Western Massachusetts Head Start Preschoolers' Vegetable Consumption in Response to a Puppet-Based Nutrition Education Intervention Focusing on the Sensory Properties of Vegetables

WESTERN MASSACHUSETTS HEAD START PRESCHOOLERS' VEGETABLE CONSUMPTION IN RESPONSE TO A PUPPET-BASED NUTRITION EDUCATION INTERVENTION FOCUSING ON THE SENSORY PROPERTIES OF VEGETABLES

A Thesis Presented

by

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ABSTRACT

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The current exploratory study is part of Massachusetts Farm Fresh (MAFF) research project. Food preferences are shaped by early experiences and exposures. Multi-sensory nutrition education interventions aimed at promoting children's preferences for vegetables have the potential to positively impact children's intake of essential micronutrients and phytochemicals. The goal for the current study, implemented in Western Massachusetts Head Start preschool classrooms, was to increase the children's familiarity and consumption of vegetables through multi-sensory exploration. Social cognitive theory, early childhood developmental milestones, and the play approach to learning provided the framework. During the 4-week intervention, the eight selected vegetables were matched by appearance and growing process to create vegetable pairs (green bean-sugar snap pea, broccoli-cauliflower, beet-radish, and carrot-parsnip). Each week, two animal puppets introduced the children in the classroom to the vegetable pairs by highlighting the vegetable's color, shape, texture, and growth process. The two puppets explored one vegetable (example: green beans) with their multiple senses. Immediately following this, one of the puppets guided the children through sensory

exploration of the other vegetable in that pair (example: peas). Complete baseline and follow-up consumption data were available for 60 three to five year old children
At baseline, children received a 56-gram serving containing all eight vegetables (7.0 g per vegetable). Total mean consumption (g) increased pre-post intervention (pre: 14.75 $\pm$ 1.38 vs. post: 17.83 $\pm$ 2.05 g) (p= 0.06). Specifically, mean consumption (g) increased for peas (pre: 1.32 $\pm$ 0.26 vs. post: 2.03 + 0.36 g) (p=0.04), parsnips (pre: 1.31 + 0.24 vs. post: 2.06 $\pm$ 0.35 g) (p=0.04), and for the high-sugar content vegetables (pre: 7.41 + 0.82 vs. post: 9.75 $\pm$1.14 g) (p=0.02). Mean consumption of the red and white colored vegetables respectively were (pre: 2.66 $\pm$ 0.41 vs. post: 3.68 $\pm$ 0.54 g) (p=0.07) and (pre: 2.81 $\pm$ 0.46 vs. post: 3.93 $\pm$ 0.61) (p=0.08). Findings suggest that a puppet based sensory nutrition education intervention highlighting taste and color attributes has the potential to increase young children's consumption of vegetables. Future research should explore the long-term impact of these findings for children enrolled in Head Start.

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CHAPTER 1

INTRODUCTION

1.1 Childhood Food Preferences

Obesity is a major public health concern in the United States (US) as well as other countries around the globe (CDC, 2011; Fox et al., 2010; Ogden et al, 2010) It greatly increases ones risk for numerous health problems including cancer, diabetes, and heart disease. Not only has the adult obesity rate dramatically increased, the obesity rate in children has increased three fold in the past three decades. One out of seven low income two to four year old US children were classified as obese in a 2010 national survey. Since dietary patterns in childhood are directly linked to the eating habits in adulthood, obesity in childhood is a strong predictor of obesity in adulthood (CDC, 2011; Fox et al., 2010; Ogden et al., 2010).

Children have an inherent liking for sweet and salty flavors as well as a dislike for sour flavors, but their actual food preferences are shaped by early experiences and exposures to food (Aldridge et al., 2008; Birch & Davison, 2001; Dazeley et al., 2011). Since familiarity greatly influences children's willingness to try and acceptance of foods, it is important that children are exposed to a wide variety of foods early on in life (Aldridge et al., 2008; Birch & Davison, 2001; Dazeley et al., 2011). It is critical for children to have many early exposures to food because they become less willing to try new and unfamiliar foods as they age (Aldridge et al, 2008; Cooke, 2007). As a result, it is more difficult to alter their food preferences and incorporate new foods into their diet (Aldridge et al., 2008; Cooke, 2007). Researchers determined that children more readily

accept new foods between the ages of two and four than between the ages of four and eight (Skinner et al., 2002). The researchers also concluded that a child's food preferences at four years old is a strong determinant of that child's food preferences at eight years old (Skinner et al., 2002) Therefore, the food experiences a child has between the ages of three and five years old can have a long lasting impact on their food preferences. This window of opportunity to alter children's food preferences is a major reason why preschool age children are a target population for nutritional interventions.

Food neophobia makes increasing the familiarity and acceptance of new foods in preschool age children more challenging because it occurs during this critical age when food preferences are forming. Food neophobia, or the fear of trying new unfamiliar foods, usually develops when children are almost three and stays an important influence until children are about five or six (Aldridge et al., 2008; Cooke, 2007). Given that preschool age children are independently exploring their environment, food neophobia is thought to be the body's way of preventing children from eating poisonous or toxic substances they find when exploring (Aldridge et al, 2008; Cooke, 2007; Dazeley et al., 2011). Luckily, a child develops 'learned safety' after multiple exposures to a food because he or she learns that the food is not toxic and is safe to eat (Birch, 2001; Cooke, 2007 Dazeley et al., 2011). Consequentially, three to five year old children may need multiple exposures before they are familiar enough with the food to incorporate it into their food preferences (Aldridge et al., 2008; Birch & Davison, 2001; Cooke, 2007; Dazeley et al., 2011). Given this information, our study provided the children with three separate opportunities to taste a variety of vegetables. We also attempted to increase three to five year old children's familiarity with vegetables by having animal puppets encourage the children to explore

the vegetables with their multiple senses. The children had the opportunity to look, touch, smell, and taste the vegetables as well as learn about their growing process during the intervention lessons.

1.2 Dietary Inadequacies and Vegetable Consumption for US Preschoolers

One out of every ten US children between the ages of two and five years old was obese in 2008 (Fox et al., 2010; Ogden et al, 2010). This staggering statistic demonstrates the need for dietary improvement in US preschool age children. The 2008 Feeding, Infants, and Toddlers Study (FITS) examined the dietary intakes of US children 0 to 47.9 months to determine the specific nutritional inadequacies of this age group (Briefel, 2010; Butte et al., 2010; Fox et al., 2010). Preschoolers were classified as children 24 to 47.9 months old and 1,461 of them participated in the study. The sample included a total of 3,273 children that were representative of the US population. Fifty six percent of the children were White, twenty one percent Hispanic, and fourteen percent Black. Seventy one percent of the children's families had an income between $20,000 and $100,000. Thirty of the children's families were part of Federal Women, Infants, and Children Program (WIC) and forty six percent of the children's mothers had at least a college degree. The parents of the children were randomly selected from two databases. The New Parent Database was used to find children less than thirty-six months old and The Consumer Database was used to find children over thirty-six months old. The parents were first sent a postcard about the study and then received a telephone interview. Once consent was received, the researchers conducted a dietary interview during which parents

were asked to complete a twenty-four hour dietary recall and dietary questionnaire for their child (Briefel, 2010; Butte et al., 2010; Fox et al., 2010).

Data from the 2008 FITS study revealed that seventy eight percent of preschoolers consumed above the 1500 mg/d tolerable upper intake level (UL) for sodium and seventy six percent of preschoolers consumed above the ten percent recommended amount of total calories from saturated fat (Butte et al., 2010; U.S. Department of Agriculture, 2011). Excessively high levels of sodium and saturated fat are indicators of a nutrient inadequate diet. Low potassium and fiber intakes were also found, which underscores the nutritional inadequacy in U.S. preschoolers' diets. Not only were the mean potassium and fiber levels below the adequate intake level (AI), the 90th percentile values were also below the potassium AI of 3,000 mg/d and dietary fiber AI of 19 g/d. While preschoolers had adequate vitamin C levels, fifty nine percent of them had preformed vitamin A levels above the UL due to supplement use. Incorporating more vegetables into their diet would provide them with food sources of vitamin A and C as well as increase dietary fiber and potassium levels (Butte et al., 2010; U.S. Department of Agriculture, 2011). To further understand the vegetable consumption of preschoolers, the 2008 FITS determined the amount of children that ate any amount of vegetables at least once a day as a distinct portion (Fox et al., 2010). A distinct portion indicates that the vegetables were not eaten as part of mixed dishes. The researchers concluded that seventy percent ate some type of vegetables, sixty percent ate cooked vegetables, and twenty two percent ate raw vegetable at least once daily. Therefore, about thirty percent of the children were not consuming vegetables on a regular basis (Fox et al., 2010). Since our study will be providing preschoolers with raw vegetables, it is important for us to

consider that most of the children consumed cooked vegetables. As a result, the preschoolers might not be as familiar with the raw form of the vegetable as the cook form and thus less accepting of it.

The 2008 FITS study data on the particular vegetables eaten by this age group guided us in the vegetables selected for our study. The researchers found that mashed potatoes, mixed vegetables, green beans, corn, and broccoli were the most popular vegetables eaten (Fox et al., 2010). White potatoes were their favorite, specifically fried potatoes like French fries. While thirty one percent of preschoolers ate white potatoes minimum once a day, only thirteen percent of preschoolers ate dark green colored vegetables and only fourteen percent ate deep yellow colored vegetables at the same frequency. Dark green vegetables included romaine lettuce, spinach, broccoli, and other types of greens. Deep yellow colored vegetables included sweet potatoes, winter squash, carrots, and pumpkin. Thirty four percent of preschoolers ate 'other vegetables' at least one time a day. This included tomatoes, corn, green beans, peas, beets, cucumbers, onions, and others (Fox et al., 2010). Knowing that white potatoes are the main source of vegetables for preschoolers, there is a need to increase the variety of colored vegetables preschoolers consume. Consequently, we chose a wide variety of colored vegetables for our study that could be consumed in their raw form.

1.3 Phytochemicals in the Selected Vegetables

Phytochemical content was also an important consideration when we selected the vegetables for our study. Phytochemicals are non-essential nutrients synthesized in plants

(Oregon State University Phytochemicals, 2011). Flavonoids, carotenoids, and chlorophyll are three classes of phytonutrients that provide the color pigments to plant based foods (Oregon State University Fruits and Vegetables, 2012; Oregon State University Phytochemicals, 2011). The phytochemicals that are present in the vegetables selected for our study can be seen in table 1. Given that appearance can greatly influence vegetable consumption in young children, we were interested in how the children's vegetable consumption differs across the color categories (Dinehart et al, 2006). While more research is needed to determine whether the beneficial effects of phytochemicals are a result of the compounds themselves or a high intake of vegetables and fruits, research has found that phytochemicals can impact the risk for some chronic diseases (Oregon State University Phytochemicals, 2011). For example, the beneficial actions of flavonoids may be a result of their role in cell signaling pathways instead of their antioxidant properties. Flavonoids may be able to control cell growth, gene expression, inflammation, and apoptosis by altering signaling pathways within the cell (Oregon State University Flavonoids). As a result, flavonoids may impact one's risk for cancer or cardiovascular disease (Haytowitz et al., 2012; Oregon State University Flavonoids, 2011). Flavonoids are a group of polyphenols present in berries, teas, and vegetables (Haytowitz et al., 2012; Oregon State University Flavonoids, 2011). Flavonoids are found in almost all of the vegetables present in our study including beets, radishes, parsnips, green beans, snap peas, broccoli, and cauliflower (Haytowitz et al., 2012) When compared to the other vegetables, broccoli has the highest flavonoid level (Haytowitz et al., 2012) The high flavonoid and glucosinolate content of cruciferous vegetables like broccoli and cauliflower causes them to have a bitter taste (Dinehart et al, 2006;

Drewnowski & Gomez-Carneros, 2000). Bitterness tends to be stronger in the raw form of the vegetable. Unfortunately, the bitter taste of vegetables can negatively impact children's consumption and preferences for those vegetables. On the other hand, perceived sweetness of a vegetable can increase consumption and preferences for vegetables (Dinehart et al, 2006; Drewnowski & Gomez-Carneros, 2000).

1.4 Social Cognitive Theory

A cognitively oriented theoretical framework is a critical part of a successful intervention because it helps the researchers understand why humans develop different behaviors and how to effectively change them (Lubans et al, 2011). Social cognitive theory (SCT) is commonly used in interventions attempting to change a certain health behavior such as physical activity, dietary patterns or smoking (Lubans et al, 2011; Rinderknecht et al, 2004; Rogers et al, 2004). The SCT states that environmental factors, the health behavior, and personal factors are all interrelated and can impact behavior change (Lubans et al, 2011; Rinderknecht et al, 2004). *Environmental factors* include reinforcement and observational learning (Berlin; Lubans et al, 2011; Milne et al, 2008; Rinderknecht et al, 2004; Rogers et al, 2004; Sharma, 2006;). Behavioral capacity, expectations, expectancies, emotional coping response, and self-efficacy are considered *personal factors* (Berlin; Lubans et al, 2011; Milne et al; Rinderknecht et al, 2004; Rogers et al, 2004; Sharma, 2006;). Self-efficacy, the confidence in oneself to change a desired behavior, is the main construct that impacts behavior change (Lubans et al, 2011; Sharma, 2006; Rinderknecht et al, 2004). As a result, the goal of interventions attempting

to change a health behavior is to increase someone's confidence that this is a realistic and feasible behavior change (Lubans et al, 2011). It is the hope that increasing their self-efficacy will also encourage them to make the behavior change (Lubans et al, 2011).

Our nutrition education intervention applied this theoretical framework with vegetable consumption as the targeted health behavior. By introducing the children to a variety of vegetables and giving them the opportunity to taste them, we hoped to increase their self-efficacy to consume more vegetables. There are seven different social cognitive constructs used in our study (Table 2) (Berlin; Lubans et al, 2011; Milne et al; Rinderknecht et al, 2004; Rogers et al, 2004; Sharma, 2006;). In addition to self-efficacy, observational learning and behavioral capacity were other two main theoretical constructs incorporated in the current study. Observational learning occurred when the puppets role modeled sensory exploration by demonstrating how to explore a vegetable's appearance, texture, and smell (Table 3). After the demonstration, the children were able to explore the featured vegetable while talking to their friends and the puppets about the vegetable's sensory properties. The children also participated in observational learning when they watched the puppets use a poster to explain the growing process of the vegetables. One puppet explained how the vegetable grows to the other puppet by pointing to the various growing stages of the vegetable plant illustrated on the poster. During this process of observational learning, the children increased their knowledge about the vegetables as well as their skill to choose the vegetables they like through the behavioral capacity construct. The knowledge the children received about the vegetables through the puppet show could alter their expectations and expectancies about vegetables. A goal of our intervention was for the children to develop new positive expectations about vegetables,

increase their familiarity with a variety of vegetables, and realize that vegetables can be tasty. We provided the children three separate chances to taste the vegetables in order to reinforce the positive experiences they have with vegetables.. Tasting samples of all eight vegetables were provided at both the baseline and follow up assessments. Also, the tasting samples containing two of the featured vegetables were provide during each of the four intervention weeks. Our study attempted to remove the stress and fear of trying vegetables by introducing them in a relaxed, safe, and fun environment through the Head Start classroom setting.

1.5 Incorporation of Preschool Age Children's Development Stages

Given that young children are very curious about their environment and enjoy using their imagination, Rickard and colleagues promote the "play approaches to learning" (Rickard et al, 1995). When children are playing, they are actively participating in something they enjoy. It is a safe environment where they can learn something without being afraid of the negative consequences. As a result, children have increased freedom during playtime and are more self-motivated to make their own decisions. Playing allows children to effectively explore their environment, cultivate their creativity and imagination, as well as increase their interpersonal skills (Rickard et al, 1995). A sensory nutrition education program built around the self-discovery of vegetables through play activities provides children with the opportunity to examine the color, shape, texture, smell and taste of the vegetables in a safe fun environment. It also nurtures the physical, mental, and social skills three to five years old children are developing to help them reach

the established milestones for this age group (Table 4). Preschool age children are learning to differentiate between various colors, shapes, and sizes. They are also comparing similar objects to different ones, learning to follow verbal directions, and expanding their verbal skills (American Academy of Pediatrics, 2012; US Department of Education, 2005). Preschoolers have a longer attention span, increased capacity to preform activities independently as well as more willing to play and share with other children when compared to toddlers (US Department of Education, 2005). In our study, we cultivated the preschoolers' matching skills by presenting the vegetables in pairs that were similar in appearance and growing process, but also have many differences (Table 5). During the beets and radishes lesson, the children learned that beets and radishes were both round and grew under the ground. In addition, the children learned that beets and radishes had many differences including: beets were larger than radishes, beets were a deeper red, and radishes were white inside. We also encouraged the children to increase their verbal language skills by asking what the vegetable looks, feels and smells like. Children were asked about the vegetable's color, shape, texture, and smell. By physically touching and feeling the vegetable, the children were able to increase their fine motor skills. Opening the pea pods and taking out the peas, pulling apart the broccoli, or picking up the pre-cut vegetables from their tasting bowl were several examples of how the children's fine motor skills were stimulated (Table 4).

1.6 Influential Nutrition Education Programs

The sensory exploration and exposure approach builds on the *Early Sprouts* program designed by researchers at Keene State College, New Hampshire (Kalich et al, 2009). The *Early Sprouts* program is a twenty four-week garden nutrition education program implemented in preschool classrooms. Green beans, bell peppers, Swiss rainbow chard, butternut squash, tomatoes, and carrots were the six vegetables featured in this program. The program implemented a "seed to table" approach where the children help plant the organic vegetable garden in May/June, tend the garden throughout the summer, and then harvest the vegetables between July and October. This was a very interactive approach to learning where the children were able to see how the vegetables actually grow. Planting a vegetable garden was a fun way for children to increase their knowledge about vegetables and gain an appreciation for where they come from. Therefore, our study adapted the vegetable garden concept and presented the children with a poster showing the growing process of the selected vegetables.

The *Early Sprouts* program devotes one week to exploring each of the six vegetables' sensory properties with a full rotation of all the featured vegetables occurring four times throughout the program. Sensory exploration, hands on recipe building and a "Family Recipe Kit" are the three segments of the curriculum that occur each week. Our sensory exploration of the vegetables is very similar to the *Early Sprouts* program. Both programs focus on the smell, look, feel, taste, and even sound of the raw vegetables. *Early Sprouts* also has the children participate in easy recipe building activities using the featured vegetables and provides the families with information about how to prepare recipes using the featured vegetables as well as the ingredients to make those recipes

(Kalich et al, 2009). Although our study did not have the recipe building activities to increase the excitement about vegetables, we did have animal puppets. Since young children find puppets exciting and are willing to have conversations with them, they could be effective education tools (US Department of Education, 2005). The puppet show engaged the children's imaginations and can generate excitement about the vegetable related activity.

Color Me Healthy was another preschool nutrition education program crucial to the development of our study (Witt & Dunn, 2011). *Color Me Healthy* was implemented in seventeen childcare centers in Texas to increase vegetable and fruit snack consumption. Carrots, tomatoes, and broccoli were the vegetable snack. Pineapple, grapes, and strawberries were the fruit snack. Similar to our study, *Color Me Healthy* had a baseline assessment a week before the program and a follow assessment a week after the program to assess the change in fruit/vegetable consumption. *Color Me Healthy* also provided the children with pre-weighed portions of the fruits snack and pre-weighed portions of the vegetables snack. The tasting period occurred at the end of the lesson in both our study and *Color Me Healthy.* The tasting samples were weighed after the children tasted them to determine intake. Pre and post weighing vegetables provides the researchers with objective consumption data from the children. *Color Me Healthy* provided the children with one cup of fruit or vegetables and then standardized the number of fruit or vegetables pieces in the serving (for example: three baby carrots). Given that fruit or vegetable pieces can be different sizes and weights, we improved on this methodology by having a set gram weight for each vegetable portion.

Color Me Healthy was a six-week program conducted twice a week during circle time in child-care centers. The fifteen to thirty minute lessons emphasized the colors of the fruits/vegetables through posters, songs, and picture cards. Our study was able to build on this idea and develop a program that focus on all the sensory properties of vegetables. We developed a five senses song as well as posters that illustrate the vegetable's growing process. *Color Me Healthy* activities included the "Brown Paper Mystery Bag" where the children guess what fruit or vegetable is in the bag by through only their sense of touch and smell. Once the children identify the fruit or vegetable, the teacher shows it to the children and explains more about its sensory properties. *Color Me Healthy* activities also include six imaginary trips where the children act out different stories involving fruits and vegetables. Our study was able to combine both of these activities into a puppet show. In the first part of the puppet show, the puppets explore a vegetable by themselves and then the puppets explore another vegetable with the children. *Color Me Healthy* program significantly increased the vegetable snack and fruit snack consumption in preschool age children. As result, *Color Me Healthy* was an influential program to our study (Witt & Dunn, 2011).

FruitZotic was in implemented in five Western Massachusetts Head Start classrooms to promote the acceptance of exotic fruits from Spring 2008 to Spring 2010 (Kannan et al, 2011). Categories of exotic fruit were selected based on their sensory attributes. For example, fruit with hair included coconuts, pineapples, and kiwis. Red fruit with seeds included raspberries, watermelons, and plums. Once a month for three months *FruitZotic* implemented thirty-five minute long lessons that emphasized the sensory properties of fruit. The fruit was passed around the circle and each child had the

opportunity to look, touch, shake and smell the fruit. Next, a picture book was read out loud that featured that fruit and the children were able to see the inside of the fruit. The children were then given a tasting sample of the solid and liquid form of the fruit (Kannan et al, 2011). The *Classroom Garden Project* was implemented in the spring of 2011 and was adapted from the *FruitZotic* format (Kannan et al, 2012). Raw broccoli, sugar snap peas, carrots, and red bell peppers were the selected vegetables for this study. These vegetables represented green (broccoli and sugar snap peas), orange (carrots), and red (red bell peppers) colored vegetable categories. Instead of passing a fruit around and reading a book, the *Classroom Garden Project* provided the health benefits of the featured vegetable though a story and a puppet. There was a different puppet each week and one of the most popular puppets was a Bunny. As a result, we decided to have the bunny puppet constant throughout all four of the intervention weeks in our study. In addition, we choose to have the sensory exploration incorporated into the story as well as have another puppet involved in the lesson. Having two puppets provides the opportunity for dialog between the puppets. The *Classroom Garden Project* also enabled us to pilot test the pre and post vegetable consumption measurement procedure (Kannan et al, 2012).

1.7 Puppet Nutrition Education Programs

A nutrition education program, entitled *Willow Comes to WIC*, was presented at the 2011 ADA Food & Nutrition Conference & Expo (Family Cook Productions, 2011; Wilson et al., 2011). This pilot was implemented in a New Jersey WIC center and was

comprised of twelve fifteen-minute lesson plans designed to highlight seasonal fruits and vegetables during the twelve months of the year. As a result, *Willow Comes to WIC* was implemented over an entire year with each lesson presented a couple times a week. Willow the rabbit guided the children through discovery, preparation, and tasting of the two or three featured fruits and vegetables during each lesson. Similar to *Willow Comes to WIC* the current study introduced a rabbit puppet named Bouncy to guide the children through discovery of two vegetables per a lesson. Also, Willow and Bouncy both encouraged the children to explore the featured vegetables using a magnifying glass and to taste a vegetable sample.

Willow Comes to WIC told a story that introduced the children to vegetables by using an apron with tree and roots, posters on the wall and Willow. Willow grew different vegetables in her own "magical garden." In the current study, two puppets discovered the two vegetables together through sight, touch, and smell. Once the two puppets discovered a vegetable, the second puppet pointed to a poster and explained how the vegetable grew. Unlike *Willow Comes to WIC*, the poster was part of the story and illustrated the different growing stages of vegetable. We believed that incorporating the poster into the story was more effective than having it on the wall because the posters acted as a visual prop. In addition, the growing process poster was a clear and concise way to explain how the vegetable grew. The number of mothers who used their WIC fruit and vegetable vouchers pre and post intervention will be the main evaluation tool for *Willow Comes to WIC.* While measuring the voucher use could be an effective tool, our method of evaluating the children's consumption of the vegetable was more objective and

quantitative (Family Cook Productions, 2011; Wilson et al., 2011). It will definitely be interesting to see the final results for *Willow Comes to WIC.*

A second puppet nutrition education program called *School Yard Kids* was implemented in a New York City public school with fifty-five first to third graders (Wright, 2007). Twenty five percent of the students were Black and sixty one percent of the students were Hispanic in this school. The researchers used puppets that looked liked people and were of similar ethnicity as the students. The program consisted of five hand puppets performing a puppet show that encouraged the students to exercise regularly and have healthy dietary habits. The puppet show was only performed once and lasted thirty minutes with seven different scenes. The students completed evaluation forms at the end of the show and one of the questions was to write a health goal. Forty-nine percent of the students wrote a health goal about exercise, forty six percent wrote a goal about eating healthy and eighty four percent felt very sure they could achieve this health goal. The researchers found that the puppet show was a successful way to teach children about both exercise and healthy eating. Furthermore these findings show that puppets can be an effective way to teach children about nutrition. Whereas puppet show in *School Yard Kids* delivered general nutrition information, the puppet show in the current study delivered very specific information about each of the eight vegetables (Wright, 2007). We explored the color, shape, size, leaves, peas/beans inside the pods, and demonstrated how the vegetable grows. We also had the puppets show scenes spread out over four weeks to provide enough time for the puppets and children to thoroughly explore each vegetable. As a result, each scene was devoted to two vegetables. The children enjoyed interacting with the puppets as they together explore the featured vegetables pair for that

week (for example: beets and radishes) Encouraging the children to participate in the puppets show made it more interesting for them with the added benefit of helping them learn.

Healthy Children Arizona was a nutrition education production implemented in thirty-seven Arizona schools with eight thousand children in kindergarten, first and second grade participating since 2005 (University of Arizona, 2009; Vanderlugt, 2010). *Healthy Children Arizona* contained five cancer prevention themed lessons. The first lesson promoted eating a variety of colored fruits and vegetables. Lesson two explained how the colored vegetables and fruits could help people stay healthy. The third lesson taught children how to distinguish healthy and unhealthy foods using the nutrition facts label. The fourth lesson involved one puppet teaching the other puppet about exercising regularly, while the fifth lesson had two animal puppets teach each other about sun safety. Health behavior role modeling by the animal puppets in the fifth lesson of *Healthy Children Arizona* was comparable to role modeling exhibited by our puppets. In our study, a new animal puppet each week helped the recurring rabbit puppet discover the featured vegetable pairs. The focus of *Healthy Children Arizona* was to teach children how to make healthy choices with the hope that they actually make those choices in the future (University of Arizona, 2009; Vanderlugt, 2010). On the other hand, the current study familiarized the children to different vegetables through sensory exposure and also provided the children a fourteen grams sample of the raw vegetable to taste (twenty eight grams for the two vegetables). Consequently, our study had a more active approach because we are attempted to increase their familiarity with the taste of the vegetables as well as teach them about the vegetables.

1.8 Massachusetts Farm Fresh

The current study is part of the larger research project titled *Massachusetts Farm Fresh* (MAFF), which is funded through the US Department of Agriculture's National Institute of Food and Agriculture – HATCH grant. *Massachusetts Farm Fresh* project includes: the *Classroom Garden Project*, *Fruitzotic*, facilitator guided sensory approach as well as our puppet focused sensory approach (Figure 1). The hand on approach was very similar to the puppet approach except there were no puppets and the children explored the vegetables with the UMass students. As a result, the theoretical foundation and goals for our study correspond with the ones present in the overall *Massachusetts Farm Fresh* project.

The research aims for *MAFF* that relate to the current study are listed below:

1. Children will increase recognition of a diverse selection of MAFF fruits and vegetables
2. Descriptively characterize the fruits and vegetables by physical and sensory characteristics.
3. Become more familiar with the lifespan of these fruits and vegetables, categorize fruits and vegetables by theme (example: fruits with seeds, vegetables with contrasting interior/exterior).
4. Expand their willingness and preferences for a variety of fruits and vegetables featured in MAFF.
5. Children will increase consumption of the targeted fruits and vegetables in the Head-Start setting.

1.9 Research Question, Aim 1, and Hypotheses

Research Question: Is there a significant difference in children's vegetable consumption based on sensory properties of the vegetables? Aim 1: To compare preschool age children's consumption of the high-sugar content vegetables with the low-sugar content vegetables at the baseline and follow up time points.

- High-sugar content vegetables include: beets, peas, parsnips, and carrots.
- Low-sugar content vegetables include: green beans, cauliflower, radishes, and broccoli.
- Sugar content categories were established by the vegetable's sugar content. Sugar content was found in the USDA national nutrient database (Table 6).

Hypothesis 1a: Not only are there innate preferences for sweet flavors, perceived sweetness of a vegetable can actually increase someone's consumption and preferences for a vegetable (Aldridge et al., 2008; Birch & Davison, 2001; Dazeley et al., 2011; Dinehart et al, 2006; Drewnowski & Gomez-Carneros, 2000). As a result, we hypothesized that the baseline consumption for the high-sugar content vegetables would be greater than the low-sugar content vegetables. Hypothesis 1b: We hypothesized there would be an increase in the children's follow up consumption for both the high-sugar content and low-sugar content vegetables.

1.10 Aim 2 and Hypotheses

Aim 2: To investigate how the children's consumption of the four vegetable pairs differs at baseline and follow up assessments.

- Green beans and peas, carrots and parsnips, beets and radishes, broccoli and cauliflower are the four vegetable pairs
- The vegetables were paired based on similarities in appearance and growing process (Table 5)
- Each vegetable pair will be featured during one of the four intervention weeks

Hypothesis 2a: The FITS study found that green beans were one of the most commonly consumed vegetables by preschoolers (Fox et al., 2010). Also, peas are fun to pay with and sweet tasting. Therefore, we hypothesized that baseline consumption of the green beans-pea pair would be higher than baseline consumption of the other three vegetable pairs (beets and radishes, broccoli and cauliflower, carrots and parsnips). We hypothesized that the baseline consumption of the green bean-pea pair would be higher than the other three vegetable pairs (carrot-parsnip, beets-radish, and broccoli-cauliflower). Hypotheses 2b: We expected that the children's consumption would increase for all the vegetable pairs at follow up.

1.11 Aim 3 and Hypotheses

Aim 3: To explore the difference in vegetable consumption across the four vegetable color categories at baseline and follow up assessments.

- Red – beets and radishes
- Orange – carrots
- Green – beans, peas, and broccoli
- White – cauliflower and parsnips

- Phytochemical content and classification by Pennington & Fisher 2009 were how the color categories were determined (Table 7).

Hypothesis 3a: The FITS study found that green beans were one of the vegetables consumed often by preschoolers and we believed that the green beans-peas pair would have the highest baseline consumption (Fox et al., 2010). Given this information, we thought there would be higher baseline consumption of green colored vegetables (green beans, peas and broccoli) than the red (beets and radishes), orange (carrots), or white (parsnips and cauliflower) colored vegetables. Hypotheses 3b: We hypothesized that between baseline and follow-up there would be an increase in the children's consumption of vegetables from for all four vegetable color categories.

CHAPTER 2

METHODOLOGY

2.1 Time Frame

Our study was implemented over six-week time period between the second week in October 2011 and third week in November 2011. The October start date provided the Head Start teachers and children time to settle into the new school year before we implemented our program. We decided to end the program before Thanksgiving in order to avoid the complications of Thanksgiving and the Holiday season. The first week was baseline baseline assessment, week two to five were intervention weeks, and week 6 was follow up (Table 8). Once a week for six consecutive weeks, a thirty- minute lesson was implemented in four Head Start classrooms between ten and eleven in the morning. The lessons took place on the same day and time each week. Not only was this the best arrangement for Head Start, but also allowed us to standardize the lesson implementation and introduce the children to the vegetables between breakfast and lunch. *Willow Comes to WIC, Color Me Healthy, Fruitzotic* and *Classroom Garden Project* have demonstrated that fifteen to thirty five minutes is the appropriate nutrition education lesson length for preschool aged children (Family Cook Productions, 2011; Kannan et al, 2011; Kannan et al, manuscript in preparation; Wilson et al., 2011; Witt & Dunn, 2011). Since our lessons encouraged all of the children to participate, the Mass Farm Fresh lesson plan took the place of the regularly scheduled Head Start classroom's circle-time. During normal circle time, all of the children and at least one teacher sit in a circle on the classroom rug to perform group activities together. The children and at least one teacher were still

sitting on the rug during our circle time, but our lesson took the place of the regularly scheduled group activity.

2.2 IRB Approval and Criteria for Selection of Head Start Sites

Since both the *Classroom Garden Project* and this current study are part of the larger Mass Farm Fresh research project, the IRB approval for the *Classroom Garden Project* in spring 2011 was applicable to the current study. Minor changes on the informed consent form were made for use in this study. The University of Massachusetts Office for Research Protections reviewed and approved all procedures. All participating children's caregivers provided consent for videotaping in the classrooms by signing video-release forms and submitted them Head Start. All forms were provided in English and Spanish. Children were screened for food allergies and food intolerances. The Head Start Nutritionist of Franklin and Hampshire County and Dr. Kannan facilitated the recruitment of Head Start sites and obtained informed consent from all parents of the children participating in the current study.

The Head Start classrooms were recruited through discussions with the Head Start site supervisors and teachers during the summer of 2011. Only Head Start preschool classrooms in Western Massachusetts that agreed to all time frame specifications were eligible to participate. In addition, the Head Start classrooms needed to be located in Hampshire or Franklin County of Western Massachusetts and relatively close to the UMass Amherst campus. In order for the UMass students to feasibly implement all six lessons, the classrooms had be a 30 minutes or less away from campus by car. The Head

Start classroom teachers and site supervisors also had to be interested in a nutrition education program focusing on vegetables to be eligible to participate in our program. Since the facilitator guided sensory approach was implemented during the same time as our current study, we need ensure that our Head Start classrooms were not already participating in the facilitator approach. Once our four classrooms were confirmed, we communicated with the Head Start teachers and site supervisors to coordinate the days and time the lessons would be implemented in their classrooms.

2.3 Recruitment and Training for the UMass Student Team

UMass undergraduates were recruited from the undergraduate Basic Nutrition Class and from an email sent to all nutrition majors. The students were interviewed to ensure they understood the time commitment for the project, felt passionate about nutrition education and were interested in working with young children. Students had to be available for the training sessions, vegetable weighing, and all six weeks of classroom lesson implementation. A training session was conducted at the UMass Nutrition Department for the student team prior to the baseline assessment. Nine UMass students attended this training session and each student was provided a training manual. Mass Farm Fresh research standards, confidentiality agreement, dress code, and timeline for our study were all included in the training manual. We also explained the study design and what the students' responsibilities were during data collection. During the training session, the UMass students signed up to help with the weekly pre and post weighing of vegetables and to implement the lessons at the Head Start classrooms. In addition, weekly

training sessions were conducted to familiarize the students with the upcoming week's lesson plan and data collection protocols. For the intervention week training sessions, the students also rehearsed that lesson's puppet show with the script. To standardize the lesson implementation, the same group of three to four students went to a particular classroom each week.

2.4 Vegetable Selection Criteria

To optimize the sensory exploration of the vegetables, we had a total of eight vegetables in our program and they were presented in pairs during the intervention weeks. When selecting the vegetable pairs for the intervention weeks, it was important that the two vegetables be similar in appearance and growing process. This provided children the opportunity to compare the similarities and differences within the vegetable pairs. For example, broccoli and cauliflower both grew above ground and made up of many tiny florets (Table 5). Broccoli was green and made up of rough loose florets, but cauliflower was white with tight smoother florets. Presenting vegetables in four vegetable pairs was also used in another study attempting to increase vegetable consumption in preschool aged children (Horne, 2011). There were four separate groups and each group contained a pair of fruits and pair of vegetables. Instead of comparing the sensory properties of the vegetable pairs, the vegetable pair was compared to a fruit pair and the effect of reward on consumption (Horne, 2011). In the current study, green beans and peas were introduced in week one of the intervention with the expectation that it would start the intervention off on a positive foot with the children (Fox et al., 2010).

Given that our program was conducted between October and November in Western Massachusetts, it was critical that the vegetables we selected were readily available during this time period in local supermarkets. We required that the chosen group of vegetables contained a wide variety of colors and were high in phytochemicals. Keeping the food safety aspects in mind, the vegetables were presented in their raw form. Similar to *Color Me Healthy*, the children had the opportunity to look, touch, smell and taste the raw form of the vegetable (Witt & Dunn, 2011). Since children's acceptance of new foods can be influenced by sensory education, it was essential to have vegetables with strong sensory characteristics in our study (Mustonen &Tuorila, 2009: Reverdy et al, 2008; Witt & Dunn, 2011). All of the vegetables were an interesting color, shape, or had some other unique attribute. For example, carrots are orange with fluffy green leaves, peas are in short wide pea pods, and beets are purple red circles (Table 5).

2.5 Vegetable Preparation

All vegetables were purchased the day before the lesson from a local supermarket. All UMass students handling the vegetables wore gloves, used clean knives, and cut the vegetables on clean cutting boards to keep the vegetables safe for consumption. All UMass students were trained and supervised by the graduate research assistant to ensure standardized vegetable preparation. After the vegetables were thoroughly washed, each vegetable was cut to bite size pieces. Carrots and parsnips were peeled and cut into circles or disks. Green beans had ends removed to create about three inch pieces. Little florets were separated from the broccoli and cauliflower heads. Two or three peas were

attached to a small rectangle piece of the pea pod. Beets were peel and cut into triangles, while radishes cut into half-moons with the skin on. Ends of carrots, parsnips, beets, and any other small pieces of vegetables that could cause choking were discarded.

2.6 Vegetable Pre-Weighing

A sample of all eight vegetables was provided to children during baseline and follow up assessment. Only the two only the two-featured vegetables were presented to the children during the intervention weeks (Table 8). A recent study validates our vegetable presentation during the baseline and follow up weeks by finding that children significantly prefer multiple colors and food items on a plate at once (Zampollo et al, 2011). The study determined that most five to twelve year old children preferred the maximum number of colors (six) and maximum number of food components (seven) on a plate at once (Zampollo et al, 2011). Our study provided a total serving size of fifty-six grams for the eight vegetable baseline and follow up tasting sample (Table 9). This was similar to the fifty gram serving of vegetables provided to preschool age children in another study (Horne, 2011). The study provided the children with two twenty-five gram vegetable servings, which makes the total serving of vegetables fifty grams (Horne, 2011). Since there were only two vegetables provided in the intervention tasting samples, we decided the intervention individual vegetable weight should be double the seven-gram baseline/follow up individual vegetable weight. Therefore, the intervention week serving size was twenty-eight grams for the two-featured vegetables and each vegetable weighted fourteen grams (Table 9). This was consistent with the twenty-four to

twenty-six gram serving size for preschoolers used in another study (O'Connell et al, 2012). Vegetable consumption was determined by the amount of vegetables the children ate from this pre portion serving.

Two UMass students trained in the vegetable weighing protocol completed the weighing and recording during each weighing session. The graduate research assistant supervised the UMass students during the weighing procedure. The vegetables were weighed to seven grams for baseline and follow up or fourteen grams for the intervention weeks on a calibrated Denver Instrument digital scale (Table 9). A paper bowl was used to weigh the vegetables on the scale. The pre or initial weight of each vegetable was recorded on a recorded weight form (Figure 2). The recorded weight forms contained the initial weight of the vegetables in grams (before going to the classroom), the final weight of the vegetables in grams (after going to the classroom) and the amount eaten by the children. The recorded weight forms as well as the pre weighing process were improved from the *Classroom Garden Project's* methods in Spring 2011 (Kannan et al, 2012). Following the recording of the vegetable weight, the vegetables were transferred to a quart-size Ziploc bag labeled with the child's first name, classroom, and location of the classroom. Since the beets could stain the other vegetables, the beets were placed in their own snack size Ziploc plastic bag. This snack size bag was placed inside the quart-size Ziploc plastic bag with all the other vegetables. The weighing process was repeated until the vegetable bags were ready for all children in the classroom. The Ziploc bags containing the vegetables were stored in the refrigerator until the morning of the lesson. Corresponding paper bowls were labeled with the children's names so that the vegetables could be transferred from the Ziploc bags into the bowls at the Head Start classroom.

2.7 Implementation of Baseline and Follow up Lessons

A container with all of the pre weighed vegetable bags, children's names pre-labeled on nametags, individualized serving bowls with first names of children, gloves, clipboards, and video cameras were brought to the classroom during all six weeks of the program. Three or four UMass students arrived at the classroom at least ten minutes in advance of the lesson session. Upon arrival, the students introduced themselves to the teachers and then the teachers placed the appropriate nametag on each child. Two video cameras were set-up by the UMass students to capture sensory explorations and consumption during circle-time. Vegetables were transferred from the child's Ziploc bag to a paper bowl with the child's first name on it. Once it was time to start the lesson, the UMass students introduced themselves to the children. For the baseline and follow up assessments, the UMass student went right into the tasting portion of the lesson. The UMass students told the children: "Here are your vegetable snacks! You can eat as much of the vegetables as you want. Please wait until everyone receives a vegetable snack before you start eating. After you finish eating we will collect the bowls from you." UMass students selected a quadrant of children to observe their willingness to try the vegetables. Willingness data was not included in this study, but was collected. UMass students provided each child in their respective quadrant his or her bowl of vegetables.

During the tasting period, the children were given seven to ten minutes to try the vegetables. A seven to ten min interval for the tasting component was selected based on teacher recommendations and previous observation from the *Classroom Garden Project* (Kannan et al, 2012). UMass students waited until all children were done eating the vegetables before the bowls were collected from the children. The UMass students placed

the entire child's bowl with the remaining vegetables back into the child's corresponding Ziploc bag. If the child spilled his or her vegetables or some other incident occurred, it was recorded by the UMass students in the classroom. Teachers were instructed to redirect conversations pertaining to vegetables to non-vegetable-related and non-food related topics to minimize the influence on vegetable consumption. Spilled or dropped food was returned to the correct bowl, and any spilled vegetables were recovered with paper towels. All materials were brought back to Dr. Kannan's office.

2.8 Post-Weighing of Vegetables

Two UMass students trained in the vegetable weighing protocol completed the weighing and recording during each weighing session. The graduate research assistant supervised the UMass students during the weighing procedure. The UMass students responsible for the post-weighing weighed each of the vegetables from each child's bowl on a calibrated Denver Instrument digital scale. The weight was noted on the recorded weights form (Figure 2). Subtracting the final or post weight of the vegetable from the initial or pre weight of the vegetable was how the vegetable consumption was determined and recorded.

2.9 Description of the Sensory Nutrition Intervention Lessons

The vegetable preparation, pre-weighing and post weighing was exactly the same for all six weeks of the study. While the baseline and follow up assessments only

contained the tasting portion of the lesson. The intervention weeks also included the Mass Farm Fresh vegetable passports, five senses song, and of course the puppet guided sensory exploration. Puppets, growing cycle posters, raw vegetables for children to explore, magnifying glasses, passports, stickers and a CD with the five senses song were the additional materials brought to the classroom during the four intervention weeks. The procedures for set-up in the classroom were very similar to the baseline and follow-up assessment. After the children received their nametags, each child was provided a Mass Farm Fresh vegetable passport with his or her name on it. The goal of the passports was two-fold: to determine whether the children could identify the vegetables before they learned about them in the puppet show and to utilize the Mass Farm Fresh vegetable passport activity as part of a visual exposure opportunity in the classroom setting. The vegetable passports contained the pages for all four-intervention weeks, but the passports were taped so that only that week's pages are accessible. The task was to identify the two-featured vegetables for that week from the vegetable pictures in the passports. The children viewed pictures of all eight vegetables, but were only asked to correctly identify and place the stickers on the featured vegetables for that week. Both featured vegetables had the same color sticker, but one was a circle and the other a rectangle. For example: green circle for peas and green square for green beans. Once children were seated, the stickers were handed out one at a time. After all the children place the stickers in their passports, the passports were collected. Next, the UMass students started singing the "Five Senses" song. This was a song about the five senses that the children and UMass students sang while pointing to the part of their face that corresponds to that sense.

The third component of the intervention lesson was the puppet guided sensory exploration of the vegetable pairs and this activity took place in two parts. First, two puppets explored a vegetable together and then the second puppet guided the children through sensory exploration of the second vegetable (Figure 3). A rabbit puppet named Bouncy stayed constant throughout all four-intervention weeks. In addition, a second animal puppet joined the story each week to teach Bouncy about the vegetables. For example, Hoppy the Frog for green beans and peas (week two), Waddles the Duck for carrots and parsnips (week three), Skip the Puppy for beets and radishes (week four), and Dash the Donkey for broccoli and cauliflower (week five). Similarly to *Willow Comes to WIC*, our puppets attempted to increase the children's knowledge about the featured vegetables by teaching them how the vegetables grow in nature (Family Cook Productions, 2011; Wilson et al., 2011). We incorporated this by having the new puppet explain to Bouncy how the vegetable grows before the sensory exploration of each vegetable. The new puppet explained the growing process as it pointed to a poster illustrating how the vegetable starts as a seed and slowly becomes a big plant. By using this poster, we were able to clearly convey to the children how the root vegetables (beets, radishes, carrots, and parsnips) grow underground; broccoli and cauliflower grow above ground; green beans and peas grow on vines.

During the children's sensory exploration of the second vegetable, each child was given a magnifying glass as well as the whole vegetable. For carrots, parsnips, beets or radishes, the children were given one whole vegetable with the leaves on top. The children were given one whole green bean or one pea pod with the peas inside. For broccoli and cauliflower, the children were given a floret that was big enough for them to

hold in their hand and see a couple mini florets within the bigger floret. When the second puppet guided the exploration of the vegetable, the children were asked about the vegetable's color, shape, feel, smell, and sound (if it made one when breaking). Here are some examples of the prompting questions: (1) what color is the parsnip? (2) What does it feel like? (3) What does it smell like? (4) How is it the same as a carrot? (5) How is it different from a carrot? The children were told not to eat this vegetable because they will be given a vegetable sample to taste soon. After the children had completed exploring the vegetable with the four non-taste senses, everything was collected from the children and then the tasting portion of the lesson started. Since we had two vegetables featured each week, we altered the order in which the two vegetables were presented to the children during the puppet guided sensory exploration (Figure 4). In each Head Start site, one classroom was randomly assigned vegetable A to be explored by both puppets and vegetable B to be explored by the puppets and children. Then we had another classroom where vegetable B was explored by both puppets and vegetable A was explored by the puppets and the children.

2.10 Data Entry and Analysis Procedure

The first step for data entry was to make sure that all of the information on the baseline and follow up weight forms was complete and that all of the values for the amount eaten category was correctly calculated. Next, the amount eaten data for all four classrooms was entered into a Microsoft Excel file. A codebook was then made and each child was given an alphanumeric identification code. A new Microsoft Excel file was

created that had only the identification codes and the data, but no names or classroom information. Due to measurement error, we had some negative values in the data set that we dealt with in two different ways. Since the vegetables were recorded to the nearest 0.2 g, the eighteen data points that were -0.02 or -0.01 were entered in the database as 0 g. For the ten negative data points that were -0.03 or higher, the data were replaced with the corresponding baseline or follow up weight. As a result, there would be no change between baseline and follow up vegetable consumption for these children.

Data were analyzed by using non-parametric statistics on (SAS version 20.0; SAS Institute, Cary, NC). In order to run two sided paired t tests and to create box plots for each of the sensory categories, we had to created summary variables for each category. To create a baseline consumption summary variable, the sum of all of the baseline consumption data points in that sensory category were calculated. For example, high sugar = sum of beets, peas, carrots and parsnips. Beets-radish pair = sum of beets and radishes. Red = sum of beets and radishes. Follow up summary variables were created the same way using the follow up data. Box plots and two-sided paired t tests and were used to the compare consumption data from baseline to baseline, follow up to follow up, and baseline to follow up. The summary variables created for the sugar content and vegetable pairs sensory categories were used to run these three types of paired t tests and box plots. Since the color categories (red, orange, green and white) contained unequal numbers of vegetables, the consumption values were standardized to Z scores before the paired t tests were run. Results were considered significant when the p value was less than 0.05.

Data analysis run for aim 1: sugar content

- High Sugar = beets, peas, parsnips, and carrots
- Low sugar = green beans, cauliflower, radishes, and broccoli
- High Sugar Baseline to Low Sugar Baseline
- High Sugar Follow up to Low Sugar Follow up
- High Sugar Baseline to High Sugar Follow up
- Low Sugar Baseline to Low Sugar Follow up

Data analysis run for aim 2: vegetable pairs

- Broccoli-Cauliflower Baseline to Beet-Radish Baseline
- Broccoli-Cauliflower Baseline to Carrot-Parsnip Baseline
- Broccoli-Cauliflower Baseline to Green bean-Peas Baseline
- Beet-Radish Baseline to Carrot-Parsnip Baseline
- Beet-Radish Baseline to Green bean-Peas Baseline
- Carrot-Parsnip Baseline to Green bean-Peas Baseline
- Same process was done for follow up
- Broccoli-Cauliflower Baseline to Broccoli-Cauliflower Follow up
- Carrot-Parsnip Baseline to Carrot-Parsnip Follow up
- Beet-Radish Baseline to Beet-Radish Follow up
- Green bean-Peas Baseline to Green bean-Peas Follow up

Data analysis run for aim 3: color categories

- Red = beets and radishes
- White = cauliflower and parsnip
- Green = broccoli, green beans, and peas
- Orange = carrots
- Red Baseline to Orange Baseline
- Red Baseline to Green Baseline
- Red Baseline to White Baseline
- Orange Baseline to Green Baseline
- Orange Baseline to White Baseline
- Carrot-Parsnip Baseline to Green bean-Peas Baseline
- Same process was done for follow up

- Red Baseline to Red Follow up
- Orange Baseline to Orange Follow up
- Green Baseline to Green Follow up
- White Baseline to White Follow up

CHAPTER 3

RESULTS

3. 1 Sample Size

A total of seventy-four children between three and five years of age participated in the study, which was implemented in two Western Massachusetts Head Start sites consisting of two classrooms each (Table 10). Each classroom consisted of between 16-21 children with a total of 37 children per Head Start site. Using the Federal Eligibility guidelines, families with income lower than the poverty level qualified to participate in Head Start (Head Start, 2012). Poverty levels depend on the number of people in the household and range from $11,170 to $38,890 for one to eight people in the household (US Department of Health and Human Services, 2012) Out of the seventy-four children who were enrolled in the study, 67 children participated in the baseline assessment and 66 children participated in the follow up assessment. Sixty children completed both the baseline and follow-up assessments.

3.2 Aim 1 and Hypotheses

Aim 1: To compare children's consumption of the high-sugar content vegetables with the low-sugar content vegetables at baseline and follow up. Hypotheses 1a: We hypothesized that the baseline consumption for the high-sugar content vegetables would be greater than the low-sugar content vegetables. The baseline vegetable consumption for the sugar content categories is illustrated in Table 11. Contrary to our hypothesis, the mean baseline consumption for the low-sugar content vegetables (green beans,

cauliflower, radishes, and broccoli) was about the same as the mean for the high-sugar content vegetables (beets, peas, parsnips, and carrots) (6.87±0.78g for high- sugar and 6.74±0.69g for low-sugar).

Hypotheses 1b: We hypothesized there would be an increase in the children's follow up consumption for both the high-sugar content and low-sugar content vegetables. The follow up vegetable consumption for the sugar content categories is illustrated in Table 11. The high-sugar content vegetables (beets, peas, parsnips, and carrots) were consumed significantly more than the low-sugar content vegetables (green beans, cauliflower, radishes, and broccoli) at follow up (9.56±1.07g vs. 7.70±0.99g p=0.01) (Table 11). The mean consumption of high-sugar content vegetables significantly increased pre-post intervention (7.41±0.82g vs. 9.75±1.14g p=0.02). A negligible degree of change was noted in the consumption of the low-sugar content vegetables between baseline and follow-up (Figure 5).

3.3 Aim 2 and Hypotheses

Aim 2: To investigate how the children's consumption of the four vegetable pairs differs at baseline and follow up. Hypotheses 2a: We hypothesized that the baseline consumption of the green bean-pea pair would be higher than the other three vegetable pairs (carrot-parsnip, beets-radish, and broccoli-cauliflower). Table 12 displays the baseline vegetable consumption for the four vegetable pairs. The mean baseline consumption for the broccoli-cauliflower and carrot-parsnip pair was significantly higher than the beets-radish pair (3.97±0.47g vs. 2.50±0.38g p=0.04 and 3.69±0.51g vs.

2.50±0.38g p=<0.01 respectively). Consequently, the carrot-parsnip pair was consumed the most during the baseline assessment.

Hypotheses 2b: We expected that the children's consumption would increase for all the vegetable pairs at follow up. Table 13 demonstrates the follow up vegetable consumption distribution for the four vegetable pairs. Follow up mean consumption for the carrot-parsnip pair was significantly higher than broccoli-cauliflower (5.27±0.64g vs. 4.06±0.60g p=0.05) or beet-radish pair (5.27±0.64g vs. 3.52±0.50g p=<0.01), but not for green bean-peas pair (5.27±0.64g vs. 4.41±0.68g p=0.28). Carrot-parsnip emerged as the most consumed vegetables pair at the follow up assessment. It is noteworthy that the beet-radish pair median and maximum consumption values increased between baseline and follow up (Figure 6). Mean consumption was not significantly different between baseline and follow up for any of the vegetable pairs (Table 14). Although not significant, there was an increase in the children's consumption for the beet-radish and carrot-parsnip pairs between baseline and follow up.

3.4 Aim 3 and Hypotheses

Aim 3: To explore the change between baseline and follow up consumption values across the four vegetable color categories (red, orange, white and green). Hypotheses 3a: We hypothesized there would be higher baseline consumption of green colored vegetables (green beans, peas and broccoli) than the red (beets and radishes), orange (carrots), or white (parsnips and cauliflower) colored vegetables. Table 15 displays the baseline consumption data for all four vegetable color categories. Upon

standardizing the color categories using a Z score we found that the difference between the baseline consumption of the four vegetable color categories was no longer significant.

Hypotheses 3b: We hypothesized that between baseline and follow up there would be an increase in the children's consumption of vegetables from for all four vegetable color categories. After standardization of the color categories through Z scores, the difference between the follow up consumption of the four vegetable color categories was no longer significant (Table 16). Red, white, and green vegetable color categories displayed increased consumption values between baseline and follow up assessments (Figure 7). Table 17 revealed that the mean consumption of red and white colored approached a significant increase between baseline and follow up (2.66$\pm$0.41g vs. 3.68$\pm$0.54g p=0.07 and 2.81$\pm$0.46g vs. 3.93$\pm$0.62g p=0.08 respectively). Therefore, children seemed to prefer more of the red and white vegetables at the follow up assessment than at the baseline assessment.

3.5 Individual Vegetable Data

Of the 56 g of vegetables provided to the children, the mean total amount consumed for all eight vegetables approached a significant increase between baseline and follow up assessments (14.75$\pm$1,38g vs. 17.83$\pm$2.05g p= 0.06). Specifically, there was a significant increase between baseline and follow up for two of the eight vegetables. When baseline and follow up consumption was compared in Table 18, there was an increase in peas (1.32$\pm$0.26g vs 2.03$\pm$0.36g p=0.04) and parsnips (1.31$\pm$0.25g vs 2.06$\pm$0.35g p=0.04). Table 19 shows baseline mean consumption and Table 20 shows the follow up

mean consumption for each vegetable. At baseline, children consumed significantly more beets (1.69±0.30g) than radishes (0.81±0.14g). Green beans (2.24±0.32g), carrots (2.76±0.33g), and broccoli (2.31±0.30g), were eaten significantly more at baseline than radishes (0.81±0.14g), parsnips (1.21±0.22g), cauliflower (1.39±0.24g), and peas (1.21±0.23g). At follow up, carrots (3.31±0.39g) were consumed significantly more than all the other vegetables excluding green beans. That is: beets (2.29±0.34g), radishes (1.23±0.22g), parsnips, (1.97±0.32g), broccoli (2.33±0.33g), cauliflower (1.72±0.31g), and peas (2.00±0.34g). Beets (2.29±0.34g) remained at significantly higher consumption amounts than radishes (1.23±0.22g) at follow up.

CHAPTER 4

DISCUSSION

To our knowledge, we were the first to evaluate the impact of a puppet based multi-sensory nutrition education intervention on Head Start preschool children's vegetable consumption. Children's consumption of peas and parsnips significantly increased between the baseline and follow up assessment (Table 21). Overall consumption of all eight vegetables approached a significant increase when baseline was compared to follow up. In addition, the sensory properties seemed to influence the children's vegetable consumption. For example, the vegetable's color appeared to impact the children's vegetable consumption. The red and white colored vegetables approached a significant increase from baseline to follow up. There was also a pattern that emerged with the follow up consumption of the vegetable pairs that were similar in appearance and growing process. The carrot-parsnip pair was consumed significantly more than the broccoli-cauliflower and beet-radish pairs. Taste, specifically sugar content, appeared to be a strong sensory attribute impacting vegetable consumption in this sample of children. High-sugar content vegetables significantly increased between baseline and follow up. In addition, the high-sugar content vegetables were consumed significantly more than the low-sugar content vegetables at follow up. Therefore, we found that many sensory properties can influence vegetable consumption with sugar content being the most pronounced.

Color Me Healthy and *Early Sprouts* were two sensory nutrition education programs that focused on vegetable consumption, but neither program incorporated the

use of puppets (Kalich et al. 2009; Witt & Dunn, 2011). While *Healthy Children Arizona* and *School Yard Kids* included a puppet show, the lessons were focused on overall healthy lifestyle practices instead of vegetable consumption (Vanderlugt, 2010; Wright, 2007). The most comparable programs to our study were *Willow Comes to WIC* and *Classroom Garden Project* (Kannan et al, 2012; Wilson et al., 2011). *Willow Comes to WIC* used a puppet to encourage the children to participate in sensory exploration of various vegetables and fruits, but did not measure the children's consumption of the tasting samples (Wilson et al., 2011). *Classroom Garden Project* utilized puppets to present developmentally appropriate terms to describe health benefits of vegetables for the children (prevents colds, good for eye sight). The focus of the program was on the vegetables' growing process and sensory properties (Kannan et al., 2012). *Classroom Garden Project* and the current study, both part of *Massachusetts Farm Fresh*, address a gap in the area of pediatric nutrition education through a multi-sensory nutrition intervention targeting the early childhood life stage.

While it was expected that the high-sugar content vegetables would have greater consumption values at baseline, we did not expect the high-sugar content vegetable consumption values to show such dominance at follow up. The sugar content in the current study was defined using the U.S. Department of Agriculture National Nutrient Database for Standard Reference (U.S. Department of Agriculture, 2011). In response to the intervention, the high-sugar content vegetables demonstrated a greater increase in follow up consumption than the low-sugar content vegetables. The two vegetables (peas and parsnips) that increased between baseline and follow up were both high sugar content vegetables. In addition, beets (highest sugar content) baseline and follow up consumption

was significantly higher than radishes (second to lowest sugar content). Between baseline and follow up, there was also a significant increase in the children's consumption of the high-sugar content vegetables (beets, peas, carrots, and parsnips). At follow up, the intake of the high-sugar content vegetables was significantly greater than the intake of the low-sugar content vegetables (broccoli, cauliflower, radishes, and green beans).

Consequently, a pattern emerged in our study where the high-sugar content vegetables were consumed more than the low-sugar content vegetables. Building on the results of the current study, which were determined using an objective assessment method, future research should investigate how the perceived sweetness of vegetables may influence vegetable consumption in preschool age children. Another study conducted with 18-60 year old adults pursued this concept and examined how the perceived sweetness of vegetables can impact vegetable consumption and preference (Dinehart et al, 2006). The researchers determined that vegetable preference was positively associated with perceived sweetness of the vegetable. Given that intake was directly impacted by vegetable preference regardless of age and sex, enhancing the perceived sweetness of a vegetable through food preparation was predicted to increase vegetable consumption (Dinehart et al, 2006). The vegetables incorporated in the current study were raw and future work could evaluate the effect of raw versus cooked vegetables for impact on consumption in young children.

Contrary to our expectations, the children had significantly higher baseline consumption of the broccoli-cauliflower pair and the carrot-parsnip pair than the beet-radish pair. The high baseline consumption of both broccoli and carrots from within each of the pairs introduced later in the intervention weeks combined with the fact that a very

low consumption of radishes was noted could have contributed to these findings. It is noteworthy that the carrot-parsnip pair follow up consumption was significantly higher than both the broccoli-cauliflower and beet-radish pair follow up consumption. We speculate that the sensory exploration activities during the intervention weeks may have led to the increase in the children's consumption of the two high sugar content vegetables (carrots and parsnips). However, pairing two high-sugar content vegetables together may have impacted the carrot-parsnip pair's consumption values. The fact that the broccoli-cauliflower pair was made up of two low sugar content vegetables may have contributed to the minimal increase in the follow up consumption. The consumption value of the beet-radish pair was perhaps decreased by the very low consumption values for radishes at both baseline and follow up. Further research needs to be done with vegetable pairs containing contrasting sugar content to investigate the impact on children's vegetable consumption and liking. Future research could incorporate vegetables pairs with one very high sugar content vegetable and one very low sugar content vegetable. Our findings were consistent with the vegetable drinks study's conclusion that a brief time period is needed to increase children's vegetable taste preferences (Havermans et al, 2007).

Another influential factor in vegetable acceptance and consumption was appearance of the food (Dazeley et al, 2012). Consistent with this premise for visual appeal, we examined the plausibility that the shape of a vegetable may impact the children's consumption. The vegetables within each vegetable pair, incorporated in the weekly sensory activities during the four-week intervention, were similar in shape. As a result, we examined how the children's consumption differed between the pairs. Broccoli and cauliflower represented mini trees; beets and radishes were circular, carrots and

parsnips long/narrow, while green beans and peas were pod shaped. We found that both the broccoli-cauliflower pair and carrot-parsnip pair had the highest baseline mean consumption values. Carrot-parsnip pair had a highest follow up mean consumption. Based on these results, we inferred that the tree shape (broccoli-cauliflower) and long/narrow shape (carrot-parsnip) were more preferred at baseline than the other two shapes. The long/narrow shape (carrot-parsnip) was more preferred at follow up than the other three shapes. Thus, a question arises about the predominant sensory attribute responsible for the high consumption of the carrot-parsnip vegetable pair. Is it the size, texture, growing process or sugar content? The children's preference for the carrot-parsnip pair demonstrates how interactions between multiple or overlapping sensory properties can impact vegetable consumption. Future research should investigate the effect of shared and overlapping sensory properties as part of research addressing children's vegetable consumption. For example, broccoli and green beans could be in the same category because they have overlapping color and taste characteristics. Both vegetables are green and contain low sugar content on a per serving basis. Similarly to visual appeal, flavor (sweet or pungent) and sounds that they make when broken or eaten could also influence children's consumption and should be investigated in future work.

In addition to shape, we examined the impact of vegetable color on children's consumption. Red and white colored vegetables approached a significant increase when baseline and follow consumption were compared. Red and white colored vegetables contain phytochemicals commonly referred to as flavonoids (Oregon State University Fruits and Vegetables, 2012; Oregon State University Phytochemicals, 2011). Specifically, red colored vegetables contain anthocyanin or betalains and white colored

vegetables contain anthoxanthin (Table 1). Consequently, we could infer that an increased consumption of red and white colored vegetables indirectly may have resulted in an increased consumption of these particular flavonoids. From a chronic disease perspective, high flavonoid consumption has been found to positively impact an adult's risk for cancer or cardiovascular disease (Haytowitz et al.; Oregon State University Flavonoids, 2011). The beneficial actions of flavonoids may be a result of their role in cell signaling pathways (Oregon State University Flavonoids, 2011). Flavonoids may be able to control cell growth, gene expression, inflammation, and apoptosis by altering signaling pathways within the cell (Oregon State University Flavonoids, 2011). Further research should be conducted on the correlation between various vegetable colors represented in the nutrition interventions targeting the early childhood life stage, the level of flavonoids acquired from vegetables and the impact of vegetable consumption on the flavonoid level in the body.

Multiple exposures to appearance of foods can decrease a child's food neophobia as well as increase their willingness to try new foods (Houston-Price et al, 2009). In our weekly puppet show involving sensory explorations with vegetable pairs (for example: broccoli-cauliflower), we provided the children with visual exposure of one vegetable (for example: broccoli) and hands on exposure with the four non-taste senses (sight, smell, hearing, touch) for the other vegetable (for example: cauliflower). For each vegetable pair featured in the intervention weeks, the children experienced visual exposure for one of the vegetables and hands on exposure for the other vegetable (Figure 3). The current study approach, although quite different in study design, builds on the visual appeal context on other studies. Visual exposure to fruits and vegetables was

implemented in another study where the researchers asked parents to read picture books to toddlers daily for two weeks (Houston-Price et al, 2009). The books showed a familiar fruit and vegetables plus an unfamiliar fruit and vegetable. The children were then provided tasting samples of the vegetables (Houston-Price et al, 2009). Willingness to try increased and food neophobia decreased for the unfamiliar fruits (Dazeley et al, 2012). In future work, it would be interesting to compare the children's vegetable consumption using a randomized control design with a group of children randomized for the visual exposure and another group, to hands-on exposure.

While we systematically incorporated the domains and constructs from the social cognitive theory into our study through the weekly sensory activities implemented in the classroom, we did not examine the change in the children's self-efficacy or expectations in response to our intervention (Berlin; Lubans et al, 2011; Milne et al; Rinderknecht et al, 2004; Rogers et al, 2004; Sharma, 2006;). Future research should measure whether there was a change in these constructs in the context of vegetable consumption in response to an intervention guided by the Social Cognitive theory. Additional research should also measure the change in the children's knowledge about the growing process and appearance of the vegetables. Research should also investigate the intervention's impact on encouraging the children to reach the preschool developmental milestones and Head Start core competencies. Our study highlighted the short-term effects of a nutrition education intervention, but future studies should explore the long-term impacts of the intervention on vegetable consumption. Also, our successful sensory nutrition education intervention could be incorporated into the Head Start curriculum. Incorporating a successful nutrition education intervention into the Head Start classroom has the potential

to improve the dietary quality of many low-income preschool children by increasing their vegetable consumption. Implementation in preschool classrooms outside of Head Start and Western Massachusetts could be another avenue for future research.

There are a few limitations of the study that must be acknowledged. The sample size may limit generalizability of the current findings. Since the current study design did not incorporate a matched control, each child served as his or her own control and the consumption was compared at baseline and follow up. It appears from our discussions with Head Start that a clear control group or a waiting-control approach may present feasibility issues because such an approach may be perceived as "exclusionary" from participating in a timely and beneficial project. One of the many strengths of this study was that it built on established literature documenting the gaining popularity of sensory nutrition education interventions. Many programs attempt to increase young children's familiarity and consumption of foods through multi-sensory exploration (Dazeley et al, 2012).

Providing the children with the opportunity to participate in hands on exploration of the vegetables was strength in our study. The children were able to examine the vegetable's appearance, texture, smell, sound, and taste. Children were also provided consistent weekly opportunities to increase their knowledge about the different properties of foods in a fun, familiar and safe environment. As a result, we expected that the children were able to develop positive expectation about foods about vegetables as well as increase acceptance and consumption from this food group. Dazeley and colleagues (2012) acknowledge that food acceptance increases after multiple exposures to a food. They also note that it can be challenging to provide a child with a food multiple times

when they keep refusing it. The key to sensory nutrition education is that the children are having fun while being exposed to the new foods (Dazeley, 2012). Through this approach, the children were able to explore the sensory properties of foods without feeling pressured or forced to participate.

Another major strength of our study was that the study framework met the developmentally appropriate guidelines for "play approach to learning." Building on the recommendation by Rickard et al (1995), we were successful in creating a fun safe environment for the children because they seemed to enjoy both the puppet show and the sensory exploration. Based on the enthusiastic participation of children in the sensory activities involving puppets, we believed that these observations were strengthened further by the US Department of Education position that "young children find puppets exciting and are willing to have conversations with them" (US Department of Education, 2005). Our trained student facilitators of the weekly puppet lessons noted similar observations about children's excitement regarding the puppets in their classrooms.

The fact that the current study's methodology was based on previously established nutrition education programs was an additional strength. We adapted the vegetable garden concept from *Early Sprouts* and presented the children with a poster showing the growing process of the selected vegetables (Kalich et al, 2009). Our sensory exploration of the vegetables was very similar to the *Early Sprouts* program. Both programs focused on the smell, look, feel, taste, and even sound of the raw vegetables (Kalich et al, 2009). *Color Me Healthy* and our study had baseline assessment one week before the program and follow assessment one week after the program to assess the change in fruit/vegetable consumption (Witt & Dunn, 2011). *Color Me Healthy* also

provided the children with pre-weighed portions of the fruits snack and pre-weighed portions of the vegetables snack. *Color Me Healthy* developed fifteen to thirty minute lessons that emphasized the colors of the fruits/vegetables through posters, songs, and picture cards. Our study was able to build on this idea and develop a program that focused on all the sensory properties of vegetables. We developed a five senses song as well as posters that illustrate the vegetable's growing process. *Color Me Healthy* concept of sensory activities and imaginary trips were translated into a puppet show in the current study (Witt & Dunn, 2011). Similar to *Willow Comes to WIC* the current study introduced a rabbit puppet named Bouncy to guide the children through discovery of two vegetables per a lesson (Family Cook Productions, 2011; Wilson et al., 2011). Willow and Bouncy both encouraged the children to explore the featured vegetables using a magnifying glass and to taste a vegetable sample. We also adapted the idea of using an apron and posters to explain the growing cycle of the vegetables in the puppet show (Family Cook Productions, 2011; Wilson et al., 2011). *School Yard Kids* demonstrated that a puppet show could be an effective tool for nutrition education and encouraged to include more nutrition specific information (Wright, 2007). *Healthy Children Arizona* had a similar concept of puppet role modeling to our study (University of Arizona, 2009; Vanderlugt, 2010).

Our study was able to incorporate the Mass Farm Fresh research aims through an attempt to increase the children's recognition of the selected vegetables, highlight the various sensory characteristics of the vegetables through sensory exploration, and increase the children's vegetable consumption. Two nutrition education programs part of Mass Farm Fresh entitled *Fruitzotic* and *Classroom Garden Project* paved the way for

implementation of current study in Head Start sites and for developing a multi-sensory education program (Kannan et al, 2011; Kannan et al; 2012) *Classroom Garden* provided pilot testing of puppets and standardized procedure for pre-post weighing of the target vegetables. Magnifying glass idea emerged from *Fruitzotic* when children began exploring fruits in the classroom (Kannan et al, 2011; Kannan et al; 2012). We were able to standardize our data collection research methods by building on established protocols available for similar nutrition education interventions (Kannan et al, 2011, 2012; Witt & Dunn, 2011) We developed and implemented standardized guidelines for preparing and weighing vegetables, and organized a series of training sessions and refresher training for students before baseline assessment as well as weekly training. The Head start site nutritionist, education site supervisors, and teachers reviewed and approved the standardized protocols for lessons and data collection on a weekly basis. Although we did not systematically assess this impact on early childhood development, we believe that we encouraged the preschool developmental milestones through classroom activities. For example, we encouraged the use of fine motor skills because we provided the children with the actual vegetables to explore with their hands. By developing and implementing a self-contained program with unique learning opportunities for the children during the regularly scheduled circle-time in their classrooms, we believe we contributed effectively to the Head Start curriculum and learning domains.

Given the strong research based methodology and promising results found in our study, we are confident that our intervention approach has the potentially for successfully promoting the consumption of a variety of vegetables representing a diverse micronutrient and phytochemical constituent dietary pattern in high-risk children. The

preschool age group offers a unique window of opportunity for introducing new foods into the children's emerging dietary patterns. Through the classroom activities implemented as part of the puppet-based sensory exploration of locally available seasonal vegetables, we have demonstrated the feasibility of this research approach in the Head Start setting. Further research should evaluate the impact of this approach on children's long-term food preferences extending beyond the vegetables incorporated here and by introducing dietary components with multiple sensory properties and health benefits.

APPENDIX A

LITERATURE SUPPORT, STUDY DESIGN, AND RESULTS TABLES

Table 1. Phytonutrients, colors, and corresponding vegetables

Phytonutrients	Colors	Vegetables
Anthoxanthins (Flavonoids)	White	Parsnips and Cauliflower
Anthocyanins (Flavonoids)	Red	Radishes
Betalains (Flavonoids)	Red/Purple	Beets
Carotenoids	Orange	Carrots
Chlorophyll	Green	Green beans, peas, and broccoli

(Oregon State University Fruits and Vegetables, 2012; Oregon State University Phytochemicals, 2011)

Table 2. Social cognitive theory constructs definitions in the context of vegetable consumption

Theoretical Construct	Definition
Self-efficacy	Confidence in oneself to consume a variety of vegetables
Behavioral Capacity	Skills to choose a variety of vegetables that one enjoys as well as gain knowledge about vegetables
Expectations	Beliefs regarding the characteristics of vegetables based on past experiences
Expectancies	Value one puts on their expectations of vegetables
Emotional Coping Response	Emotional stress associated with vegetable consumption
Observational Learning	Learning how to explore vegetables with your multiple senses by watching the puppets perform the activity.
Reinforcement	Repeated positive experience with a vegetable can alter food preferences

(Berlin; Lubans et al, 2011; Milne et al; Rinderknecht et al, 2004; Rogers et al, 2004; Sharma, 2006;).

Table 3. Incorporation of social cognitive theory constructs into the intervention week activities

Theoretical Construct	Construct Incorporation Program
Self-efficacy	Increase confidence to consume vegetables through looking, touching, smelling, and tasting vegetables
Behavioral Capacity	Children discover the selected vegetables through sensory exploration and learning about the growing process
Expectations	New positive beliefs about vegetables can develop through the sensory exploration of vegetables
Expectancies	These new expectations may have a larger impact on the children's vegetable intake
Emotional Coping Response	Since the vegetable tasting was in a relaxed environment, children realized tasting vegetables was not stressful or scary **s in**
Observational Learning	Puppets acted as role models by demonstrating how to explore a vegetable with the many senses. Children watched each other look, feel, smell, and taste the vegetables.
Reinforcement	Provided three opportunities to taste the vegetables. Also, children explored a vegetable's appearance, texture, and smell

(Berlin; Lubans et al, 2011; Milne et al; Rinderknecht et al, 2004; Rogers et al, 2004; Sharma, 2006;).

Table 4. Encouragement of preschool age children's developmental milestones during the intervention week activities

Developmental Milestone [a]	Encouragement of this milestone
Learns how to match similar objects with one another.	Present vegetables in pairs that are similar in shape, texture and growing cycle
Can compare similarities and differences	Determine the differences and similarities of the two vegetables in the pair
Knows some of the colors	Identify the colors of the vegetables
Follows short and clear directions	Request that the children stay seated during the puppet show and use the magnifying glass to look at the vegetable.
Able to verbally explain thoughts to strangers Provide multiple words answers to questions	Ask children for words that describe the appearance, texture and smell of a vegetable
Enjoys imaginative play	Perform a puppet show where two puppets discover the growing process, appearance, texture and smell of a vegetable
Remembers a portion of a story	Format of the four puppet shows is similar during all four intervention weeks plus one of the puppets returns each week
Increased fine motor skills	Opportunity to independently physical explore the natural form of the vegetable (ex: whole beet with leaves or pea pod with peas)

[a] Milestones adapted from the American Academy of Pediatrics description of three to five year old children's developmental milestones (American Academy of Pediatrics, 2011).

Table 5. Sensory characteristics of the four vegetable pairs featured during the intervention weeks

Vegetable Pair [a]	Color	Shape	Sugar Content [b]	Growing Process and Other Features
Green Beans Peas	Green Green	Pod shaped	Low High	Grows on a vine Small round peas/beans inside the pod
Carrots Parsnip	Orange White	Long and Narrow	High High	Grows under the ground with fluffy green leaves above ground
Beets Radishes	Red/Purple Red outside with white inside	Circular	High Low	Grows under the ground Beets have large green leaves with red stalk. Radishes have small green leaves
Broccoli Cauliflower	Green White	Mini tree	Low Low	Grows above ground Head contains many florets. Tighter florets in cauliflower than broccoli

[a] Each vegetable pair was featured during one of the four intervention weeks. The vegetable pairs were similar in appearance and growing process.

[b] Sugar content as determined by the USDA national nutrient database for standard reference (U.S. Department of Agriculture, 2011)

Table 6. Total Sugar content of all eight vegetables based on the USDA national nutrient database for standard reference

Raw form of vegetable	Total sugar content (grams) per 100 grams [a]	Total sugar content (grams) per 7 grams [b]
High sugar content		
Beets	6.76	0.47
Peas	5.67	0.40
Parsnips	4.80	0.34
Carrots	4.74	0.33
Low sugar content		
Green beans	3.26	0.23
Cauliflower	1.91	0.13
Radishes	1.86	0.13
Broccoli	1.70	0.12

[a] Sugar content as determined by the USDA national nutrient database for standard reference (U.S. Department of Agriculture, 2011).

[b] Seven grams was the amount of the raw vegetable each child was given at the baseline and follow up assessments.

Table 7. Color categories and corresponding vegetables base on phytochemical content

Color Categories[a]	Vegetables
Red	Beets and radishes [b]
Orange	Carrots
Green	Green beans, peas, and broccoli
White	Cauliflower and parsnip

[a] Color categories were based on phytochemical content and classification by Pennington & Fisher 2009

[b] Pennington & Fisher 2009 placed radishes in the white category, but we think it should be in the red category due to the red phytochemical content in the skin.

Table 8. Overview of study design including timeline, classroom activities, and outcomes

Timeline	Classroom Activities	Outcomes
Week 1 Baseline	Tasting of *all eight* vegetables	Consumption of *all eight* vegetables that is measured by pre and post weighting
Intervention Weeks Week 2 Green Beans and Peas	 Passports Five senses song Puppet guided sensory exploration Tasting of the *two featured* vegetables	 Consumption of the *two featured* vegetables that is measured by pre and post weighting
Week 3 Carrots and Parsnips	Passports Five senses song Puppet guided sensory exploration Tasting of the *two featured* vegetables	Consumption of the *two featured* vegetables that is measured by pre and post weighting
Week 4 Radishes and Beets	Passports Five senses song Puppet guided sensory exploration Tasting of the *two featured* vegetables	Consumption of the *two featured* vegetables that is measured by pre and post weighting
Week 5 Broccoli and Cauliflower	Passports Five senses song Puppet guided sensory exploration Tasting of the *two featured* vegetables	Consumption of the *two featured* vegetables that is measured by pre and post weighting
Week 6 Follow up	Tasting of *all eight* vegetables	Consumption of *all eight* vegetables that is measured by pre and post weighting

Table 9. Pre weighed vegetable amount provided to each child during the tasting portion of the lesson

Week Type	Individual Vegetable Weight [a]	Number of Vegetables [b]	Total Vegetable Serving Weight [c]
Baseline and Follow up	7 grams $\pm$ 0.1	8	56 grams
Intervention Weeks	14 grams $\pm$ 0.1	2	28 grams

[a] Weight of each individual vegetable portion

[b] Number of vegetables in a total serving of pre-weighed vegetables

[c] Weight of all the individual vegetable portions together

Table 10. Sample size distribution among all four classrooms

Classroom Identifier	Classroom Size[a]	Number of children who participated in **baseline** assessment[b]	Number of children who participated in **follow up** assessment[b]	Number of children who participated in **both** assessments[c]
A	21	20	15	14
B	16	13	14	12[d]
Total for site one	37	33	29	26
C	19	17	19	17
D	18	17	18	17
Total for site two	37	34	37	34
Total sample size	**74**	**67**	**66**	**60**[d]

[a] Total number of children in the classroom throughout the study

[b] Only the children present in the classroom during assessments were able to participate. Therefore, children absent on the day the assessments were implemented were counted as missing.

[c] Number of children that were present in the classroom during both the baseline and follow assessment.

[d] One of the children in classroom B was missing for both baseline and follow up. As a result, the child was only counted once during the third column calculations.

Table 11. Comparison of baseline and follow consumption for high and low sugar content vegetables

Vegetable	Sample Size	Mean Consumption (g) [h]	Standard Error Mean	P value
High-Sugar Baseline [a]	67[e]	6.87	0.78	
Low Sugar Baseline [b]	67	6.74	0.69	0.85
High-Sugar Follow up [c]	66[f]	9.56	1.07	
Low-Sugar Follow up [d]	66	7.70	0.99	0.01*
High-Sugar Baseline	60[g]	7.41	0.82	
High-Sugar Follow up	60	9.75	1.14	0.02*
Low-Sugar Baseline	60	7.34	0.73	
Low-Sugar Follow up	60	8.08	1.05	0.37

[a] High-Sugar = sum of beets, peas, parsnips and carrots baseline consumption values.

[b] Low-Sugar = sum of green beans, cauliflower, radishes, and broccoli baseline consumption values.

[c] High-Sugar = sum of beets, peas, parsnips and carrots follow up consumption values.

[d] Low-Sugar = sum of green beans, cauliflower, radishes, and broccoli follow up consumption values.

[e] Sample size represents the number of children present in the classroom during the baseline assessment.

[f] Sample size represents the number of children present in the classroom during the follow up assessment.

[g] Sample size represents the number of children present in the classroom during both the baseline and follow up assessment.

[h] Since the initial weight of each vegetable portion was 7 grams and there were four vegetables in each sugar content category, consumption was considered the amount of the 7 x 4 = 28 grams the children ate.

* $P < 0.05$ from a two-sided paired t test

Table 12. Baseline consumption for the four vegetables pairs similar in appearance and growing process (n = 67 children) [e]

Vegetable Pairs	Mean Consumption (g) [f]	Standard Error Mean	P value
Broccoli Cauliflower [a]	3.69	0.51	
Beet Radish [b]	2.50	0.38	0.04*
Broccoli Cauliflower	3.69	0.51	
Carrot Parsnip [c]	3.97	0.47	0.54
Broccoli Cauliflower	3.69	0.51	
Green bean Peas [d]	3.45	0.49	0.70
Beet Radish	2.50	0.38	
Carrot Parsnip	3.97	0.47	<0.01**
Beet Radish	2.50	0.38	
Green bean Peas	3.45	0.49	0.06
Carrot Parsnip	3.97	0.47	
Green bean Peas	3.45	0.49	0.34

[a] Broccoli-Cauliflower = sum of broccoli and cauliflower baseline consumption values.

[b] Beet-Radish = sum of beet and radish consumption baseline values.

[a] Carrot-Parsnip = sum of carrot and parsnip baseline consumption values.

[b] Green bean-Peas = sum of green bean and peas baseline consumption values.

[e] Sample size represents the number of children present in the classroom during the baseline assessment.

[f] Since the initial weight of each vegetable portion was 7 grams and there were two vegetables in each vegetable pair, consumption was considered the amount of the 7 x 2 = 14 grams the children ate.

* $P < 0.05$ from a two-sided paired t test

Table 13. Follow up consumption for the four vegetables pairs similar in appearance and growing process (n = 66 children) [e]

Vegetable Pairs	Mean Consumption (g) [f]	Standard Error Mean	P value
Broccoli Cauliflower [a]	4.06	0.60	
Beet Radish [b]	3.52	0.50	0.25
Broccoli Cauliflower	4.06	0.60	
Carrot Parsnip [c]	5.27	0.64	0.048*
Broccoli Cauliflower	4.06	0.60	
Green bean Peas [d]	4.41	0.68	0.56
Beet Radish	3.52	0.50	
Carrot Parsnip	5.27	0.64	<0.01*
Beet Radish	3.52	0.50	
Green bean Peas	4.41	0.68	0.14
Carrot Parsnip	5.27	0.64	
Green bean Peas	4.41	0.68	0.28

[a] Broccoli-Cauliflower = sum of broccoli and cauliflower follow up consumption values.

[b] Beet-Radish = sum of beet and radish consumption follow up values.

[a] Carrot-Parsnip = sum of carrot and parsnip follow up consumption values.

[b] Green bean-Peas = sum of green bean and peas follow up consumption values.

[e] Sample size represents the number of children present in the classroom during the follow up assessment.

[f] Since the initial weight of each vegetable portion was 7 grams and there were two vegetables in each vegetable pair, consumption was considered the amount of the 7 x 2 = 14 grams the children ate.

* $P < 0.05$ from a two-sided paired t test

Table 14. Comparison of baseline and follow consumption for the four vegetables pairs similar in appearance and growing process (n = 60 children) [g]

Vegetable Pairs	Mean Consumption (g) [h]	Standard Error Mean	P value
Broccoli Cauliflower[a] B	4.00	0.55s	
Broccoli Cauliflower F	4.26	0.64	0.68
Beet Radish[b] B [e]	2.66	0.41	
Beet Radish F [f]	3.68	0.54	0.70
Carrot Parsnip[c] B	4.31	0.50	
Carrot Parsnip F	5.34	0.68	0.12
Green bean Peas[d] B	3.78	0.53	
Green bean Peas F	4.55	0.71	0.20

[a] Broccoli-Cauliflower = sum of broccoli and cauliflower consumption values.

[b] Beet-Radish = sum of beet and radish consumption values.

[a] Carrot-Parsnip = sum of carrot and parsnip consumption values.

[b] Green bean-Peas = sum of green bean and peas consumption values.

[e] B = baseline consumption values

[f] F = follow up consumption values

[g] Sample size represents the number of children present in the classroom during both the baseline and follow up assessment.

[h] Since the initial weight of each vegetable portion was 7 grams and there were two vegetables in each vegetable pair, consumption was considered the amount of the 7 x 2 = 14 grams the children ate.

* $P < 0.05$ from a two-sided paired t test

Table 15. Baseline consumption for the four vegetable color categories (n = 67 children) [e]

Color Category	Mean Consumption (g) [f]	Zscore Mean [g]	Zscore Standard Error Mean [g]	P value
Red [a]	2.50	0E-7	0.12	
Orange [b]	2.76	0E-7	0.12	1.0
Red	2.50	0E-7	0.12	
Green [c]	5.76	0E-7	0.12	1.0
Red	2.50	0E-7	0.12	
White [d]	2.60	0E-7	0.12	1.0
Orange	2.76	0E-7	0.12	
Green	5.76	0E-7	0.12	1.0
Orange	2.76	0E-7	0.12	
White	2.60	0E-7	0.12	1.0
Green	5.76	0E-7	0.12	
White	2.60	0E-7	0.12	1.0

[a] Red = sum of the beet and radish baseline consumption values

[b] Orange = sum of carrot baseline consumption values

[c] Green = sum of the green beans, peas, and broccoli baseline consumption values

[d] White = sum of the cauliflower and parsnip baseline consumption values

[e] Sample size represents the number of children present in the classroom during the baseline assessment.

[f] Initial weight of each vegetable portion was 7 grams and that was multiplied by the number of vegetables in the category to determine the initial weight for the category. Consumption was the amount of initial weight for the category the child ate. Here the different initial weights for the color categories: Red and White had two vegetables in the category 7 x 2 = 14 grams. Orange had one vegetable 7 x 1 = 7 grams. Green had three vegetables 7 x 3 = 21 grams.

[g] Since the categories have an unequal amount of vegetables in them, we had to standardize the mean with Z scores.

Table 16. Follow up consumption for the four vegetable color categories (n = 66 children) [e]

Color Category	Mean Consumption (g) [f]	Zscore Mean [g]	Zscore Standard Error Mean [g]	P value
Red [a]	3.52	0E-7	0.12	
Orange [b]	3.31	0E-7	0.12	1.0
Red	3.52	0E-7	0.12	
Green [c]	6.75	0E-7	0.12	1.0
Red	3.52	0E-7	0.12	
White [d]	3.69	0E-7	0.12	1.0
Orange	3.31	0E-7	0.12	
Green	6.75	0E-7	0.12	1.0
Orange	3.31	0E-7	0.12	
White	3.69	0E-7	0.12	1.0
Green	6.75	0E-7	0.12	
White	3.69	0E-7	0.12	1.0

[a] Red = sum of the beet and radish follow up consumption values

[b] Orange = sum of carrot follow up consumption values

[c] Green = sum of the green beans, peas, and broccoli follow up consumption values

[d] White = sum of the cauliflower and parsnip follow up consumption values

[e] Sample size represents the number of children present in the classroom during the follow up assessment.

[f] Initial weight of each vegetable portion was 7 grams and that was multiplied by the number of vegetables in the category to determine the initial weight for the category. Consumption was the amount of initial weight for the category the child ate. Here the different initial weights for the color categories: Red and White had two vegetables in the category 7 x 2 = 14 grams. Orange had one vegetable 7 x 1 = 7 grams. Green had three vegetables 7 x 3 = 21 grams.

[g] Since the categories have an unequal amount of vegetables in them, we had to standardize the mean with Z scores.

Table 17. Comparison of baseline and follow consumption for the four vegetable color categories (n = 60 children) [g]

Color Category	Mean Consumption (g) [h]	Standard Error Mean	P value
Red [a] B [e]	2.66	0.41	
Red F [f]	3.68	0.54	0.07
Orange [b] B	2.99	0.36	
Orange F	3.28	0.40	0.47
Green [c] B	6.28	0.68	
Green F	6.94	0.95	0.33
White [d] B	2.81	0.46	
White F	3.93	0.62	0.08

[a] Red = sum of the beet and radish consumption values

[b] Orange = sum of carrot consumption values

[c] Green = sum of the green beans, peas, and broccoli consumption values

[d] White = sum of the cauliflower and parsnip consumption values

[e] B = baseline consumption values

[f] F = follow up consumption values

[g] Sample size represents the number of children present in the classroom during both the baseline and follow up assessment.

[h] Initial weight of each vegetable portion was 7 grams and that was multiplied by the number of vegetables in the category to determine the initial weight for the category. Consumption was the amount of initial weight for the category the child ate. Here the different initial weights for the color categories: Red and White had two vegetables in the category 7 x 2 = 14 grams. Orange had one vegetable 7 x 1 = 7 grams. Green had three vegetables 7 x 3 = 21 grams.

Table 18. Comparison of baseline and follow consumption for the individual vegetables (n = 60 children) [a]

Vegetable	Mean Consumption (g) [b]	Standard Error Mean	P value
Broccoli Baseline	2.50	0.33	
Broccoli Follow up	2.39	0.35	0.77
Cauliflower Baseline	1.50	0.27	
Cauliflower Follow up	1.87	0.34	0.26
Carrot Baseline	2.99	0.36	
Carrot Follow up	3.28	0.40	0.47
Parsnip Baseline	1.31	0.25	
Parsnip Follow up	2.06	0.35	0.04*
Beet Baseline	1.78	0.32	
Beet Follow up	2.39	0.36	0.13
Radish Baseline	0.88	0.15	
Radish Follow up	1.29	0.24	0.10
Green bean Baseline	2.46	0.35	
Green bean Follow up	2.52	0.39	0.86
Peas Baseline	1.32	0.26	
Peas Follow up	2.03	0.36	0.04*

[a] Sample size represents the number of children present in the classroom during both the baseline and follow up assessment.

[b] Since the initial weight of each vegetable portion was 7 grams and there was one vegetable, consumption was considered the amount of the 7 x 1 = 7 grams the children ate.

* $P < 0.05$ from a two-sided paired t test

Table 19. Baseline consumption for the individual vegetables (n = 67 children) [a]

Vegetable	Mean Consumption (g) [b]	Standard Error Mean
Broccoli	2.31	0.30
Cauliflower	1.39	0.24
Carrot	2.76	0.33
Parsnip	1.21	0.22
Beet	1.69	0.30
Radish	0.81	0.14
Green bean	2.24	0.32
Peas	1.21	0.23

[a] Sample size represents the number of children present in the classroom during the baseline assessment.

[b] Since the initial weight of each vegetable portion was 7 grams and there was one vegetable, consumption was considered the amount of the 7 x 1 = 7 grams the children ate.

Table 20: Follow up consumption for the individual vegetables (n = 66 children) [a]

Vegetable	Mean Consumption (g) [b]	Standard Error Mean
Broccoli	2.33	0.33
Cauliflower	1.72	0.31
Carrot	3.31	0.39
Parsnip	1.97	0.32
Beet	2.29	0.34
Radish	1.23	0.22
Green bean	2.41	0.37
Peas	2.00	0.34

[a] Sample size represents the number of children present in the classroom during the follow up assessment.

[b] Since the initial weight of each vegetable portion was 7 grams and there was one vegetable, consumption was considered the amount of the 7 x 1 = 7 grams the children ate.

Table 21: Key findings in children's baseline and follow up vegetable consumption

Vegetable category	Follow up consumption	Increase consumption between baseline and follow up
Sugar Content	High-sugar content greater than low sugar content*	High-sugar content*
Vegetable pairs similar in appearance and growing process	Carrot-parsnip greater than broccoli-cauliflower and beet-radish pair*	None
Color	None	Red and White°
Vegetable consumption	Carrots greater than all other vegetables except green beans Beets greater than radishes	Peas and Peas* Overall consumption of all eight vegetables°

* Statistically significant because P <0.05 from a two-sided paired t test.

° Approached a statistically significant increase

APPENDIX B

BLOTS PLOTS, BAR GRAPHS, AND STUDY DESIGN FIGURES

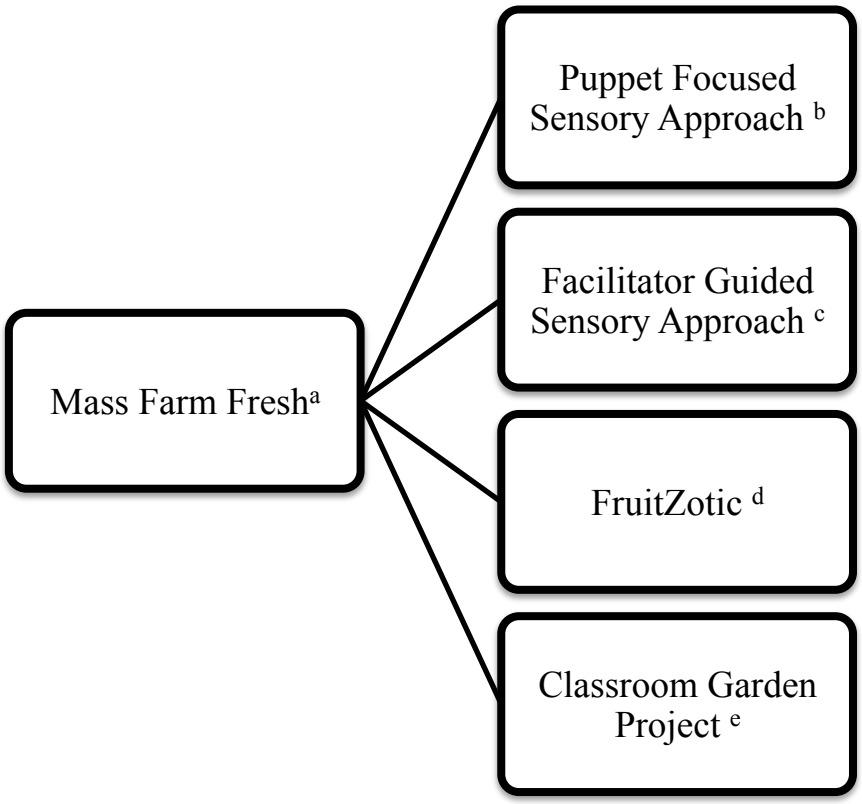

Figure 1. Preschool sensory nutrition education programs included in the Massachusetts Farm Fresh research project

[a] Mass Farm Fresh the umbrella research project containing four sensory nutrition education programs.

[b] Puppet focused sensory approach – the current study's Mass Farm Fresh component. Two puppets taught the children about the growing process of the vegetables and encouraged them to explore the vegetables with their multiple senses.

[c] Facilitator guided sensory approach – very similar to the puppet guided sensory approach, but no puppets were present. UMass students took the place of the puppets in the lesson.

[d] FruitZotic – encouraged children to explore the sensory properties of exotic fruits with their multiple senses through hands on activities and picture books.

[e] Classroom Garden Project – promoted the health benefits of vegetables with puppets and stories. Study also encouraged the children to engage in multi-sensory exploration of the vegetables.

Mass Farm Fresh: Baseline and Follow up Recorded Weight Form

Head Start Location: Head Start Classroom:

Date of initial measurement: Initial measurer's name:

Date of final measurement: Final measurer's name:

Child's name:

Vegetable	**Initial weight (g)** [a]	**Final weight (g)** [b]	**Amount eaten (g) initial – final** [c]
Broccoli			
Cauliflower			
Parsnip			
Carrots			
Beets			
Radishes			
Green Beans			
Peas			
Total for serving [d]			

Figure 2. Mass Farm Fresh recorded weight form used during the baseline and follow up assessment

[a] Initial weight – standardized 6.9 to 7.1 grams portion measured on a Denver Instrument digital scale

[b] Final weight – vegetable weight remaining after the classroom lesson's tasting portion measured on a Denver Instrument digital scale

[c] Amount eaten – vegetable consumption determined by subtracting the final weight column from the initial weight column

[d] Total for serving – total for all eight vegetable weights

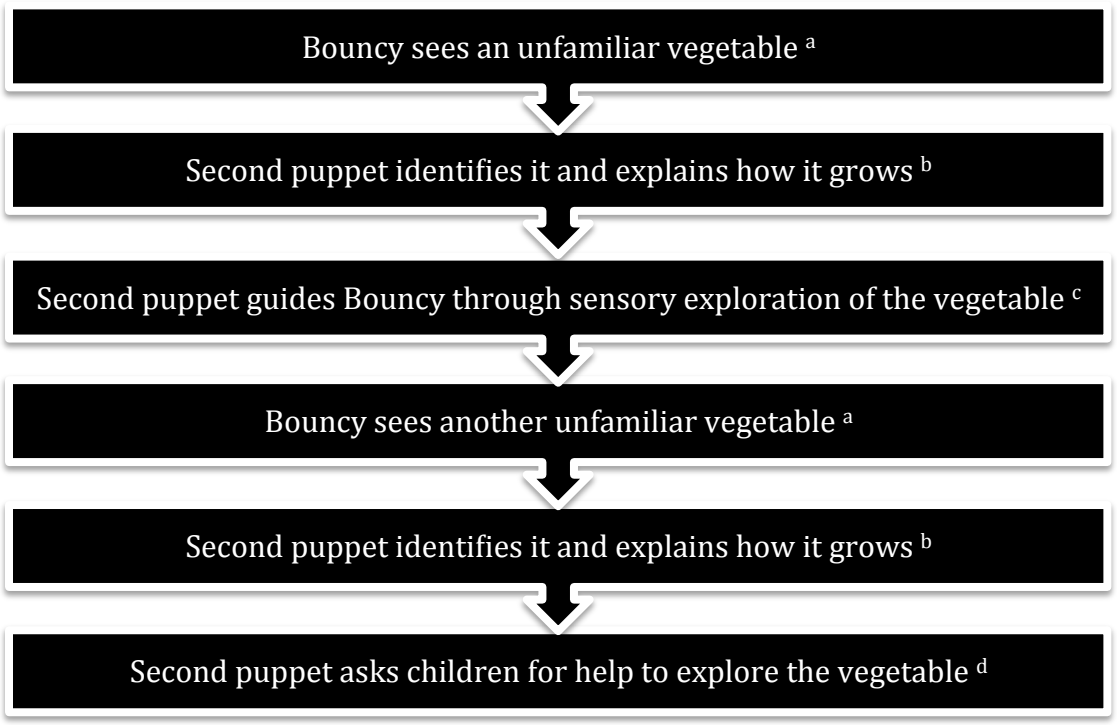

Figure 3. Standard storyline used in the puppet guided sensory exploration components of the intervention lessons

[a] Bouncy was a bunny puppet present in all four lessons

[b] Second puppet was a different animal puppet in all four lessons and pointed to a poster illustrating the featured vegetable's growing process.

[c] During sensory exploration, the second puppet asked Bouncy about the vegetable's appearance, texture and smell. The children were passive observers at this point.

[d] During sensory exploration, the second puppet asked the children about the vegetable's appearance, texture and smell. Children were provided the featured vegetable and a magnifying glass to facilitate the hand on sensory exploration.

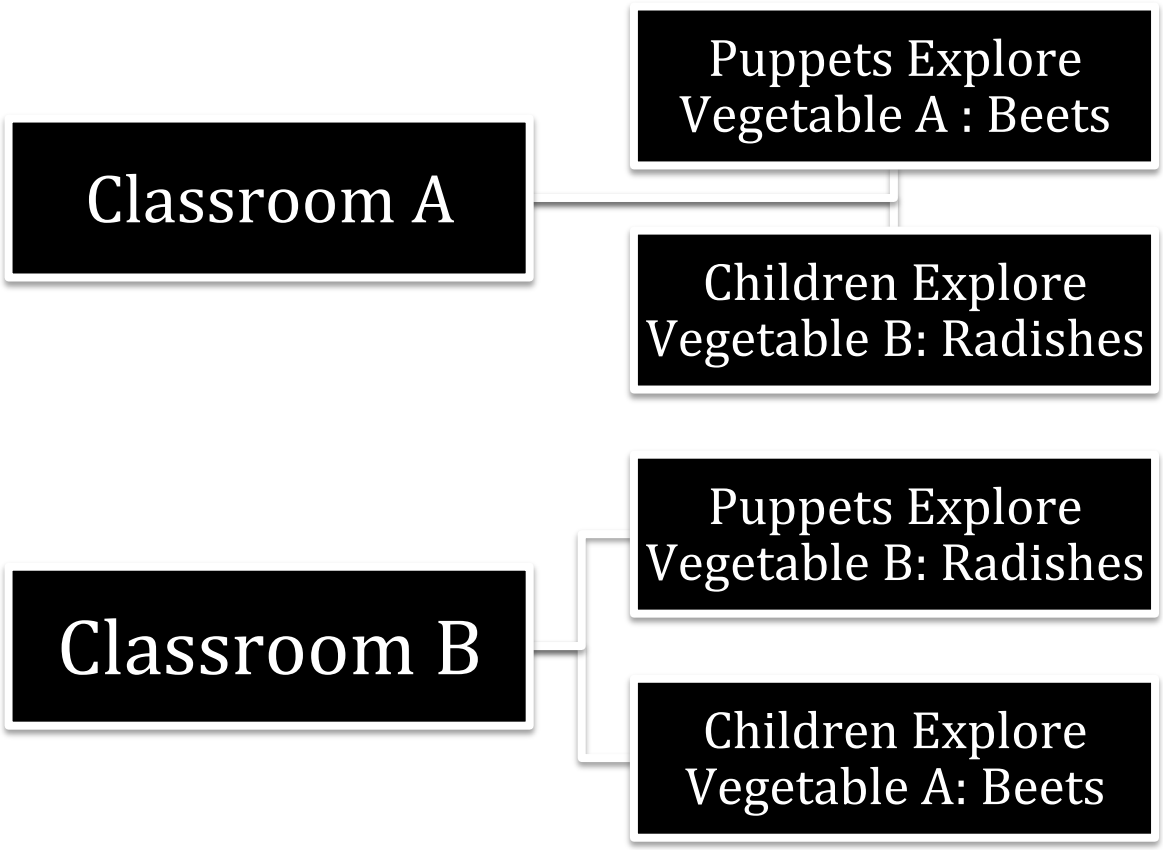

Figure 4. Order of vegetables presented during the puppet guided sensory exploration component of the intervention lessons

The puppet guided sensory exploration storyline was the same in all the classrooms, but the vegetables were presented in a different order. One classroom would observe the puppets explore the beets and the children would explore the radishes, while another classroom would observe the puppets explore the radishes and the children would explore the beets.

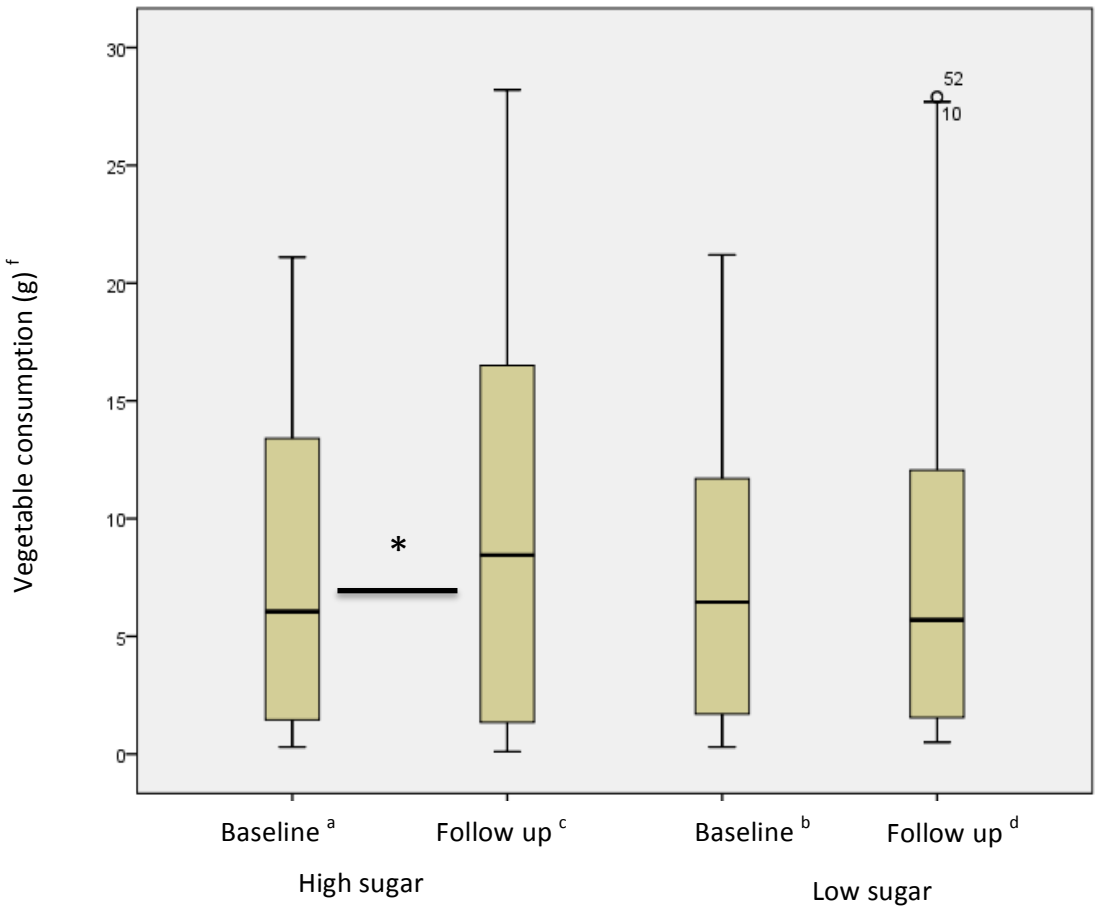

Figure 5. Comparison of baseline and follow consumption for high and low sugar content vegetables (n = 60 children) [e]

[a] High Sugar = sum of beets, peas, parsnips and carrots baseline consumption values.

[b] Low Sugar = sum of green beans, cauliflower, radishes, and broccoli baseline consumption values.

[c] High Sugar = sum of beets, peas, parsnips and carrots follow up consumption values.

[d] Low Sugar = sum of green beans, cauliflower, radishes, and broccoli follow up consumption values.

[e] Sample size represents the number of children present in the classroom during both the baseline and follow up assessment

[f] Since the initial weight of each vegetable portion was 7 grams and there were four vegetables in each sugar content category, consumption was considered the amount of the 7 x 4 = 28 grams the children ate.

* P <0.05 from a two-sided paired t test

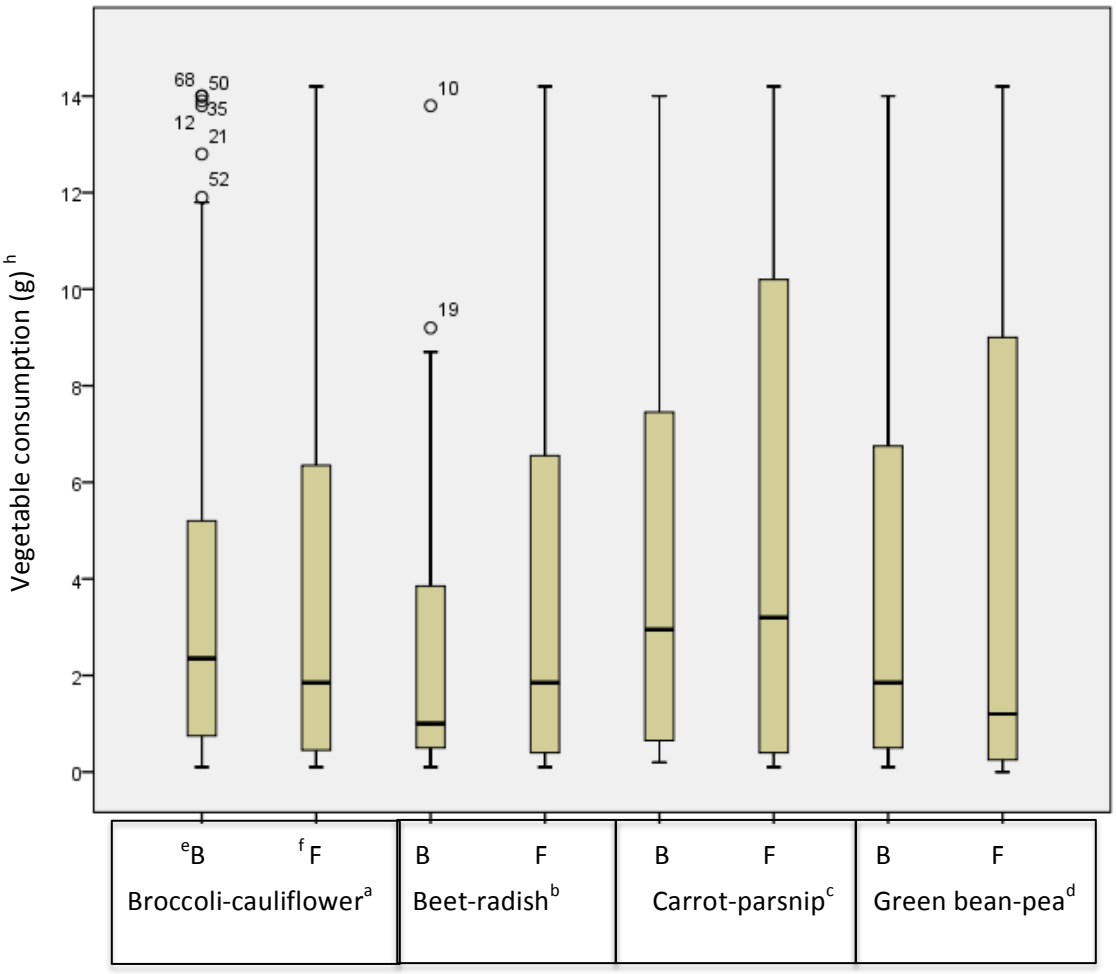

Figure 6. Comparison of baseline and follow consumption for the four vegetables pairs similar in appearance and growing process (n = 60 children) [g]

[a] Broccoli-Cauliflower = sum of broccoli and cauliflower consumption values.

[b] Beet-Radish = sum of beet and radish consumption values.

[c] Carrot-Parsnip = sum of carrot and parsnip consumption values.

[d] Green bean-Peas = sum of green bean and peas consumption values.

[e] B = baseline consumption values

[f] F = follow up consumption values

[g] Sample size represents the number of children present in the classroom during both the baseline and follow up assessment.

[h] Since the initial weight of each vegetable portion was 7 grams and there were two vegetables in each vegetable pair, consumption was considered the amount of the 7 x 2 = 14 grams the children ate. * P <0.05 from a two-sided paired t test

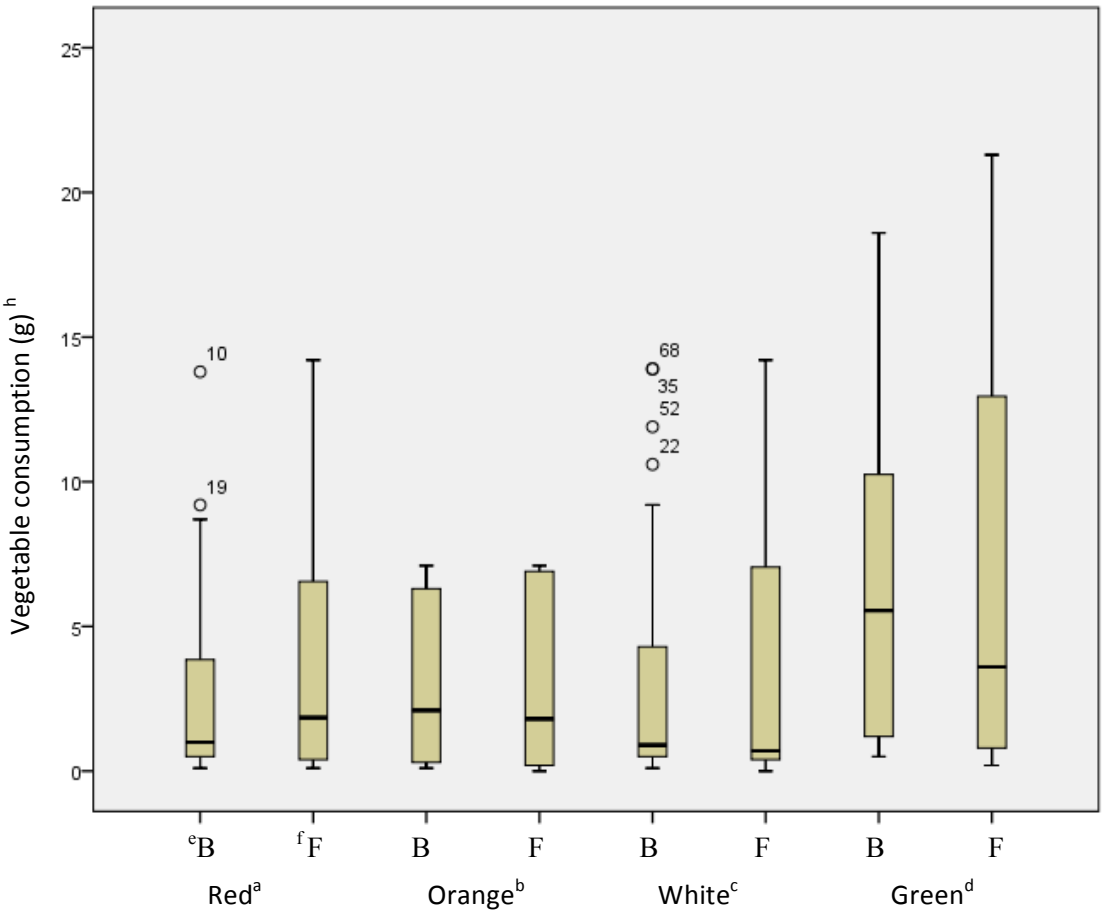

Figure 7. Comparison of baseline and follow consumption for the vegetable color categories (n = 60 children) [g]

[a] Red = sum of the beet and radish consumption values

[b] Orange = sum of carrot consumption values

[c] White = sum of the cauliflower and parsnip consumption values

[d] Green = sum of the green beans, peas, and broccoli consumption values

[e] B = baseline consumption values

[f] F = follow up consumption values

[c] Sample size represents the number of children present in the classroom during both the baseline and follow up assessment.

[f] Initial weight of each vegetable portion was 7 grams and that was multiplied by the number of vegetables in the category to determine the initial weight for the category. Consumption was the amount of initial weight for the category the child ate. . Here the different initial weights for the color categories: Red and White had two vegetables in the category 7 x 2 = 14 grams. Orange had one vegetable 7 x 1 = 7 grams. Green had three vegetables 7 x 3 = 21 grams.

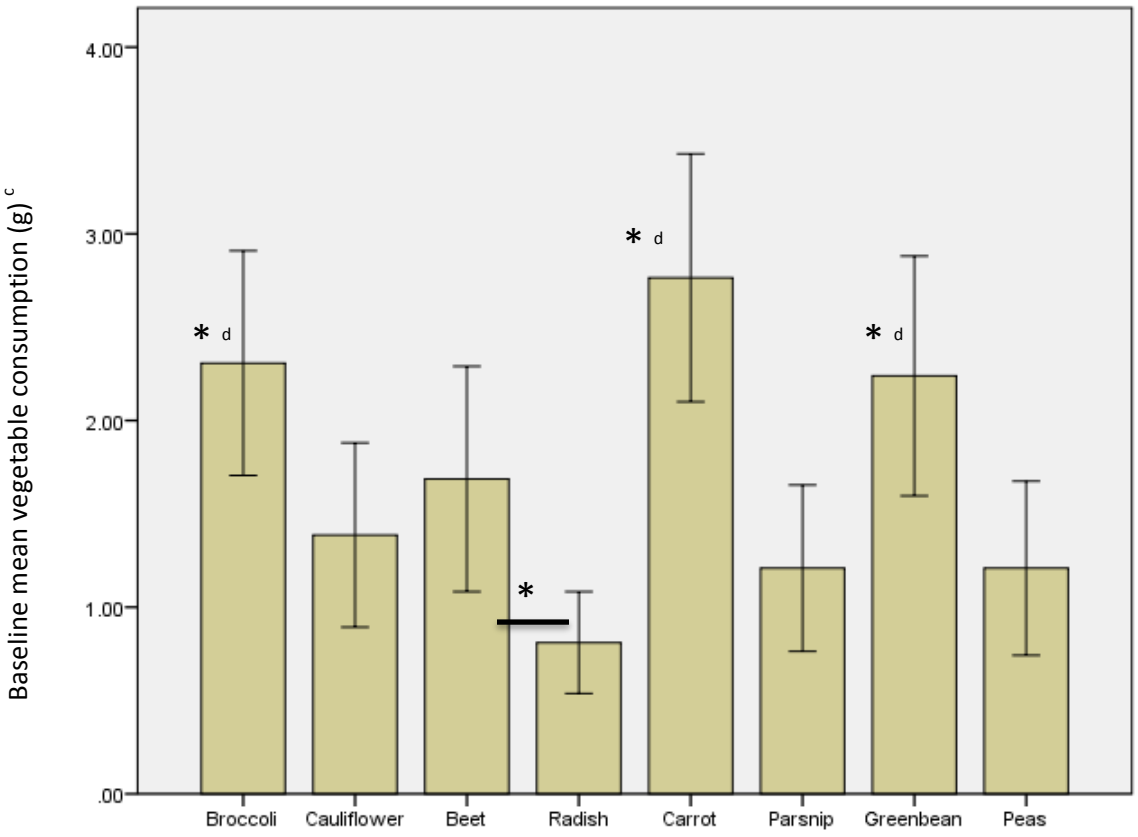

Figure 8. Baseline consumption for the individual vegetables (n = 67 children) [b]

[a] Error bars were the 95% confidence intervals

[b] Sample size represents the number of children present in the classroom during the baseline assessment.

[c] Since the initial weight of each vegetable portion was 7 grams, consumption was considered the amount of the 7 grams the children ate.

[d] Broccoli, green beans, and carrots were all significantly higher than radishes, cauliflower, peas and parsnips

* P <0.05 from a two-sided paired t test.

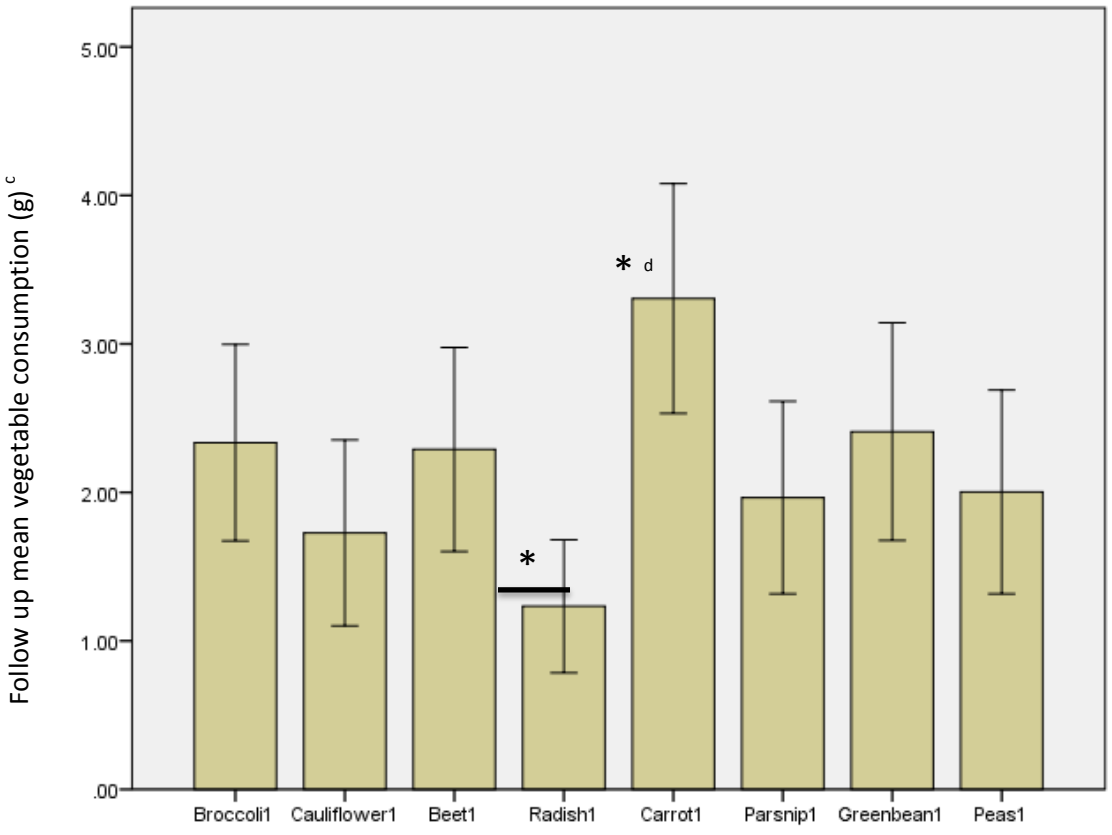

Figure 9. Follow up consumption for the individual vegetables (n = 66 children) [b]

[a] Error bars were the 95% confidence intervals

[b] Sample size represents the number of children present in the classroom during the follow up assessment.

[c] Since the initial weight of each vegetable portion was 7 grams, consumption was considered the amount of the 7 grams the children ate.

[d] Carrots were significantly higher than beets, radishes, cauliflower, peas, parsnips, broccoli and cauliflower

* P <0.05 from a two-sided paired t test.

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