houston-Price 2009). At the end of the tasting session, the sample bowls were recollected by student observers/facilitators, put back into the child's labeled bag and then transported to campus. Members of the student team re-weighed all vegetables separately to obtain post-weights. A recorder assisted the student weighing the vegetables and recorded post-weights on the same Recorded Weights Form used for pre-weights. Cup weights have also been used in previous interventions that have studied child consumption of fruits and vegetables with children 4-11 years old (Horne 2004, Lowe 2004).

3.7.2 Parent Component

Parent intent to purchase the unfamiliar vegetable varieties and prepare them at home was determined by taking a count of how many vegetable bags and resources have been taken home by the parents. Both child and parent food neophobia scores will be obtained from the scales completed by those parents who attended the parent night. Self-efficacy will be assessed by looking at responses to questions on the parent entrance and exit surveys.

3.8 Description of Variables

3.8.1 Outcome Variables

The two outcome variables in our study include willingness and consumption. Children’s willingness is defined as their inclination to explore and try the vegetables presented to them. We use a 5-point rating scale to assess willingness. The ratings on the scale increase with increased willingness, and we interpret a rating of 3 (spit out) as a child being more willing to try the vegetables than a rating of 2 (licked only) and so we are assessing children’s maximum willingness during the tasting. In other words, we are interested in what the children are “most willing” to do with the vegetables during the tasting activity. For this reason, we use the “max” willingness score for each child for each vegetable when analyzing our data.

Children’s consumption is defined as swallowing any amount of the vegetables presented to them. Consumption for each vegetable was measured using pre- and post-weights and total consumption was calculated by subtracting the post-weight in grams from the pre-weight in grams.

3.8.2 Exposure Variables

The eight vegetables were categorized three ways in order to investigate whether there were differences between them based on different sensory attributes. Table 7 lists all eight vegetables and indicates all of the sensory categories into which each vegetable falls. Vegetables were categorized by taste by separating them into two groups or categories: “sweet” and “less-sweet”. “Sweet” tasting vegetables include carrots, parsnip, beets and snap peas. “Less-sweet” tasting vegetables include broccoli, cauliflower, radish and green bean. Vegetables were placed into the appropriate category based on their sugar content. Those vegetables that contained ≥4.0g of sugar per 100g were considered to be “sweet” tasting. Those vegetables ≤3.9g per 100g were considered “less-sweet” tasting. Sugar content per 100g is as follows for each of the eight target vegetables in their raw form: sugar snap peas with pod 4.0g, without pod (peas alone) 5.67g; green beans 3.26g; carrots 4.26g; parsnip 4.80g; beets 6.76g; radishes 1.86g; broccoli 1.70g; cauliflower 1.91g. Information was obtained from the USDA National Nutrient Database (USDA).

Four color groups/categories were created among the eight target vegetables: red, orange, green and white. Vegetables were defined by the pigment of their skin and/or flesh. The vegetables were arranged in categories as follows: beets and radish are red; carrots are orange; broccoli, green beans and snap peas are green; and cauliflower and parsnip are white.

Vegetable pairings were defined based on similarities in shape, texture and growth pattern. The vegetables were presented in the following pairings during the four intervention weeks: green beans and snap peas for the first intervention week; carrots and parsnips for the next intervention week; beets and radishes for the third intervention week; and broccoli and cauliflower for the final intervention week. Green beans and snap peas are both pod-shaped, with their seeds (peas or beans) presented inside a pod; they have similar waxy texture on the outside; and they both grow on poles or vines. Carrots and parsnip are shaped almost exactly the same, with a long, tapered body and leaves shooting out the top of the vegetable; they are both hard and crunchy in texture; and they are both root vegetables, growing underneath the ground. Beets and radishes are round, globe-shaped vegetables that have leaves growing from their tops; they have a crunchy texture; and they are also root vegetables that grow underneath the ground.

Our two sensory-exploration intervention approaches included facilitator-guided and self-guided. We defined facilitator-guided sensory-exploration as showing and instructing the children how to use their senses (see-touch-smell-hear) to explore the vegetables through the use of guiding prompts, questions and visual demonstrations. Self-guided sensory-exploration is defined as child-directed exploration of the vegetables.

Table 7. Sensory Attributes of each Vegetable

Category	Vegetable							
	Snap Peas	Green Beans	Carrot	Parsnip	Beet	Radish	Broccoli	Cauliflower
Sweet[a] Tasting	X		X	X	X			
Less-sweet[a] Tasting		X				X	X	X
Red					X	X		
Orange			X					
Green	X	X					X	
White				X				X
Tree							X	X
Root					X	X		
Long-root			X	X				
Pod	X	X						

[a] sweet and less-sweet tasting are based on sugar content per USDA National Nutrient Database

3.9 Data Analysis

Data were analyzed using SPSS version 20. The current analysis includes data for those children who had complete data collected at both baseline and follow-up time-points, n= 50 children in 6 classrooms. Significance was set at $p<0.05$. The data were combined for 3-5 year old children in each classroom and the analysis was conducted at the site level and by classroom (data are not reported here). There is a need to take into consideration developmentally based learning readiness and responses to the intervention, however due to power, the sensory education group was pooled to include all children who received the intervention. The outcome measures were willingness to explore and try the vegetables and consumption, and exposure variables include taste (sweet and less-sweet), color (red, orange, green and white), pairings (based on shape, texture and growth pattern) and intervention approach (facilitator-guided and self-guided). Descriptions of all variables are included in a previous section.

Frequencies were run for the willingness ratings and distribution percentages were obtained for the full range of the rating scale scores at both time-points (baseline, and follow-up). Using the observed willingness data for individual vegetables (ex. broccoli, beets), vegetable pairs (ex. beets and radishes), and taste (i.e. sweet and less-sweet) and color (red, green), marginal homogeneity was tested using nonparametric tests. For the analysis for Aim 1, variables for taste, color and shape/texture were generated by taking the maximum willingness rating score among the vegetables within each category. For example, creation of sweet tasting and less-sweet tasting max was done as follows: sweet=MAX(beets, carrots, peas), less-sweet=MAX(broccoli, cauliflower, radish, parsnip, green beans). This same procedure was repeated for vegetables in each of the four color categories (red, orange, green and white) and the four vegetables pairings offered during the respective intervention weeks (tree, root, long-root and pod). As described above in the methods section, the Willingness Rating Scale (WRS) included a 5-point rating scale, where each rating increased as children's willingness increased. We used the maximum willingness score for each child for each vegetable when creating the MAX variables above because the maximum willingness score represents what children were "most willing" to do with each vegetable (i.e. examine, spit out, etc).

Using the newly created MAX variables, within-category willingness data analysis was conducted comparing baseline and follow-up (i.e. sweet vs. less-sweet at baseline, sweet vs. less-sweet at follow-up; red vs. green at baseline, red vs. green at follow-up, etc). The quantitative shift in willingness for each category *from* baseline *to* follow-up (i.e. sweet from baseline to follow-up, less-sweet from baseline to follow-up, etc) was analyzed.

For consumption data for Aim 1, descriptive analysis was run to obtain the mean consumption in grams (+/- standard deviation) of each of the eight vegetables. Child consumption was analyzed using paired t-tests (within-subjects pre-post: baseline and follow-up, between-subjects: from baseline to follow-up). We used this paired samples approach due to the fact that it employs a "self-pairing" technique (Pagano 2000); where for each observation or value in the first group (i.e. baseline consumption), there is an observation or value in the second group (i.e. follow-up consumption). The data model for our paired T-tests is:

$$t = \frac{\bar{d} - \delta}{sd/\sqrt{n}}$$

where $\bar{d}$ = mean of the set of differences, δ= the true difference in population means, and $sd/\sqrt{n}$= the standard error of $\bar{d}$.

Comparisons were made using the mean difference in consumption of the paired test for each analysis. This allowed us to determine both the direction (positive or negative, from baseline to follow-up) and magnitude of the change in consumption. We ran paired t-tests analysis for individual vegetables as well as for vegetable categories to examine change between baseline and follow-up, as well as between the abovementioned categories (i.e. taste, color and pairs). New variables were then created for each separate category of vegetables tested (ex. sweet, less-sweet). Vegetables were placed in each taste category using subjective taste assessments. For the sweet tasting vs. less-sweet tasting and for color analysis, uneven numbers of vegetables were represented (i.e. sweet= beets, carrots, peas, less-sweet= broccoli, cauliflower, radish, parsnip, green beans, red= beet and radish, orange= carrot, green= broccoli, peas and green beans, white= cauliflower and parsnip) so two sets of variables were created. A first set of variables was generated by taking the mean of each of the vegetables in the group. For example, sweet=mean(beet, carrot, peas). Paired t-tests were performed within-categories from baseline to follow-up as well as between-the categories at each time-point. A second set of variables was then generated by taking the sum of the vegetables in each category (i.e. sweetsum=sum(beet, carrot, peas). Analysis was run comparing the groups the same as for the first set of variables. Variables were then standardized (due to the uneven number of vegetables in each group) and paired t-tests were re-run.

In the analysis of vegetable pairings (tree, root, long-root and pod), the score of the pairing was a sum of the two vegetables that were structurally similar. For example, tree=sum(broccoli, cauliflower), root=sum(beet, radish), long root = sum(carrot, parsnip) and pod =max(green beans, peas). Within-pair (baseline to follow-up) and between-pair analysis (baseline to follow-up) were conducted using paired t-tests to investigate vegetable structure-pairings induced effects on observed willingness to taste measure and the consumption data.

As described in Aim 2, the two intervention approaches {facilitator-guided (FG) and self-guided (SG)} were compared to evaluate whether there were differences in outcome measures in response to each of the 2 methods. Willingness to taste was assessed through marginal homogeneity using nonparametric testing. The two intervention approaches, FG and SG, were compared at baseline and at follow-up for each of the eight vegetables. Willingness score percentiles for FG and SG were also calculated for the vegetables. One-way ANCOVA was used to assess the differences between FG and SG in the consumption of each vegetable, while controlling for baseline intakes of the respective vegetable. We controlled for baseline to look at the follow-up consumption and determine the effect of the intervention between the two groups. One-way ANCOVA was an appropriate fit because we have one categorical, independent variable (intervention approach, FG vs. SG); one continuous, dependent variable (consumption at follow-up); and one continuous covariate (consumption at baseline). The data model used for ANCOVA is:

$$Y_{ij} = \mu. + \tau_i + \gamma(X_{ij} - \overline{x}) + \varepsilon_{ij}$$

where Y_{ij}=follow-up consumption, $\mu.$= an overall mean, τ_i=interaction/treatment effects ,γ= regression coefficient, X_{ij}=baseline consumption , $\overline{x}$=the overall mean ,ε_{ij}=independent N .

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Results

Table 8 shows the sample descriptive for both the full sample size (n=94 children) and the sample size (n=50) used for analysis. Our total sample size included 94 children from four Head Start sites (A-D). The current analysis includes 50 children for whom we have complete data at both baseline and follow-up. Sample sizes were similar between sites A and B, and between C and D. Gender distributions are shown for both samples, and by Head Start site for the sample used in the analysis. For our sample of 50 children, 48% were male (n=24) and 52% were female (n=26). There were more females at sites A-C, and only site D had more males.

Table 8. Description of Data Sample

Sample Descriptives		**Full Sample***	**Sample used for Data Analysis****	**Descriptives by Head Start Site of Sample used for Analysis**			
				Site A	**Site B**	**Site C**	**Site D**
Sample size		**94**	**50**	**9**	**8**	**18**	**15**
Gender distribution for sample	**M**	**40**	**24**	**3**	**3**	**8**	**10**
	F	**54**	**26**	**6**	**5**	**10**	**5**

***** Full sample represents all children who participated in the study, and for which we obtained data at any of the 3 (baseline, intervention, follow-up) time-points
** Sample used for data analysis includes children who had complete data at both baseline and follow-up

The distribution of willingness-to-taste scores for the eight target vegetables is shown in Table 9. The percentage of children in the study who were willing to taste the vegetables ranged from 30-48% at baseline, as shown in the table for the distribution of the sample with a baseline score of 4. This is in contrast with the follow-up time-point when the percentage of children willing to explore the vegetables ranged from 18-54%. A consistent pattern emerged for the “no engagement” rating with fewer children at follow-up remaining in this lower end of the scale, relative to baseline. The pre-post shift in scores (from 0 to 1) demonstrates that children were more willing to explore and try the eight vegetables at follow-up. Children’s willingness to “swallow one or more bites” (a rating of 4 on the scale) at follow-up did not differ much from baseline, but in general, willingness to examine the vegetables (rating of 1 on the scale) improved. Thus, at the end of our 4-week intervention, more children explored the vegetables even if they did not always try more vegetables. There is evidence that at follow-up, children are showing an interest in exploring those vegetables for which they initially demonstrated a reluctance to explore or try. These results suggest that the sensory exploration approach has promise for application with young children in the Head Start setting.

Table 9. Distribution of Willingness to Taste Scores at Baseline and at Follow-up by Vegetable

Vegetables	**n**	**Baseline Willingness Score**					**Follow-up Willingness Score**				
		0[a] (%)	**1[b] (%)**	**2[c] (%)**	**3[d] (%)**	**4[e] (%)**	**0[a] (%)**	**1[b] (%)**	**2[c] (%)**	**3[d] (%)**	**4[e] (%)**
Peas	50	48	12	0	2	38	32	22	0	0	46
Green Beans	50	40	16	0	0	44	26	30	0	2	42
Carrot	50	44	12	0	0	44	24	20	0	2	54
Parsnip	50	50	16	2	2	30	44	38	0	0	18
Beets	50	38	10	2	2	48	36	32	0	0	32
Radish	50	46	10	4	0	40	42	34	4	0	20
Broccoli	50	46	20	0	0	34	22	36	0	4	38
Cauliflower	50	60	10	0	0	30	34	38	0	0	28

[a] 0=no engagement
[b] 1=examined (looked, touched, smelled)
[c] 2=licked only
[d] 3=spit out
[e] 4=swallowed one or more bites

Overall, consumption in grams and changes in consumption from baseline to follow-up, differed among the eight target vegetables in our study. Total and mean consumption are shown for all vegetables in Figure 3 and Table 10. We saw an increase in children's intake for all (Table 10), and these changes were significant for carrots (p=.013) and radishes (p=.023). At baseline, children ate a similar amount of peas, green beans, broccoli and cauliflower (mean consumption approximately 1.5 grams each). Mean consumption at follow-up was approximately 1-2 grams for all vegetables except carrots. Intake was highest for carrots (mean +/- standard error: 2.45 +/- .39 at baseline, 3.49 +/-.43 at follow-up) and lowest for parsnips (mean +/- standard error: 0.88 +/-.25 at baseline, 0.93 +/-.31 at follow-up) at both time points (Table 10). Cauliflower was the only vegetable where no increase in consumption was noted (mean consumption of 1.32 grams at both baseline and follow-up, total consumption of 65.80 grams at baseline and 65.90 grams at follow-up). Although generally consumption increased by the end of the intervention, children ate approximately the same amount of parsnip, broccoli and cauliflower during both baseline and follow-up; the mean difference for each of these vegetables was close to 0. Children's preferences for certain vegetables (ex. carrots and beets) in comparison to others (ex. parsnip and cauliflower) remained the same at both time-points. These results indicate that our intervention did not have the same effect on all vegetables, and that the intervention may have contributed to the increased intake of some vegetables while intakes of others did not change much.

Figure 3. Total Overall Consumption for Eight Target Vegetables

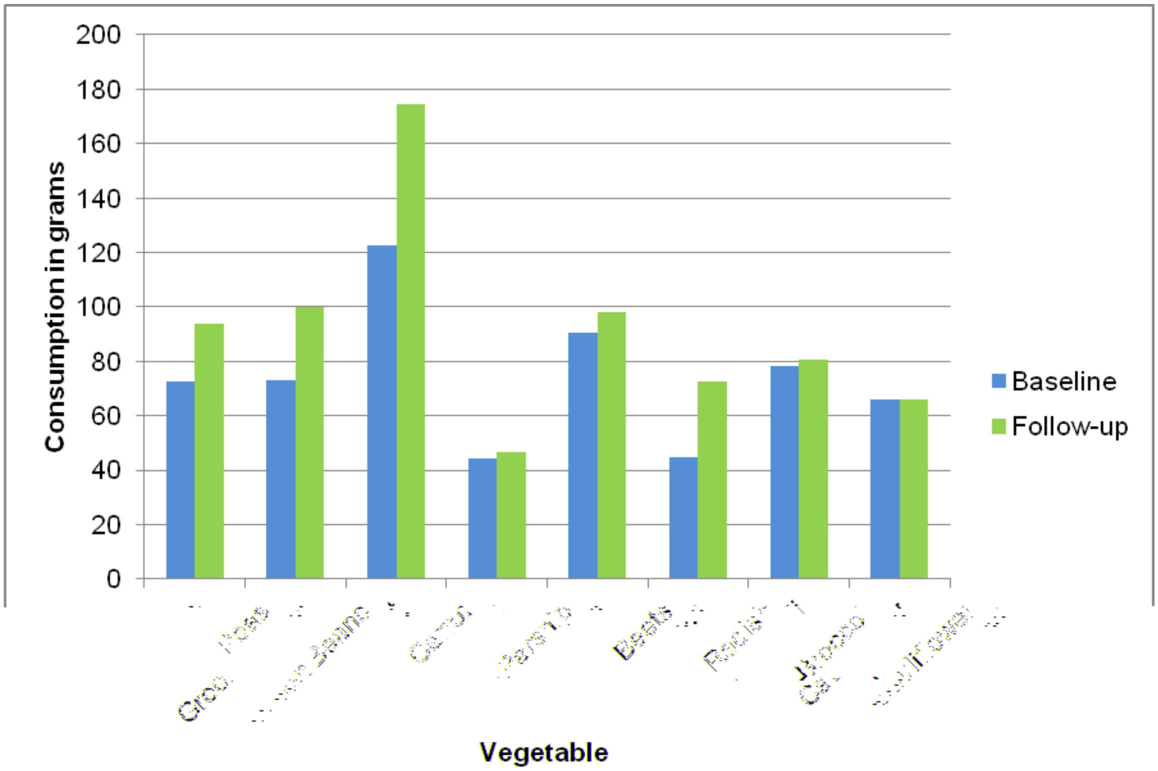


Table 10. Vegetable Consumption at Baseline and at Follow-up

Vegetable	n	**Mean Consumption in grams (SE[a])**		**Mean Difference Consumption in grams (SE[a])**	**95% CI[b]**	**p value**	**Direction of Change**
		Baseline	Follow-up				
Peas	50	1.45 (.29)	1.87 (.37)	.42 (.31)	(-1.06, .22)	.191	↑
Green Beans	50	1.46 (.34)	2.00 (,41)	.54 (.35)	(-1.25, .17)	.131	↑
Carrot	50	2.45 (.39)	3.49 (.43)	1.04 (.40)	(-1.85, -.23)	.013*	↑
Parsnip	50	.88 (.25)	.93 (.31)	.04 (.25)	(-.55, .46)	.862	↑
Beet	50	1.81 (.35)	1.96 (.38)	.14 (.33)	(-.81, .52)	.664	↑
Radish	50	.90 (.22)	1.45 (.29)	.55 (.24)	(-1.03, -.08)	.023*	↑
Broccoli	50	1.56 (.35)	1.61 (.36)	.05 (.33)	(-.71, .61)	.880	↑
Cauliflower	50	1.32 (.34)	1.32 (.35)	.002 (.31)	(-.62, .62)	.995	↑

[a] SE=standard error mean
[b] CI= confidence interval
* <.05

Differences in vegetable consumption based on taste are shown in Table 11. Those vegetables in the “sweet tasting” category were consumed in larger amounts than “less-sweet tasting” vegetables at both baseline and at follow-up. At baseline mean consumption for “sweet” vegetables like peas was 1.65 grams, but for those less-sweet vegetables like broccoli and radishes, mean consumption was about 1.3 grams. Mean consumption was almost half of a gram more for sweet vegetables over the other taste category at follow-up. . A second analysis was run, excluding carrots from the sweet tasting category, to determine if carrots were skewing the results. This analysis showed that when carrots were removed, mean consumption of the “sweet” tasting vegetables was lower, particularly at follow-up (2.06 grams with carrots, 1.59 grams without carrots). The taste profile of the vegetables featured in our study appears to have had an effect on children’s consumption.

Table 11. Mean Consumption for Sweet[e] Tasting Vegetables and Less-sweet[e] Tasting Vegetables at Baseline and Follow-up

Taste Category		**Including Carrots**		**Not Including Carrots**	
	n	**Mean Consumption in grams (SE[d]) at Baseline**	**Mean Consumption in grams (SE[d]) at Follow-up**	**Mean Consumptio n in grams (SE[d]) at Baseline**	**Mean Consumption in grams (SE[d]) at Follow-up**
Sweet[a]	50	1.65 (.26)	2.06 (.28)	1.38 (.25)	1.59 (.28)
Less-sweet[b]	50	1.31 (.25)	1.59 (.29)	1.31 (.25)	1.59 (.29)

[a] sweet=beets, carrots, peas, parsnip
[b] less-sweet=broccoli, cauliflower, radish, green beans
[c] variables were standardized due to uneven number of vegetables in each category
[d] SE=standard error mean
[e] taste categories were determined by sugar content of vegetables per USDA National Nutrient Database

Results from Table 12 show that vegetable consumption differed at baseline and follow-up for all color categories except white. For those other color categories (red, orange and green), children ate about 1 gram more at follow-up. Baseline consumption was similar across the red, orange and white groups at about 2.5 grams. Children’s intake was highest for vegetables in the green category with a mean intake of 4.47 grams at baseline and 5.49 grams at follow-up, though this category contained three vegetables while the other categories contained one (orange) or two (red and white). Once the variables were standardized, all means and standard deviations became the same. It appears that color may play a role in children’s overall intake of vegetables.

Table 12. Mean Vegetable Consumption for each Color Category at Baseline and at Follow-up

Color Category	**Baseline**			**Follow-up**		
	n	**Pre-standardized[e] Mean Consumption in grams (SE[f])**	**Standardized[e] Mean Consumption in grams (SE[f])**	**n**	**Pre-standardized[e] Mean Consumption in grams (SE[f])**	**Standardized[e] Mean Consumption in grams (SE[f])**
Red[a]	50	2.71 (.53)	0E-7 (.14)	50	3.41 (.58)	0E-7 (.14)
Orange[b]	50	2.45 (.39)	0E-7 (.14)	50	3.49 (.43)	0E-7 (.14)
Green[c]	50	4.47 (.87)	0E-7 (.14)	50	5.49 (.97)	0E-7 (.14)
White[d]	50	2.20 (.52)	0E-7 (.14)	50	2.25 (.62)	0E-7 (.14)

[a] red=beets and radishes
[b] orange=carrots
[c] green=broccoli, peas, green beans
[d] white=cauliflower, parsnip
[e] variables were standardized due to uneven number of vegetables in each category
[f] SE=standard error of mean

Vegetable pairs in Table 13 were categorized based on similarities in shape, texture and growth pattern. Intake at both baseline and follow-up differed slightly between the categories. Overall, consumption was higher at follow-up, though the increase was minimal for “tree” vegetables (mean +/- SE: 2.88 grams +/- .61 at baseline and 2.93 +/- .64 at follow-up) compared to the other categories. Children consumed beets and radishes the least (mean +/- SE: 2.71g +/- .53) and carrots and parsnips the most (mean 3.33g +/- .58) at baseline. At follow-up, children’s intake was highest for those vegetables in the “long-root” category (mean +/- SE: 4.42 g +/-.62) and lowest for those vegetables in the “tree” category (mean +/- SE: 2.93 g +/- .64). Intake was similar for “root” and “pod” vegetables. Pairing vegetables according to shape, texture and growth may possibly have an impact on children’s consumption patterns, but perhaps only when controlling for other factors.

On the whole, there was an increase in consumption among all vegetable pairs (Table 13). Children ate significantly more vegetables belonging to the “long-root” category at follow-up (p=.029) versus at baseline with a mean difference of 1.09 g +/- .48 (mean +/-standard error). Consumption did not differ much between the two time-points for those vegetables in the “tree” category, with a mean increase of 0.05. Children ate close to 1 gram more of peas and green beans at follow-up, though this was not significant. Nor was the difference of .70 grams for beets and radishes. The effects of the intervention of child intake appear to differ based on the shape and texture of the vegetable.

Table 13. Mean Consumption at Baseline and at Follow-up by Vegetable Pair Categories

Category	**Baseline**		**Follow-up**		**Change in Mean Consumption (SE[e])**	**95% CI[f]**	**p value**	**Direction[g] of change**
	n	**Mean Consumption in grams (SE[e])**	**n**	**Mean Consumption in grams (SE[e])**				
Tree[a]	50	2.88 (.61)	50	2.93 (.64)	.05 (.46)	(-.97, .87)	.910	↑
Root[b]	50	2.71 (.53)	50	3.41 (.58)	.70 (.46)	(-1.61, .22)	.132	↑
Long-root[c]	50	3.33 (.55)	50	4.42 (.62)	1.09 (.48)	(-2.06, -.11)	.029*	↑
Pod[d]	50	2.91 (.60)	50	3.87 (.72)	.96 (.59)	(-2.14, .22)	.108	↑

[a] tree=broccoli and cauliflower
[b] root=beet and radish
[c] long-root=carrot and parsnip
[d] pod=peas and green beans
[e] SE=standard error of mean
[f] CI= confidence interval
[g] ↑ indicates an increase from baseline to follow-up, ↓ indicates a decrease
* <.05

Table 14 shows us the difference in consumption within each of the four vegetable pairings which were incorporated in the sensory nutrition intervention lessons. Consumption of peas and beans was approximately the same at both baseline and follow-up with mean differences being .01 grams and .13 grams. Children consistently preferred carrots over parsnips, with children consuming about 1.5 grams more carrots at baseline, and about 2.5 grams more at follow-up. Significant differences were seen between carrots and parsnips (p=.000) at baseline and follow-up and between beets and radishes (p=.001) at baseline. The significant difference in consumption observed between beets and radishes at baseline decreased from .92 to .51 grams at follow-up and was no longer significant. Results showed that children show preference for consuming one vegetable over the other only for certain vegetable pairings.

Table 14. Comparison of Mean Consumption within Vegetable Pairs

Vegetable	**Baseline**			**Follow-up**		
	Mean Difference[a] in grams (SE[b])	**p value**	**95 % CI[c]**	**Mean Difference[a] in grams (SE[b])**	**p value**	**95% CI[c]**
Peas vs. Green Beans	.01 (.21)	.969	(-.42, .40)	.13 (.29)	.658	(-.72, .46)
Carrot vs. Parsnip	1.57 (.38)	.000*	(.80, 2.33)	2.56 (.42)	.000*	(1.71, 3.42)
Beet vs. Radish	.92 (.25)	.001*	(.41, 1.43)	.51 (.34)	.145	(-.18, 1.19)
Broccoli vs. Cauliflower	.25 (.31)	.437	(-.38, .88)	.29 (.28)	.302	(-.27, .86)

[a] mean difference of paired sample test
[b] SE=standard error mean
[c] CI= confidence interval
* <0.05

In general, half of the children's maximum willingness rating score was a 4.00, indicating that about half of the children tried some vegetables at baseline and follow-up. Table 15 shows between-category comparisons for sweet and less-sweet tasting vegetables from baseline to follow-up, and significance was found for those vegetables that are "less-sweet" (p=.013).There was no significant difference between the two categories at baseline or at follow-up. Results were also not significant for beets, carrots, parsnip and snap peas between the two time-points. In fact, as indicated in Table 15, following the intervention children were just as willing to explore and try the less-sweet vegetables. These results show that the current sensory based intervention may have positively influenced children's willingness to try certain vegetables based on taste properties.

Table 15. Willingness to Taste Data for Sweet[d] Tasting Vegetables and Less-sweet[d] Tasting Vegetables

Taste Category	n	Percentiles			Mean MH[c] Statistic	p value
		25th	50th (Median)	75th		
Sweet[a] (baseline)	50	1.00	4.00	4.00	42.00	.112
Sweet[a] (follow-up)	50	4.00	4.00	4.00		
Less-sweet[b] (baseline)	50	1.00	4.00	4.00	36.50	.013*
Less-sweet[b] (follow-up)	50	3.75	4.00	4.00		
Sweet[a] (baseline)	50	1.00	4.00	4.00	21.00	.399
Less-sweet[b] (baseline)	50	1.00	4.00	4.00		
Sweet[a] (follow-up)	50	4.00	4.00	4.00	23.50	.909
Less-sweet[b] (follow-up)	50	3.75	4.00	4.00		

[a] sweet=beets, carrots and peas
[b] less-sweet=broccoli, cauliflower, radishes, parsnip and green beans
[c] MH=marginal homogeneity
[d] taste categories were determined by sugar content of vegetables per USDA National Nutrient Database
* <0.05

Children consumed vegetables differently based on their perceived sweetness. There was a very significant difference seen for one category over the other based on taste (Table 16). Consumption of sweet vegetables such as beets was higher at baseline than broccoli and other less-sweet vegetables, with a mean difference of .34 grams. This was similar at follow-up, with a .47 gram increase in the mean difference between the categories. These results were significant with a p-value of .015 at baseline and .009 at follow-up. There was also an increase in intake for both groups from baseline to follow-up, and this was significant for the vegetables that taste "sweet" (p=.048). However once carrots were removed from the "sweet" tasting group, to determine if carrots were skewing the results, differences between the two categories were no longer significant at either time point. Therefore, in this study, children showed a distinct preference to eat vegetables in one taste category over the other, and this preference seems to be attributed mostly to carrots.

Table 16. Mean Consumption for Sweet[h] Tasting versus Less-sweet[h] Tasting Vegetables

Taste Category (time-point)	**Including Carrots**			**Not Including Carrots**			**Direction[g] of Change**
	Mean Difference [d] in grams (SE[e])	**95% CI[f]**	**p value**	**Mean Difference[d] in grams (SE[e])**	**95% CI[f]**	**p value**	
Sweet[a] (baseline) vs. Less-sweet[b] (baseline)	..34 (.14)	(.07, .61)	.015*	.07 (.14)	(-.21, -.34)	.595	N/A
Sweet[a] (follow-up) vs. Less-sweet[b] (follow-up)	..47 (.17)	(.12, .81)	.009*	.01 (.16)	(-.34, .32)	.954	N/A
Sweet[a] (baseline) vs. Sweet[a] (follow-up)	.41 (.20)	(-.82, -.003)	.048*	..20 (.21)	(-.63, .22)	.344	↑
Less-sweet[b] (baseline) vs. Less-sweet[b] (follow-up)	.29 (.19)	(-.67, .10)	.143	.29 (.19)	(-.67, .10)	.143	↑

[a] sweet=beets, carrots, snap peas and parsnip
[b] less-sweet=broccoli, cauliflower, radishes and green beans
[c] variables were standardized due to uneven number of vegetables in each category
[d] mean difference of paired sample test
[e] SE=standard error mean
[f] CI= confidence interval
[g] ↑ indicates an increase from baseline to follow-up, ↓ indicates a decrease
[h] taste categories were determined by sugar content of vegetables per USDA National Nutrient Database

* <.05

Overall, about half of the children were willing to explore or try the vegetables as indicated by a score of 1.00 or 4.00 on the willingness rating scale (Table 17). At baseline, children explored orange and white vegetables using sight, smell and touch and tried one or more bites of red and green vegetables. Maximum willingness scores remained the same at a rating of 1.00 (representing examined using look-smell-touch) for cauliflower and parsnips. This indicates that children were no more willing to try these two vegetables after the intervention than they were at baseline. At the end of the intervention, an increase in children's willingness was seen for green vegetables, which approached significance (p=.076). When comparing the difference between color categories at baseline and at follow-up, we found significant results among red vs. orange (p=.039), red vs. white (p=.006), orange vs. green (p=.030) and green vs. white (p=.022) at baseline, and red vs. green (p=.003), orange vs. white (p=.003) and green vs. white (p=.000) at follow-up. Results neared significance at follow-up between red vs. white and orange vs. green comparisons. Color showed to have a strong impact on children's willingness to explore and try the different vegetables offered.

Table 17. Willingness to Taste Assessment Comparisons between Color Categories

Category	n	Percentiles			Mean MH[e] Statistic (SD[f])	p value
		25th	50th (Median)	75th		
Red[a] (baseline)	50	.00	4.00	4.00	36.00 (7.75)	.039*
Orange[b] (baseline)	50	.00	1.00	4.00		
Red[a] (baseline)	50	.00	4.00	4.00	28.00 (6.16)	.006*
White[d] (baseline)	50	.00	1.00	4.00		
Orange[b] (baseline)	50	.00	1.00	4.00	29.00 (6.93)	.030*
Green[c] (baseline)	50	.75	4.00	4.00		
Green[c] (baseline)	50	.75	4.00	4.00	32.00 (6.96)	.022*
White[d] (baseline)	50	.00	1.00	4.00		
Red[a] (follow-up)	50	.00	1.00	4.00	43.00 (7.81)	.003*
Green[c] (follow-up)	50	1.00	4.00	4.00		
Red[a] (follow-up)	50	.00	1.00	4.00	43.00 (7.68)	.068**
White[d] (follow-up	50	.00	1.00	4.00		
Orange[b] (follow-up)	50	.75	4.00	4.00	48.00 (7.84)	.074**
Green[c] (follow-up)	50	1.00	4.00	4.00		
Orange[b] (follow-up)	50	.75	4.00	4.00	47.00 (7.62)	.003*
White[d] (follow-up)	50	.00	1.00	4.00		
Green[c] (follow-up)	50	1.00	4.00	4.00	49.00 (7.81)	.000*
White[d] (follow-up)	50	.00	1.00	4.00		
Green[c] (baseline)	50	.75	4.00	4.00	47.50 (7.05)	.076**
Green[c] (follow-up)	50	1.00	4.00	4.00		

[a] red=beets and radishes
[b] orange=carrots
[c] green=broccoli, peas and green beans
[d] white=cauliflower and parsnip
[e] MH=marginal homogeneity
[f] SD=standard deviation
* <0.05
** <0.10

There was considerable variation in the amount of vegetables consumed from among the pre-defined color categories (Table 18). Overall, children consumed cauliflower and parsnips (white vegetables) the least compared to the other three color categories. At baseline, the biggest differences were between green and white (mean +/- SE: 2.27 g +/- .61), orange and green (mean +/- SE: 2.02 g +/- .68) and red and green (mean +/- SE: 1.76 g +/- .72) combinations, and these differences were statistically significant with a $p<0.05$. At follow-up, children ate notably more of the orange color vegetable than green or white vegetables. A higher consumption was also seen for peas, green beans and broccoli over cauliflower and parsnips. The mean difference between the two groups was 3.24 g +/- .76 (mean +/- SE) with a highly significant p-value of .000. Analysis performed by comparing baseline to follow-up for each color category for the vegetables showed a non-significant overall increase for all color categories and although the difference failed to reach significance for carrots ($p=0.13$). After standardized means were included in the analysis, the between-color categories difference was no longer quite significant (Table 18). These results albeit preliminary support the prediction that select sensory properties such as color would exert an influence on young children's consumption.

Table 18. Change in Consumption for Color Categories

Category	n	Pre-standardized[e] Mean Difference[f] (SE[g])	95% CI[h]	p value	Standardized[e] Mean Difference[f] (SE[g])	95% CI[h]	p value
Red[a] (baseline)	50	1.76 (.72)	(-3.22, -.31)	.019*	0E-8 (.13)	(-.27, .27)	NS[i]
Green[c] (baseline)	50						
Orange[b] (baseline)	50	2.02 (.68)	(-3.38, -.67)	.004*	0E-8 (.12)	(-.23, .23)	NS[i]
Green[c] (baseline)	50						
Green[c] (baseline)	50	2.27 (.61)	(1.04, 3.50)	.001*	0E-8 (.11)	(-.21, .21)	NS[i]
White[d] (baseline)	50						
Red[a] (follow-up)	50	2.08 (.72)	(-3.53, -.62)	.006*	0E-8 (.12)	(-.23, .23)	NS[i]
Green[c] (follow-up)	50						
Red[a] (follow-up)	50	1.16 (.53)	(.11, 2.21)	.032*	0E-8 (.12)	(-.25, .25)	NS[i]
White[d] (follow-up	50						
Orange[b] (follow-up)	50	1.99 (.85)	(-3.71, -.28)	.023*	0E-8 (.14)	(-.29, .29)	NS[i]
Green[c] (follow-up)	50						
Orange[b] (follow-up)	50	1.25 (.59)	(.07, 2.42)	.038*	0E-8 (.15)	(-.31, .31)	NS[i]
White[d] (follow-up)	50						
Green[c] (follow-up)	50	3.24 (.76)	(1.72, 4.76)	.000*	0E-8 (.12)	(-.25, .25)	NS[i]
White[d] (follow-up)	50						
Orange[b] (baseline)	50	1.04 (.40)	(-1.85, -.23)	.013*	0E-8 (.14)	(-.28, .28)	NS[i]
Orange[b] (follow-up)	50						

[a] red=beets and radishes
[b] orange=carrots
[c] green=broccoli, peas and green beans
[d] white=cauliflower and parsnip
[e] variables were standardized due to uneven number of vegetables in each category
[f] mean difference of the paired sample test
[g] SE=standard error mean
[h] CI= confidence interval
[i] NS= not significant
* <.05

When examining the change in willingness scores for the 4 vegetable pairs between the two time-points (Table 19) the scores increased from baseline to follow-up, although the difference in the scores did not achieve statistical significance. However, the general increase in scores show that children may be responding well to the sensory themed interventions addressing the shape, texture and growth patterns of vegetables and as a result may experience positive shifts along the continuum of the willingness rating scale.

Willingness score comparisons between the vegetable pairings at baseline and at follow-up are shown in Table 19. Children were more willing to explore and try beets and radishes at baseline than broccoli and cauliflower, and this was significant with a p-value of .023. Differences were found to be trending toward significance between “root” vs. “long-root” (p=.073) and “root” vs. “pod” (p=.091) vegetables. These results suggest that children may be paying attention to shape of food while exploring and trying vegetables and vegetable pairs.

Table 19. Willingness to Taste Scores from Baseline to Follow-up for Vegetables Pair Categories

Category	n	Percentiles			Mean MH[e] Statistic (SD[f])	p value
		25th	50th (Median)	75th		
Tree[a] (baseline)	50	.00	1.00	4.00	45.00 (7.65)	.150
Tree[a] (follow-up)	50	1.00	3.00	4.00		
Root[b] (baseline)	50	.00	4.00	4.00	49.50 (7.53)	.127
Root[b] (follow-up)	50	.00	1.00	4.00		
Long-root[c] (baseline)	50	.00	2.00	4.00	56.00 (8.49)	.195
Long-root[c] (follow-up)	50	1.00	4.00	4.00		
Pod[d] (baseline)	50	.00	2.00	4.00	50.50 (7.60)	.130
Pod[d] (follow-up)	50	1.00	4.00	4.00		
Tree[a] (baseline)	50	.00	1.00	4.00	35.5 (6.80)	.023*
Root[b] (baseline)	50	.00	4.00	4.00		
Root[b] (follow-up)	50	.00	1.00	4.00	47.5 (7.53)	.073**
Long-root[c] (follow-up)	50	1.00	4.00	4.00		
Root[b] (follow-up)	50	.00	1.00	4.00	47.50 (7.98)	.091**
Pod[d] (follow-up)	50	1.00	4.00	4.00		

[a] tree=broccoli and cauliflower
[b] root=beets and radishes
[c] long-root=carrots and parsnip
[d] pod=peas and green beans
[e] MH=marginal homogeneity
[f] SD=standard deviation
* <.05
** <.10

When comparing the consumption between vegetable pairings based on shape, texture and growth pattern, we found that overall the results varied (Table 20). At baseline, the difference was about .5 grams or less for all comparisons. None of the mean differences between pairs reached significance during baseline. However, mean consumption at follow-up carrots and parsnips was significantly higher than broccoli and cauliflower (p=.005). Results for the mean consumption of vegetables at follow-up in the "long-root" category compared with vegetables in the "root" category (i.e. beet and radish) approached significance (p=.071). The differences ranged from about .50 grams to 1.5 grams at follow-up. Therefore, the shape, texture and growth pattern of vegetables may have an impact of child consumption.

Table 20. Comparison of the Change in Consumption between Vegetable Pairs

Category (time-point)	Mean Difference[e] Consumption in grams (SE[f])	95% CI[g]	p value
Tree[a] (baseline) vs. Root[b] (baseline)	.17 (.55)	(-.95, 1.28)	.763
Tree[a] (baseline) vs. Long-root[c] (baseline)	.46 (.46)	(-1.38, .47)	.326
Tree[a] (baseline) vs. Pods[d] (baseline)	.03 (.51)	(-1.07, .99)	.948
Root[b] (baseline) vs. Long-root[c] (baseline)	.62 (.39)	(-1.42, .17)	.123
Root[b] (baseline) vs. Pods[d] (baseline)	.20 (.56)	(-1.33, .93)	.721
Long-root[c] (baseline) vs. Pods[d] (baseline)	.42 (.39)	(-.37, 1.21)	.290
Tree[a] (follow-up) vs. Root[b] (follow-up)	.48 (.55)	(-1.59, .63)	.390
Tree[a] (follow-up) vs. Long-root[c] (follow-up)	1.49 (.51)	(-2.52, -.46)	.005*
Tree[a] (follow-up) vs. Pods[d] (follow-up)	.94 (.62)	(-2.19, .31)	.137
Root[b] (follow-up) vs. Long-root[c] (follow-up)	1.01 (.55)	(-2.12, .09)	.071**
Root[b] (follow-up) vs. Pods[d] (follow-up)	.47 (.56)	(-1.59, .66)	.409
Long-root[c] (follow-up vs. Pods[d] (follow-up)	.55 (.65)	(-.77, 1.86)	.407

[a] tree=broccoli and cauliflower
[b] root=beets and radishes
[c] long-root=carrots and parsnip
[d] pod=peas and green beans
[e] mean difference of paired sample test
[f] SE=standard error mean
[g] CI= confidence interval
* <0.05
** <0.10

Descriptive results for willingness data comparing the two intervention approaches are shown in Table 21. At baseline, willingness scores across the percentiles were generally similar between the two approaches. Children were willing to try one of more bites of more vegetables that would be receiving the facilitator-guided approach than the self-guided (4 vegetables versus 1). Prior to the intervention, children did not engage at all with 5 of the 8 vegetables (broccoli, radish, carrot, green bean and cauliflower). Parsnip and cauliflower were the two vegetables whose maximum willingness scores reached 1.00 and not 4.00 during baseline, and this was in the facilitator-guided group. An overall increase in willingness was seen at follow-up, and scores were similar between the two intervention groups. Scores were lowest for radish and parsnip in the FG group and parsnip in the SG group, with 1.00 being the maximum score for these vegetables, and 4.00 being the maximum score for all others. Table 22 shows that the similarities in willingness we saw between the two groups produced no significant results. Therefore, though there were slight variations for some vegetables in the two intervention groups, in general the intervention approach did not have an effect on willingness scores.

Table 21. Descriptive Statistics for Willingness Data by Intervention Approach

Time-point	Intervention Approach	Vegetable	n	25th	50th (Median)	75th
Baseline	**Facilitator-guided**	**Broccoli**	27	.00	1.00	4.00
		Radish	27	.00	4.00	4.00
		Carrot	27	.00	4.00	4.00
		Green Bean	27	.00	4.00	4.00
		Cauliflower	23	.00	.00	1.00
		Beet	23	.00	1.00	4.00
		Parsnip	23	.00	.00	1.00
		Peas	23	.00	.00	4.00
	Self-guided	**Broccoli**	23	.00	.00	4.00
		Radish	23	.00	.00	4.00
		Carrot	23	.00	.00	4.00
		Green Bean	23	.00	.00	4.00
		Cauliflower	27	.00	.00	4.00
		Beet	27	.00	4.00	4.00
		Parsnip	27	.00	1.00	4.00
		Peas	27	.00	1.00	4.00
Follow-up	**Facilitator-guided**	**Broccoli**	27	.00	1.00	4.00
		Radish	27	.00	1.00	1.00
		Carrot	27	1.00	4.00	4.00
		Green Bean	27	.00	4.00	4.00
		Cauliflower	23	.00	1.00	4.00
		Beet	23	.00	1.00	4.00
		Parsnip	23	.00	1.00	1.00
		Peas	23	.00	1.00	4.00
	Self-guided	**Broccoli**	23	1.00	1.00	4.00
		Radish	23	.00	1.00	4.00
		Carrot	23	.00	4.00	4.00
		Green Bean	23	1.00	1.00	4.00
		Cauliflower	27	.00	1.00	4.00
		Beet	27	.00	1.00	4.00
		Parsnip	27	.00	.00	1.00
		Peas	27	.00	1.00	4.00

Table 22. Intervention Approach Comparisons of Willingness to Taste Data at Baseline and at Follow-up for each Vegetable

Vegetable (intervention approach)	Baseline			Follow-up		
	n	Mean MH[c] Statistic	p value	n	Mean MH[c] Statistic	p value
Broccoli (FG[a])	27	.000	NS[d]	27	.000	NS[d]
vs. Broccoli (SG[b])	23			23		
Radish (FG[a])	27	.000	NS[d]	27	.000	NS[d]
vs. Radish (SG[b])	23			23		
Carrot (FG[a])	27	.000	NS[d]	27	.000	NS[d]
vs. Carrot (SG[b])	23			23		
Green Bean (FG[a])	27	.000	NS[d]	27	.000	NS[d]
vs. Green Bean (SG[b])	23			23		
Cauliflower (FG[a])	23	.000	NS[d]	23	.000	NS[d]
vs. Cauliflower (SG[b])	27			27		
Beet (FG[a])	23	.000	NS[d]	23	.000	NS[d]
vs. Beet (SG[b])	27			27		
Parsnip (FG[a])	23	.000	NS[d]	23	.000	NS[d]
vs. Parsnip (SG[b])	27			27		
Peas (FG[a])	23	.000	NS[d]	23	.000	NS[d]
vs. Peas (SG[b])	27			27		

[a] FG=facilitator-guided intervention approach
[b] SG=self-guided intervention approach
[c] MH=marginal homogeneity
[d] NS=not significant

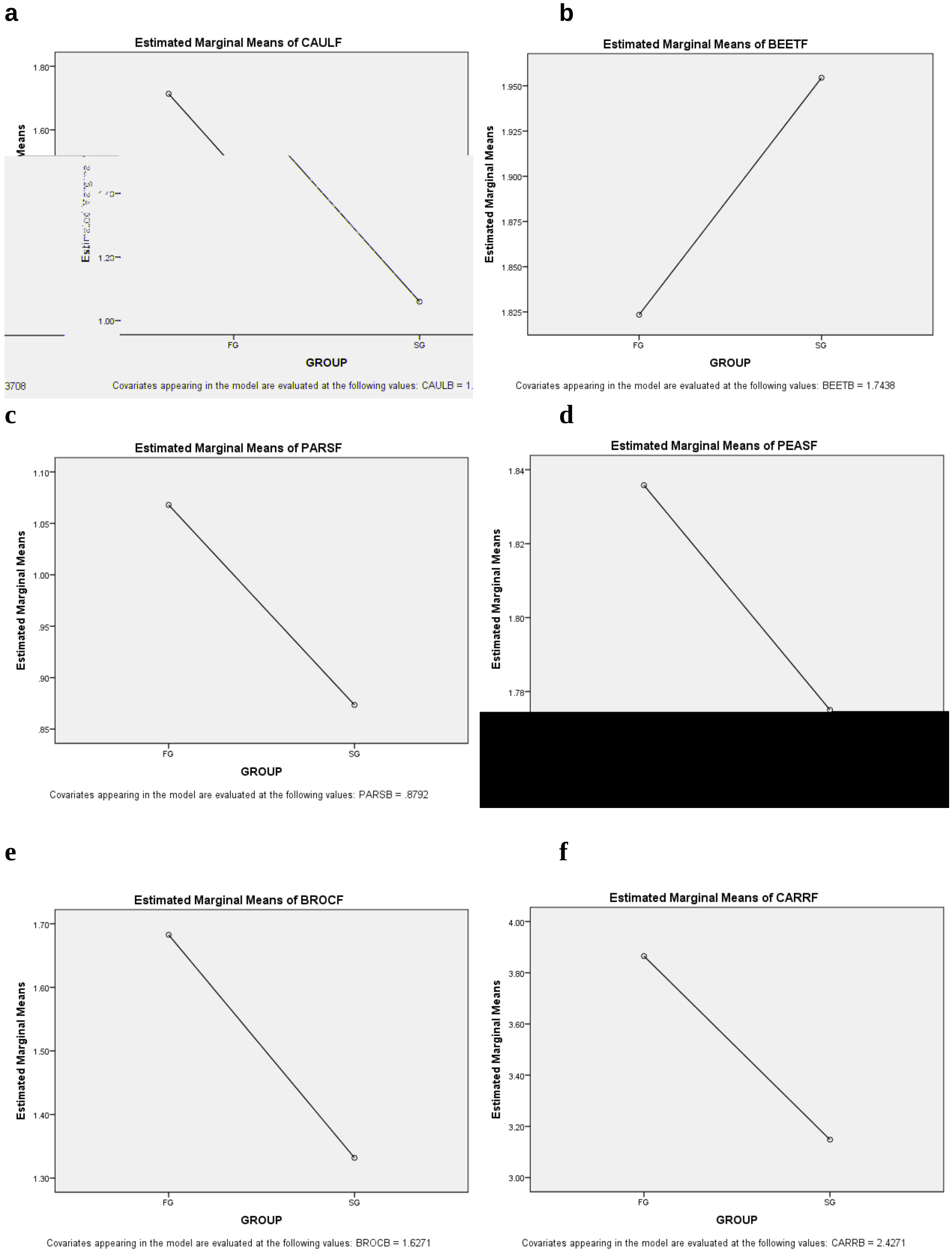
We compared the effect the two intervention approaches (facilitator-guided versus self-guided) had on vegetable consumption and results are shown in Table 23 and Figure 4. Consistent will other results, children consumed more carrots (3.66 g +/- 3.09 for FG and 3.34 g +/- 3.01 for SG) than any other vegetable and this was regardless of the intervention approach. Mean intakes were similar between the two groups for all eight vegetables. In particular, cauliflower consumption was almost exactly the same: 1.39 g +/- 2.62 for facilitator-guided and 1.36 g +/- 2.42 for self-guided. For more than half of the vegetables, children ate slightly more in response to the self-guided approach, though no results showed any significance. Figure 4 shows us the estimated marginal means of FG and SG for each vegetable; the x-axis represents intervention approach (FG and SG); the y-axis represents the estimated marginal means, which stands for the adjusted means, i.e. the means after removing the covariate (in this case, baseline consumption). Once means were adjusted, we see in Figure 4 that consumption was higher for the facilitator-guided approach for all vegetables except beets (as shown by the line drawn between the two points representing the two intervention approaches. Though we did not find a significant difference between our two intervention strategies, we did see a general trend toward the self-guided approach when controlling for baseline consumption.

Table 23. Effect of Facilitator-guided and Self-guided Intervention Approaches on Vegetable Consumption

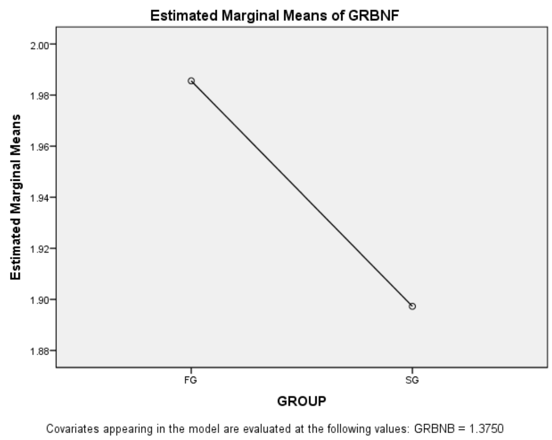
Vegetable	**Facilitator-guided**		**Self-guided**		**p value**	**Partial ETA Squared[b]**
	n	**Mean Consumption (SD[a])**	**n**	**Mean Consumption (SD[a])**		
Cauliflower	23	1.39 (2.62)	25	1.36 (2.42)	.281	.026
Beet	23	1.74 (2.58)	25	2.03 (2.74)	.840	.001
Parsnip	23	.87 (2.24)	25	1.06 (2.31)	.711	.003
Peas	23	1.75 (2.51)	25	1.86 (2.65)	.926	.000
Broccoli	23	1.56 (2.33)	25	1.44 (2.57)	.533	.009
Carrot	23	3.66 (3.09)	25	3.34 (3.01)	.355	.019
Green Bean	23	1.57 (2.65)	25	2.28 (2.99)	.906	.000
Radish	23	1.40 (2.04)	25	1.54 (2.14)	.668	.004

[a] SD=standard deviation
[b] partial ETA squared indicates the what percentage of the variance is explained

Figure 4. Estimated Marginal Means of Each Vegetable



g



h

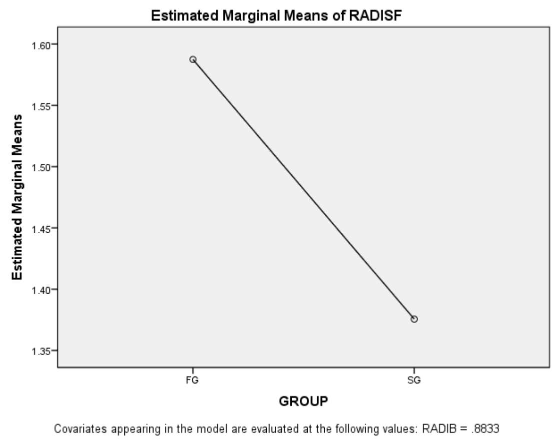


Table 24 presents children's responses during the sensory activities (vegetable exploration and tasting) throughout the intervention weeks. The table includes a mixture of data from all six classrooms. For many pairs, children noticed differences or similarities between the two vegetables. For example, it was noted that both beets and radishes (when presented to the children as a cross-sectional slice) were round, or circular. Some children replied that green beans and peas smelled alike. For parsnip, children answered that it "doesn't look like the carrot". A variety of adjectives were used to describe the different sensory properties of the eight vegetables such as "bumpy", "cold", "stinky", "slippery" and "spicy". The target vegetables were compared to other foods such as cherries, celery, pancakes and popcorn, as well as other items like grass, paper and an iceberg. During the intervention, children elicited very intuitive answers to questions asking them to describe the sensory properties of the vegetables. We saw from these responses that three to five year-old children are very perceptive and in tune with their senses.

Table 24. Children's Verbal Responses during Sensory and Tasting Activities

Vegetables	Sense				
	"See"	**"Smell"**	**"Hear"**	**"Touch"**	**"Taste"**
Peas	-I see peas! - I found a big seed	- like green beans - I don't know what smells like this	- it popped	-it feels slippery -I ripped it	- these taste bad
Green Bean	-I see beans! - green -let's see how green the inside is	- like green bean - like cherries	-it sounds like a snap - makes noises -boom!	-feels cold -kind of rough on the outside	-eww
Carrot	- it's orange -I see stripes -look, this one's fat!	- these smell like carrots do - like dirt - like a strawberry	- big snap! -crunchy	- it feels bumpy - feels like celery	-tastes yummy -sugary - like ice cream
Parsnip	- doesn't look like the carrot - looks like a banana	- it smells good -smells funky	-they don't sound the same	- softer than carrots	-dirty -I don't like them -like bananas
Beet	-it's big and round - it looks like pizza - I can see the circles	- smells like beets -smells like mashed potatoes	-sounds like a crack -it makes noises when I tap it -like grass	- it feels like a pancake -it squirted at me! - I have pink fingers	-taste like gummy bears
Radish	- it's a circle too -it's little - it has some dots inside	-smells a little bit yucky - smells like paper	- sounded like an egg cracking - heard a crack like a chicken	-it's hard -it's just smooth -cold, like an iceberg	-tastes like something spicy -the radish is hot
Broccoli	- it's green, look at this -looks like a tree! but trees don't have green bottoms -mine has a big stem	-like cauliflower -like broccoli leaves -like a vegetable	-crack	-bumpy - feels like grass -tickles my hand	- like broccoli pie
Cauliflower	-it's white --growing bigger (using magnifying glass)	- P U! -stinky	-snap! - sounds like popcorn	-it's bumpy -it's soft, cold - feels like sand	-yucky -good -like grass

4.2 Discussion

To the best of our knowledge, the present study is the first sensory-based nutrition intervention that has assessed the impact on both *willingness to try* and *consumption of vegetables* among preschoolers in a Head Start classroom setting. There has been a recent surge in the popularity of nutrition interventions seeking to increase children's acceptance of vegetables through exposure to their sensory attributes (Birch 1987, Havermans 2007, Houston-Price 2009, Mustonen 2010, Dazeley 2012). In spite of the recent spotlight on using the sensory approach to educate young children, it remains unknown how sensory based nutrition interventions work to increase willingness to try and consumption of the vegetables they target.

Our study focused on all 5 senses to promote change in acceptance through the use of a sensory-based nutrition intervention focused on vegetable exploration. Recently researchers have also incorporated the five senses into their nutrition intervention work with older children. In 8-11 year olds, food neophobia was reduced in response to sensory lessons adapted from a widely used French sensory education program*, Classes du gout* (Mustonen 2010). Other researchers have evaluated more specifically the impact of select sensory attributes on taste preferences. Birch (1987) found that, when comparing "look" exposure to "taste" exposure, only the taste exposure was effective at increasing taste preferences for seven novel fruits in 2 to 5 year old children (Birch 1987). Houston-Price et al (2009) assessed children's willingness to taste fruits and vegetables in response to visual exposure of foods in picture books. They found that children tasted more exposed than non-exposed foods, and that the impact of exposure was dependent upon children's familiarity with the foods (Houston-Price 2009).

In response to the multi-sensory themed intervention in the current study, children's willingness scores dramatically shifted from no engagement to examining through look-touch-smell for all eight vegetables. The percentage of children who were at the lower end of the willingness scale at baseline doubled, and for some vegetables (i.e. radish, beet and cauliflower) more than tripled, by follow-up. This movement from non-engagement to examination of the vegetables using sight, smell and touch is an exciting finding. This lends further weight to the efficacy of experiential sensory based learning and exposure in children of this age group in transforming limited engagement with vegetables into willingness to engage. This transformation has the potential to increase children's intake of vitamin C, fiber and iron which are essential nutrients for growth, digestive health, brain development and immunity.

In addition to the micronutrient composition highlighted above, the eight target vegetables provide a repertoire of phytochemicals including carotenoids, indoles, isothiocyanates and flavoids such as anthocyanin, anthoxanthins and betalains (Brown 2008). Phytochemicals, non-nutritive compounds found in the pigments of F&V, such as flavonoids and carotenoids, have antioxidant properties and may help reduce disease and cancer risk among adults (Brown 2008). Eating habits and food preferences are established early on (Byrne 2002) and can track throughout childhood and into adulthood (Wardle 2003a, French

2003, Lowe 2004, Brug 2008). Building on this premise we expect that the current study's focus on eight vegetables with a wide ranging variety of phytonutrients has enabled these children to experience a wide variety of phytochemical vegetable sources in their early childhood. We found that consumption increased for the eight vegetables among these children, with one of the biggest increases seen in radish consumption. This is especially astounding because radish was one of the two least consumed vegetables at baseline (parsnip being the other). During follow-up, total consumption increased to slightly less than double. As far as we know, no other intervention has tested acceptance and consumption of radishes in children therefore comparisons with the literature are not feasible. Researchers have investigated a wide range of other vegetables and foods (Wardle 2003a, b, Olsen 2012, Witt 2012) but radishes and parsnips (two assumed unfamiliar vegetables to young children) are unique to our study. The positive effect of our intervention is of particular interest due to the spicy flavor of radishes, a taste we would not expect to be greatly accepted by young children. Future work is needed investigating the mechanisms for change in consumption of radishes

Our study was designed using constructs from the Social Cognitive Theory. The observational learning construct which has been defined as "acquired behaviors from observing the behaviors of others and outcomes of those behaviors" (Gaines 2009) was perhaps the most influential construct in regard to our intervention design. This construct provided the framework specifically for our facilitator-guided intervention approach, where children were “guided” through the exploration of vegetables using explanations, demonstrations, prompts and questions centered on using the five senses. Our results showing a positive effect of sensory-based learning on willingness and consumption of select vegetables are in accordance with other studies employing the use of the five senses to promote vegetable acceptance (Reverdy 2008). In (*Classes du gout),* researchers evaluated the impact on a variety of food behaviors in young children (Reverdy 2008, 2010, Mustonen 2009, 2010). Sensory education improved free odor naming in both older and younger children, taste identification for younger children after the first education period, and descriptive characterization of bread for the younger children. Their results indicated that after participating in the education program, children performed better in the sensory assessments than children who were not exposed to the sensory education, and they paid more attention to certain sensory attributes of food during the study (i.e. appearance, texture) than the control group (Mustonen 2009). In our study, children paid attention to sensory attributes of the vegetables during the exploration and taste activities, and verbalized a variety of descriptors in response to our sensory-centered questions and prompts.

Though we did not assess child’s neophobia before the start of our study, based on the increases in willingness and consumption that we saw for some vegetables in response to our intervention, we can speculate that children’s neophobia was reduced by the sensory-based approach of the MAFF project. Food neophobia, i.e. the fear or avoidance of new foods (Birch 1999), tends to be heightened in younger children (Birch 1999, Reverdy 2008).In response to the

French EduSens sensory education program (children received 12 lessons over a 4-month period) neophilia increased for the experimental group, and decreased in the control group, though neither of these changes showed statistical significance, Willingness to try novel foods also increased for those children in the experimental group, (Reverdy 2008). The evidence suggests that neophobia can be reduced or perhaps overcome when foods become more familiar, particularly if consumed (Cooke 2007, Heath 2011). Children's exposure to the eight target vegetables during our intervention may lead to future changes in consumption of not only vegetables, but other less familiar foods.

While our intervention was targeted toward 3-5 year old children, the studies conducted by Mustonen et al. and Reverdy et al. were done with older children. A gap in the literature exists with regard to sensory-based education, which has proven to be effective with slightly older children (7-11 years old) (Reverdy 2008, Mustonen 2009) but this has not extensively been researched in younger children. Addressing the issue of food acceptance earlier in life is crucial. Early childhood (within the first 6 years) is when dietary preferences are formed (Byrne 2002, Aldridge 2009). Eating habits are more modifiable during childhood, and practices developed early in life may more likely be carried into adulthood (Brug 2008). The exposure to and exploration of the vegetables in our study may contribute to changes in children's diets through their positive shift in willingness to explore and try these vegetables and increased consumption.

In the present study, variations were found in total and mean consumption of the eight target vegetables. At baseline, similarities in consumption were seen between sugar snap peas and green beans, parsnip and radishes, and broccoli and cauliflower. Beets and carrots stood out above the other vegetables, with carrot consumption being the highest. At follow-up, consumption of carrots was still highest among the vegetables and the change from baseline consumption was statistically significant. There was an increase from baseline in the amounts consumed for all vegetables except cauliflower, and the change for parsnip was negligible. To explore the possibility for differences in outcome measures based on taste properties, the vegetables were grouped in the present study into two taste categories: sweet tasting and less-sweet tasting.

At our baseline and follow-up assessments incorporating all eight vegetables, a combination of “sweet” and “less-sweet” flavors, were presented to the children. We examined whether there was a difference in consumption between “sweet tasting” vegetables (sugar snap peas, beets, carrots and parsnips) and “less-sweet” tasting vegetables. Investigation into flavor-flavor learning, a conditioning procedure thought to increase preference for a neutral or disliked flavor through learned association, by Havermans et al in 2007 showed that this procedure can be effective at enhancing children’s preference for vegetables (Havermans 2007). A major sensory determinant of food acceptance and preference as supported by the literature is taste and children have an innate pre-disposition for sweet tastes and a natural dislike for bitter flavors (Birch 1999). Along with snap peas and parsnip, carrots and beets were included in the “sweet tasting” category in this study, and carrots and beets were two of the three most consumed vegetables at follow-up. It was hypothesized that intake of the “sweet tasting” vegetables would be higher than “less-sweet tasting” at both baseline and follow-up, and that the change in consumption from baseline to follow-up would be noticeably greater for the vegetables in the “less-sweet” group.

As expected, we found that there was a significant difference between “sweet” and “less-sweet” vegetable consumption at both baseline and follow-up. There was also a significant change from baseline to follow-up for the “sweet” vegetable group but not for the “less-sweet” group as we had hypothesized. However, after carrots were removed from the “sweet” tasting category and analysis was re-run, the sweetness by time-point interaction was no longer significant. Carrots seem to have been skewing the results, and the significant preference of “sweet” over “less-sweet” in our study may be attributed to carrots.

These findings are in contrast to what we found the willingness data. When comparing the willingness data between the taste categories, results showed that the difference between baseline and follow-up for “less-sweet” vegetables was significant (p=.013). The maximum willingness scores were higher at follow-up versus baseline, showing a positive effect. The results of the study are encouraging although children may have consumed higher amounts of the “sweet” than the “less-sweet” vegetables, Based on the current analysis, we believe our intervention was effective in increasing children’s willingness to explore and try the “less-sweet” vegetables like broccoli and cauliflower. This is an encouraging finding and warrants exploration in future research addressing the consumption of “less-sweet” vegetables such as broccoli and cauliflower which have been found to confer multiple health benefits with long-term consumption in adults.

Our findings were in accordance with the literature, that children naturally have a preference for foods that are sweet, including fruit, and an aversion to foods that are typically bitter, such as vegetables (Birch 1999). Research has examined the use of taste exposure, compared with other types of exposure (e.g. visual), to determine what is the most effective method for increasing acceptance in young children. A classic study from Birch in 1987 compared the two above mentioned approaches. One group of children was exposed to “taste”, i.e. vision, olfaction and taste, while the second group was received “look” exposure, i.e. vision and olfaction only. The children then made two judgments about the foods in the study: one based on taste and the judgment based on looking. The foods that were both tasted and looked at were more preferred than those foods that were just looked at. Results indicated that taste exposure enhances taste preference, but visual exposure alone was not effective in increasing taste preference (Birch 1987). However, these results do not imply that there is not a role for visual exposure in enhancing willingness to try and consume vegetables when used in combination with other forms of exposure (i.e. taste).

Color was a visual attribute of the vegetables and one of the main focuses of our study. Consistent with the current research study theme for assessing sensory attributes and evaluating their potential impact on the outcome measures in these children, we assessed willingness to explore and try vegetables as well as consume them based on color. We expected to see differences in our outcome measures across the four color groups: red, orange, green and white. More specifically, we anticipated that willingness scores and consumption would be higher for “red” and “orange” vegetables versus “green” and “white”. This expectation was based on a study by Baxter et al (2000) who found a preference for brightly-colored vegetables over dark green in children. In support of our hypotheses, we saw significantly higher intakes at baseline for orange over green, and green over white vegetables. The color theme seems to have extended to the follow-up time point, when cauliflower and parsnip were consumed significantly less than red, orange and green. Contrary to our hypothesis, in the present study green vegetables were found to be consumed in larger amounts than red vegetables at baseline and follow-up time-points, Given that the present data analysis strategy based on color resulted in each color category containing an uneven number of vegetables (red=2, orange=1, green=3, white=2), the color variable were generated for analysis were standardized, and the noted differences between means were no longer significant.

Compared to the consumption data, the willingness data supported our hypotheses in a much stronger fashion. Willingness measures incorporated in the analysis reflected the maximum rating score by percentiles in each color category therefore the uneven number of vegetables per category did not influence results. In support of our hypothesis, we saw significantly higher willingness scores at baseline for red over white and at follow-up for red over green , red over white , and orange over white ($p=.003$). These significant findings for willingness scores at follow-up overlap with significant findings for consumption between the same color categories.

Our findings although preliminary reinforce existing research that highlights the role of color as an important sensory attribute that contributes to increased willingness and acceptance of foods. In a recent study, Poelman et al. (2011) focused on preparation method and typicality of color. They evaluated whether the method of cooking and color of vegetables affects acceptance in 5 to 6 year olds. Each of the three vegetables (sweet potatoes, cauliflower and French beans) were prepared three different ways depending on the vegetable. A second, atypical color of each vegetable was also prepared (using one of the three cooking methods). Expected but not actual preference was affected by color as was vegetable acceptance (Poelman 2011). A study by Lavin and Lawless (1998) documented that color can even influence perceived taste. A series of colored solutions (light and dark red and green), all with the same level of sweetness, were presented to a sample of 5-14 year old children (split into 3 groups: 5-7 year olds, 8-10 year olds, 11-14 year olds). Children first screened each sample, rating for sweetness and then taste-tested each sample. Though the results were not significant, children (8-11 years old) as well as adults rated the dark red drink as the sweetest and dark green as the least sweet prior to tasting the samples (Lavin 1998). Baxter et al. suggest a potential explanation: that certain color-flavor associations may be formed, causing children to associate certain colors (i.e. those of the red and yellow spectrum) with sweeter tastes (Baxter 2000). The current study findings build on this associative conditioning concept, Red and orange colored vegetables, especially beets and carrots which are sweet tasting vegetables, were consumed in higher amounts overall compared with the other vegetables. Further research specifically comparing the potential for increased consumption of red/orange vegetables with green through within-vegetable varieties interacting with taste properties would provide further insight into this theory about associative conditioning.

Shape, texture and growth patterns of vegetables are characteristics which may influence children's food choices (Dazeley 2012) and the remaining sensory attributes investigated in our study. During the four intervention weeks, vegetables were paired based on these three characteristics to determine what role they play in food acceptance and we investigated differences between each of these pairings for both willingness and consumption. Our hypothesis was that we would see differences across the four vegetable pairs. Because previous research has not investigated acceptance by these properties, we did not have access to apriori hypothesis. We are unable to speculate whether any one pair would be accepted more based only on the aforementioned sensory attributes, and if so, which pairing would facilitate prominent willingness to try and intakes. Results in the current study however did show a difference between the four pairings (categorized as "tree", "root", "long-root" and "pod"). The maximum willingness rating score increased for all but the "root" vegetables. When comparing between the pairs, broccoli and cauliflower received the lowest (maximum) scores versus all other pairs at baseline. Willingness increased for the “tree” vegetables during follow-up, and at this time-point, children were least willing to explore and try beets and radishes.

When looking at consumption by pair, the greatest change (increase) in consumption was for carrots and parsnips. Based on our other results described in the previous sections of this thesis, we attribute this change particularly to carrots. The change in consumption was least for broccoli and cauliflower. Again, based on our results that compared consumption by vegetable, there was no change from baseline to follow-up for cauliflower and so we think that this affected consumption of the “tree” pairing. The vegetables that children tried at baseline (shown by a willingness score of 4) were eaten at follow-up in larger quantities than those vegetables that were not sampled. However, even when we did not see an increase in consumption for certain vegetables, we did see a difference in their willingness to explore the vegetables. In spite of this study being exploratory in nature and the results, preliminary, this finding is encouraging. In further data analysis and as part of future research, we will investigate potential associations between willingness to try and consumption.

Although we did not directly measure the effect of texture on our outcome measures, texture is acknowledged as a one of the main reasons for liking and disliking foods by young children (Zeinstra 2007) and there is emerging research that has investigated differences between texture of vegetables and acceptance (Zeinstra 2010, Poelman 2011). Studies that have looked at the sensory attribute “texture” and examined the impact of differences in cooking methods on acceptance as described above (Zeinstra 2010, Poelman 2011). Poelman et al found that texture did not affect acceptance. Zeinstra et al, on the other hand, found that crunchiness of vegetables among younger children (4 to 6 year olds) was related to higher preference. We collected qualitative data during intervention weeks using a sensory exploration chart to document children's verbal sensory assessment of each vegetable. Children were asked to describe the various vegetables across the various sensory attributes (color, shape, texture, smell, sound) using words like, "smooth", "rough", "bumpy" and "hard" in response to specific questions (what does the vegetable smell like? what color is the vegetable? touch the vegetable with your fingers- what does it feel like?, etc). These results could be partly explained by the raw vegetables incorporated in our study, thereby contributing to the crunchy texture described for these vegetables, by the children We believe the children provided these sensory descriptors because the vegetables were tasted raw; textures might have been more similar (i.e. softer) if prepared and served cooked. When presented raw, broccoli and cauliflower have a rougher and bumpier outer exterior and would produce a different feel (when touched) and mouth-feel (when tasted) than the beets and radishes

In the current study the vegetables were offered raw during the tasting for a few reasons. First, we felt that there would be more food safety considerations if vegetables were cooked or included in a prepared dish or recipe. Cooking the vegetables, perhaps transportation would be an issue to ensure that the vegetables were kept at or cooled to the proper temperature for food safety procedures. By serving the vegetables raw, we offered them to the children in their purest and most natural form. We felt it was important to introduce the children to the vegetables this way first and work with the parents during the parent night to offer preparation and recipe ideas for the target vegetables.

The specific responses given by the children during the sensory exploration activities were impressive. There were a variety of responses, and many differed by vegetable. Observations based on sight were very illustrative; children commented on the color shape and size of the vegetables. For example, for beets, children commented that the beet was big and round, had circles on the inside and looked like a pizza, because for the tasting portion, the beets were first sliced then cut into wedges. There were many different descriptors and phrases used for touch such as “slippery” (snap peas), “bumpy” (broccoli, cauliflower, carrot), “it feels like grass” (broccoli), and “it’s cold, like an iceberg” (radish). Children noticed immediately that the radishes were “spicy” and “hot” and that the cauliflower was “stinky”, “P U”. What was most noteworthy with our qualitative data was that children were verbalizing differences in texture, as well as other, sensory characteristics between the vegetables while exploring and tasting them. The descriptors used may be a hint that our sensory education approach showed a positive impact on the children’s ability to articulate characteristics of the vegetables. Similar results were seen in other research (Mustonen 2009), and a possible explanation is that pre-school aged children are in the perceptual stage of socialization (Mustonen 2009). These results indicate that nutrition education programs such as ours could be playing a constructive role in child development.

The collective results presented here provide evidence that our nutrition intervention may have helped children to activate their five senses when tasting vegetables subsequent to participating in our 4-week program. Children had higher willingness scores at follow-up for those vegetables that they were less likely to explore or taste at baseline. This positive shift demonstrates that children in our study were more engaged as a result of our program highlighting the use of all five senses when eating. We found it important to use all of the senses in our study; i.e. for it to be an inclusive construct. Eating is multi-modal (Birch 1987). We don't just consume food. We use a combination of all of our senses when we eat.

We first introduced the children to all five senses and explained how to use each one. This was done by asking the children, "what do we use to see?" and then pointing to a specific body part (e.g. eyes). We then sang a "5 Senses Song" with the children while again, pointing out the body parts appropriate for each sense. We then tested two intervention approaches during the four weeks between baseline and follow-up. The first approach we titled, Facilitator-guided (FG). The second approach was titled, Self-guided (SG). This approach always followed FG in each lesson, and a second vegetable in the pair (for example, cauliflower) was explored. For this part of the lesson, children were allowed to examine the vegetable on their own. We hoped that children would similarly use their senses to inspect this second vegetable just as they had been asked to do by the facilitator.

We hypothesized that willingness and consumption would be higher in response to the FG approach. The current research is part of the Mass Farm Fresh research project which has been developed around the constructs of the Social Cognitive Theory (Bandura 2004, Gaines 2009). Our hypothesis stated above further stemmed from research that has investigated the use of modeling to enhance food acceptance. However the results in the current study did not lend support to our hypothesis; results demonstrated that there was no difference between the two approaches for their impact on either willingness or consumption data. Other studies have looked at the effects of modeling by peers, teachers and parents (Hendy 2000, 2002, Lowe 2004, Horne 2004, Blanchette 2005). A review by Blanchette and Brug found studies showing an association between parent and child consumption (Blanchette 2005). Teacher modeling, when presented in an enthusiastic manner, was effective in increasing food acceptance in preschoolers (Hendy 2000). Peer modeling using “Food Dudes” videos proved effective for increasing overall daily consumption of fruits and vegetables in 4-7 year olds (Lowe 2004, Horne 2004).

Although our hypothesis was not supported by our results, our design was consistent with one of the major constructs of the Social Cognitive Theory (SCT), observational learning (Gaines 2009). In their review of various interventions utilizing the SCT, Gaines and Turner describe role modeling using peers, students, or parents to enhance observational learning. We applied observational behavior through the use of facilitator-guided sensory exploration to encourage children to use their senses to examine vegetables, and consume them. Our study was very unique in its design and use of dual intervention approaches by classroom. Though we did not see the results that we had anticipated, in retrospect, the results are encouraging; we were successful in respect to giving the children the opportunity and freedom to explore the vegetables on their own. The facilitator-guided approach may have influenced children's self-guided exploration and opened up children's creativity. Perhaps dichotomizing the methods into separate classrooms (instead of all classrooms receiving both approaches), we may have been able to more accurately test our specified aim and seen the results we expected: i.e. to see differences in between the two approaches. This is a consideration for future research. Also, a larger sample size might be necessary to produce more sample power to test such a hypothesis.

What our study has brought to the well-established research field of early childhood nutrition is a novel application of sensory-based nutrition education. To the best of our knowledge, no other study has evaluated both willingness and consumption of vegetables in preschoolers after participation in a dual intervention design focusing on the five senses. Our use of observed willingness was also unique; we have not come across any other studies using direct observations in the classroom setting for evaluating willingness measures in the same manner as we have done in the present study.

The results of this preliminary study aimed at the assessment of the feasibility target development of methodological protocols around the research framework proposed here. It also offers the potential for pursuit of nutrition interventions research centered on the sensory properties of within-vegetable varieties (i.e. different color varieties of vegetables) over a longer sustainable period of time.

Our results may be stretched and extended into other realms and open up many possibilities for Head Start. Head Start incorporates a vegetable of the month into their menus, and a nutrition education program could help teach the children about each of these vegetables, using our hands-on sensory approach. Those vegetables that we used in our study that have not yet been incorporated into Head Start menus could now be added into the rotation. Many Head Start sites have gardens on location, and a sensory-based education program could work with this already existing theme. Involving parents, as we did with parent events, contributes to the sustainability of our program, but more importantly to developing and sustaining more healthful eating habits for children and parents. Creating a positive environment (Young 2004) for young children and building positive relationships with food may increase willingness to try a variety of foods and increase consumption of more nutrient-dense foods such as fruits and vegetables. Though we did not specifically identify mechanisms of change in our study, we can speculate that our sensory-based approach led to the increases we saw in both willingness to try and consumption of the target vegetables.

It is important to recognize that the goal of this early childhood intervention study is consistent with the goal of the Mass Farm Fresh (MAFF) research project which is to assess to what degree a sensory nutrition education program can increase recognition, knowledge and awareness (RKA) of local varieties of fresh F&V and consequently diversify the F&V selections in pre-school children living in Western Massachusetts. Underlying the research rationale in MAFF is the premise that “individuals vary according to the extent to which they perceive and respond to sensory information (Dunn, 1999). With special attention to the naturally-occurring variations in appearance/smell/taste characteristics across locally grown varieties of F&V, the specific aims of MAFF are to: (1) *Examine the impact of the sensory play approach (taste/smell, visual and tactile) on preschool children's willingness to taste, early F&V preferences and consumption of locally grown and locally available F&V, controlling for socio-demographic, child variables and parental variables; AND (2) Examine whether the educational intervention-associated change in RKA: (a) Predicts change in skills and self-efficacy levels (b) Impacts changes in willingness, preferences and consumption differ among children with different levels of recognition, knowledge and awareness, skills and self-efficacy.*

Future possibilities to extend our program include “Train the Trainer” models, where Head Start teachers are trained to implement select components of the project themselves. This would reduce resources needed (i.e. student volunteers and workers), while improving the cost-benefit ratio of the program. By reducing costs, and providing significant results, we can stake a claim to increase funding for nutrition education programs focusing on fruit and vegetable consumption among young children, which would also help to increase the sustainability of these important programs. By emphasizing the need of nutrition education using our findings, which show that the intervention was successful at increasing consumption, and as a result, increasing the intake of important nutrients (and eventually lessening deficiencies), children's risk for sub-optimal nutritional and health is reduced. Emphasizing and focusing on prevention is key to the success of our program, because the current public health problems plaguing our country, such as obesity and type 2 diabetes, can be reduced.

CHAPTER 5

CONCLUSIONS

5.1 Study Conclusions

Overall, our nutrition education program had positive effects on children's willingness to taste and consumption of the eight target vegetables we presented. We saw higher consumption for all vegetables except cauliflower at follow-up compared with baseline. And we did see a positive shift in willingness scores, indicating that even if more children did not try the vegetables at follow-up, more children were willing to explore them after participation in our program. This could have implications in the future with more exposures to these vegetables. Increased willingness to explore may increase familiarity, and later, increase consumption. We were able to activate children's senses using our multi-sensory approach and increased their exposure to a variety of vegetables. Because this study was exploratory in nature, in the future we would like to validate the instruments and methods tested here, and consider it would be worthwhile to further assess the effectiveness of our approach in a larger sample of children over a longer period of time. The ideas tested and presented here also open up future research opportunities with preschool children in Head Start settings focusing on vegetables and the use of the five senses of within-vegetable varieties.

5.2 Limitations of the Study

This study is associated with a few limitations. Because we conducted our intervention in a classroom setting, we were not able to randomize the individual study participants (children) into experimental and control groups, nor were we able to have a control group. Per a recommendation by the Head Start Nutritionist, it was viewed that a control group, which would not have received any intervention, would not be fair to some of the children, and therefore did not agree to our study design including this. However, the classroom sites were matched up based on sample size (i.e. the number of children in each classroom, and at each site). This gave us comparable groups when analyzing the intervention approaches. The current study data will be compared with data from a concurrent intervention which was also conducted under Mass Farm Fresh involving the use of puppets and incorporating the same eight vegetables in other Head Start classrooms.

A second limitation is the sample size used to conduct our analysis, n=50 children, was limited in power for assessing the full scope of effect of the intervention. . Although the larger sample included 94 children, the analysis presented here are included only for those 50 children who had complete data at *both* baseline and follow-up. We felt that this approach would allow the analysis to be robust. In further ongoing analyses, we will be using imputations procedure for the missing data.

We did not dichotomize our intervention approaches, and so we may not have been able to assess e what impact each individual vegetable in a pair may have independently exerted on willingness and consumption. of the vegetable-pairs. Similarly by pairing the two intervention approaches (facilitator-guided, and child self-guided), one after the other, the study design did not permit the exploration of the aim related to the difference in consumption by the respective approach. However, the observations from the intervention classrooms clearly demonstrate that the facilitator-guided approach has a positive influence children's self-guided exploration. And that the children expanded their sensory descriptions vocabulary and sensory engagement as a follow-up to the facilitator-guided approach in each classroom on a weekly basis.

5.3 Study Strengths

Our study came with strengths. First, our design is an adaptation of previous work within a similar population of Head Start pre-schoolers in the Western Massachusetts area (Kannan et al, 2011; Kannan et al, 2012). The current research aims are best viewed as exploratory. This feasibility study will contribute key components such as establishing the validity of our study design and instruments for future expansion in the Head Start community.

The classroom based sensory components and activities addressed in the curriculum designed for this s research project are in line with some of Head Start's competencies and domains including, *initiatives and curiosity* and *conceptual knowledge of the natural and physical world* (Head Start). The current research project clearly fills a gap in the Head Start curriculum and complements the ongoing classroom components already existing within the Head Start curriculum.

Another strength that should be noted was the use of pre- and post-vegetable weights to measure consumption. This method has been utilized in other research (Horne 2004, Lowe 2004), and helped to provide reliable data. In addition the use of trained observers in the classrooms during lessons provided reliable observed willingness data. In future work, we will establish the reliability and validity of the data collection protocols used here.

Finally, we have just completed a 3-month follow-up for which data are currently undergoing processing and will soon involve analysis. This provides an opportunity for us to explore whether the findings for willingness and consumption persist into the long term.

5.4 Implications

Our nutrition education intervention offers some important implications for child-focused nutrition and also future research. Sensory-based exposure appears to be an effective strategy for increasing vegetable consumption and for promoting exploration of vegetables by young children in their formative stages of life. Greater willingness to explore vegetables with the five senses will potentially result in children's increased familiarity with the vegetables and in the use of multiple senses to enjoy fresh produce, and this could in turn lead to increased consumption with subsequent exposure. The use of a preschool age nutrition education program focusing on the use of all five senses when eating created opportunities for these children to establish a positive relationship with vegetables. It is important to expose children to a variety of foods and to create these positive relationships with food in early childhood so that they may carry these experiences throughout the rest of their lives.

APPENDICES

APPENDIX A

MASS FARM FRESH, CLASSROOM VEGETABLE SENSORY EXPLORATION: BASELINE/FOLLOW-UP WILLINGNESS ASSESSMENT RATING SCALE-FALL 2011

Head Start Site Name: **Time assessment began: ___(hr)___(min)**
Observer:
Classroom: **Time assessment end: ____(hr)____(min)**
Use an X to indicate rating. Mark ALL that apply

CHILD'S NAME:					
Vegetable	Not willing to do anything(0)	Examined (looked, touched, smelled) (1)	Licked only (2)	Spit out (3)	Swallowed one or more bites (4)
Broccoli					
Cauliflower					
Parsnip					
Carrots					
Beets					
Radishes					
Green Beans					
Pea pods					
NOTES:					

CHILD'S NAME:					
Vegetable	Not willing to do anything(0)	Examined (looked, touched, smelled) (1)	Licked only (2)	Spit out (3)	Swallowed one or more bites (4)
Broccoli					
Cauliflower					
Parsnip					
Carrots					
Beets					
Radishes					
Green Beans					
Pea pods					
NOTES:					

APPENDIX B

RECORDED WEIGHTS FORM

Mass Farm Fresh Recorded Weights – FALL 2011: Sensory Vegetable Exposure

Head Start Location: Date: Classroom:

Initial Measurer:

Type of Vegetable: Final Measurer:

Child's name	Pre-weight (g)	Post weight (g)	Consumption: total weight (g)

Total for whole classroom			

Total Consumption (net)= pre-weight – post weight = total net consumption

APPENDIX C

SENSORY EXPLORATION CHART

HEAD START SITE____________________ HEAD START CLASSROOM____________

DATE: ________________________ OBSERVER: _______________________________

Vegetable Sensory Exploration Chart: **Mass Farm Fresh Research Project** **Funded by USDA HATCH.** **Project Director and Principal Investigator: Srimathi Kannan, PhD** **Research Assistants: Shannon Seguin, MS Nutrition Candidate; Arielle Magro: MS Nutrition Candidate** **Use this chart to record descriptive phrases mentioned by the children during the Sensory Exploration and Tasting Segments of the Lesson Plan.** RECORD ALL PHRASES STATED BY THE CHILDREN: ALL CHILDREN THESE DATA ARE RECORDED AT THE CLASSROOM LEVEL NOT NECESSARILY BY INDIVIDUAL CHILD					
Vegetable	***See***	***Touch***	***Smell***	***Hear***	***Taste***

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