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STRATEGIES TO INCREASE VEGETABLE INTAKE AND MODERATE ENERGY INTAKE IN PRESCHOOL-AGED CHILDREN

A Dissertation in
Nutrition
by
Maureen K. Spill

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The dissertation of Maureen K. Spill was reviewed and approved* by the following:

Barbara J. Rolls  
Helen A. Guthrie Chair  
Professor of Nutritional Sciences  
Dissertation Advisor  
Chair of Committee  

Leann L. Birch  
Distinguished Professor of Human Development  
Director, Center for Childhood Obesity Research  

Terryl Hartman  
Associate Professor of Nutritional Sciences  

Cynthia Bartok  
Assistant Professor of Kinesiology  

Danielle Symons Downs  
Associate Professor of Kinesiology  

Gordon Jensen  
Professor of Nutritional Sciences  
Head of the Department of Nutritional Sciences  

*Signatures are on file in the Graduate School
ABSTRACT

Despite the known benefits for consuming vegetables, vegetable consumption is far below recommendations in children and adults. In addition, rates of childhood overweight and obesity have been rising over the past 3 decades. Children’s dietary habits are likely to continue into adulthood and can affect their risk of chronic diseases such as diabetes, cardiovascular disease, and some cancers. Therefore, it is imperative to identify strategies to improve the diet habits of children particularly through increasing vegetable intake and decreasing energy intake.

Serving larger portions of low-energy-dense vegetables at a meal could have beneficial effects on children’s food and energy intake. We investigated whether increasing the portion size of vegetables served at the start of a meal leads to increased vegetable consumption and decreased meal energy intake in children. Using a crossover design, 3- to 5-year-old children (n=51) in a daycare center were served a test lunch once a week for 4 weeks. In 3 of the meals, a first course of raw carrots was varied in portion size (30, 60, or 90 g), and in the control meal, no first course was served. Children consumed the first course ad libitum over 10 minutes and then were served a main course of pasta, broccoli, applesauce, and milk, also consumed ad libitum. Total vegetable consumption at the meal increased as the portion size of carrots was increased (P<0.0001). Doubling the portion size of the first course increased carrot consumption by 47%, or 12±2 g (P<0.0001). Tripling the portion size of carrots, however, did not lead to a further increase in intake (P=0.61). Meal energy intake was not significantly affected by the amount of carrots served in the first course. The effect of portion size on intake was not significantly influenced by the children’s age or body weight status. Increasing the portion size of a vegetable served as a first course can be an effective strategy to increase vegetable consumption in preschool children.
Study 2 tested whether varying the portion of low-energy-dense vegetable soup served at the start of a meal affects meal energy and vegetable intakes in children. Subjects were 3- to 5-year-olds (n=72) in daycare facilities. Using a crossover design, children were served lunch once a week for four weeks. On three occasions, different portions of tomato soup (150, 225, and 300 g) were served at the start of the meal, and on one occasion no soup was served. Children had 10 minutes to consume the soup before being served the main course which consisted of pasta, broccoli, applesauce, and milk. All foods were consumed ad libitum. The primary outcomes were soup intake as well as energy and vegetable intake at the main course. A mixed linear model tested the effect of soup portion size on intake. Serving any portion of soup reduced entrée energy intake compared with serving no soup, but total meal energy intake was only reduced when 150 g of soup was served. Increasing the portion size increased soup and vegetable intake. Serving low-energy-dense, vegetable soup as a first course is an effective strategy to reduce children’s intake of a more energy-dense main entrée and increase vegetable consumption at the meal.

Substantial amounts of vegetables can be incorporated into foods to reduce their energy density (kcal/g; ED) without children noticing. This strategy, which has the potential to increase vegetable intake and decrease energy intake, was tested in a crossover study with 3- to 5-year-old children. In a daycare center, 40 children were served all meals and snacks one day a week for 3 weeks. Across conditions, breakfast, lunch, and dinner entrées were reduced in ED by increasing the proportion of puréed vegetables. The conditions were 100% ED (standard), 85% ED (tripled vegetable content), and 75% ED (quadrupled vegetable content). These were served with unmanipulated side dishes, and children were instructed to eat as much as they liked. The results showed that daily vegetable intake increased significantly by 52 g (50%) in the 85% ED
condition and 73 g (73%) in the 75% ED condition compared to the standard condition (both p<0.0001). Consuming more vegetables in the entrées did not affect consumption of the vegetable side dishes. Children ate a similar weight of food across conditions, thus significantly decreasing daily energy intake by 142 kcal (12%) from the 100% ED to the 75% ED condition (p<0.05). Children rated their liking of the manipulated foods similarly. Incorporating substantial amounts of puréed vegetables into foods is an effective strategy to increase vegetable intake and decrease energy intake in young children.

These studies have provided evidence that increasing the portion size vegetables served to children and incorporating puréed vegetables into children’s entrées can be used to increase children’s vegetable intake. Serving vegetables at the start of the meal and within the entrées added to intake of vegetable side dishes at the meal and increased total vegetable intake. Providing soup at the start of the meal reduced energy intake of the energy-dense entrée, and may be an effective strategy to decrease energy intake in children. Incorporating puréed vegetables into entrées led to a significant reduction of children’s daily energy intake. Offering vegetables as a first course, providing large portions of well-liked vegetables, serving vegetable-enhanced entrée, and serving vegetable side dishes are all methods that parents and caregivers should incorporate into their daily meal routines to significantly increase children’s vegetable consumption. Used together these techniques are likely to have a substantial impact on the number of children meeting their recommended vegetable intake levels.
# TABLE OF CONTENTS

List of Figures ............................................................................................................................ ix
List of Tables ................................................................................................................................. x
List of Photographs ......................................................................................................................... xi
Acknowledgements ...................................................................................................................... xii

Chapter 1 – Introduction ................................................................................................................ 1

Chapter 2 – Study 1: Eating vegetables first: using portion size to increase vegetable intake in preschool children .................................................................................................................. 25
  Introduction ................................................................................................................................. 26
  Methods ...................................................................................................................................... 27
  Results ......................................................................................................................................... 33
  Discussion ................................................................................................................................... 39
  References .................................................................................................................................. 44

Chapter 3 – Study 2: Serving large portions of vegetable soup at the start of a meal affected children’s energy and vegetable intake ............................................................................................ 47
  Introduction ................................................................................................................................. 48
  Methods ...................................................................................................................................... 49
  Results ......................................................................................................................................... 56
  Discussion ................................................................................................................................... 63
  References .................................................................................................................................. 68

Chapter 4 – Study 3: Hiding vegetables to reduce energy density: an effective strategy to increase children’s vegetable intake and reduce energy intake ..................................................... 71
  Introduction ................................................................................................................................. 72
  Methods ...................................................................................................................................... 73
  Results ......................................................................................................................................... 81
  Discussion ................................................................................................................................... 86
  References .................................................................................................................................. 91

Chapter 5 – Conclusions .................................................................................................................. 93
Appendix A – Parent Recruitment Letter (Study 1) ................................................................. 104
Appendix B – Informed Consent Form (Study 1) ................................................................. 106
Appendix C – Parent Reminder (Study 1) ........................................................................ 109
Appendix D – Parent Letter (Study 1) ............................................................................. 111
Appendix E – Demographic/Background Information Questionnaire (Study 1 & 2) ........ 113
Appendix F – Lunch Script (Study 1 & 2) ....................................................................... 117
Appendix G – Intake Sheets (Study 1) ............................................................................ 119
Appendix H – Height and Weight Script (Study 1 & 2) ..................................................... 124
Appendix I – Preference Assessment Script (Study 1, 2, & 3) ....................................... 126
Appendix J – Face Scale (Study 1, 2, &3) ..................................................................... 129
Appendix K – Parent Recruitment Letter (Study 2) .......................................................... 133
Appendix L – Informed Consent Form (Study 2) ............................................................... 135
Appendix M – Intake Sheets (Study 2) .......................................................................... 138
Appendix N – HHD Research Request Form (Study 3) .................................................. 147
Appendix O – Parent Recruitment Letter (Study 3) .......................................................... 153
Appendix P – Informed Consent Form – Bennett Family Center (Study 3) ...................... 156
Appendix Q – Informed Consent Form – Child Development Laboratory (Study 3) .... 159
Appendix R – Parent Letter (Study 3) ............................................................................. 162
Appendix S – Parent Email Reminder (Study 3) ............................................................... 164
Appendix T – Parent Breakfast Instructions (Study 3) ..................................................... 166
Appendix U – Parent Evening Snack Instructions (Study 3) ............................................ 168
Appendix V – Compensation Request Form (Study 3) .................................................... 170
Appendix W – Demographic/Background Information – Cover Letter (Study 3) ...... 172
Appendix X – Demographic/Background Information Questionnaire (Study 3) ............... 174
Appendix Y – Breakfast Script (Study 3) ........................................................................ 178
Appendix Z – Lunch Script (Study 3) ........................................................................... 180
Appendix AA – Afternoon Snack Script (Study 3) ........................................................ 182
Appendix BB – Dinner Script (Study 3) ......................................................................... 184
Appendix CC – Intake Sheets (Study 3) ......................................................................... 186
LIST OF FIGURES

Figure 1-1. Percentages of selected sex-age groups who meet or exceed the combined recommended number of servings of fruits and vegetables............................3

Figure 2-1. Mean weight of vegetables consumed at lunch (Study 1).................................38

Figure 3-1. Mean weight of vegetables consumed at lunch (Study 2).................................62

Figure 4-1. Mean weight of vegetables consumed from entrées (Study 3)...............................84

Figure 4-2. Mean energy intake consumed from entrées (Study 3)........................................85
LIST OF TABLES

Table 1-1. Summary of studies examining the effect of portion size on children’s intake ...18

Table 1-2. Summary of satiation studies investigating changes in energy density on children’s food and energy intake.................................................................20

Table 2-1. Items served at a test lunch in which the first course of carrots was varied in portion size (Study 1) .................................................................32

Table 2-2 Characteristics of participating children. (Study 1).................................33

Table 2-3. Food and energy intake at the test lunch (Study 1).................................37

Table 3-1. Items served at a test lunch in which the first course of tomato soup was varied in portion size (Study 2) .................................................................55

Table 3-2. Characteristics of participating children (Study 2) ..................................57

Table 3-3. Food and energy intake at the test lunch (Study 2) .................................60

Table 4-1. Manipulated vegetable-enhanced entrées served on test days (Study 3) ........79

Table 4-2. Unmanipulated snacks and side dishes served on test days (Study 3) ..........80

Table 4-3. Characteristics of participating children (Study 3) ..................................82

Table 4-4. Food and energy intakes of all foods and beverages (Study 3) .................83

Table 4-5. Liking ratings and preference rankings of manipulated entrées (Study 3) .....86
LIST OF PHOTOGRAPHS

Photograph 2-1. The portion sizes of carrots served as a first course at lunch (Study 1).....32
Photograph 2-2. Food and beverage served as a main course at lunch (Study 1)..................32
Photograph 3-1. The portion sizes of soup served as a first course at lunch (Study 2)........54
Photograph 3-2. Food and beverage served as a main course at lunch (Study 2)...............54
Photograph 4-1. Manipulated entrées served at breakfast, lunch, and dinner (Study 3). .....78
Photograph 4-2. Manipulated entrées and unmanipulated side dishes served at breakfast, lunch, and dinner (Study 3).................................................................78
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Chapter 1

Introduction
Vegetable consumption is well below recommendations for all Americans over 2-years-old (1). Less than half of 2- to 3-year-old children meet their combined fruit and vegetable recommendations (4 servings/day). The number of children meeting these recommendations drops to 10% of girls and 5% of boys between the ages of 4 to 8 (5-6 servings/day), and continues to decline into adulthood (Figure 1-1). Children develop food preferences and eating habits early in life that persist into adulthood (2-4), therefore providing strategies that encourage vegetable consumption in children can have long term benefits.

Vegetables are an important dietary component for several reasons. Vegetables provide a source of micronutrients and fiber, and consuming vegetables may protect against certain diseases including cardiovascular disease and some types of cancer (5-7). Also, because of their high water content, vegetables are low in energy density, as defined as the amount of energy for a particular weight of food and usually reported as kcal/g. Increasing vegetable consumption can reduce dietary energy density, and low-energy-dense diets have been associated with greater diet quality (8) and healthier body weight in adults (9). Reducing dietary energy density through increased vegetable consumption may, therefore, be an effective strategy for weight management.

Obesity is not a problem isolated to adults. According to the CDC, rates of childhood obesity have tripled in the past 30 years (10). It has recently been reported that more than 20% of 2- to 3-year-old children are considered overweight or obese (defined as having a sex-specific BMI-for-age percentile at or above the 85th percentile), and this rises to approximately 35% in older children (11). Several studies have linked body fatness in children to dietary energy density (12-14). One prospective study found that high-energy-dense diets of 7-year-olds were a risk factor for adiposity at age 9 (13). On the other hand, low-energy-dense diets were associated
with lower fat mass and better diet quality in children and adolescents (15). Encouraging vegetable consumption to lower children’s dietary energy density may be an effective approach to improve children’s diet quality and reduce the onset of obesity.

**Figure 1-1.** Percentages of selected sex-age groups who meet or exceed the combined recommended* number of servings of fruits and vegetables (including juice) per day, estimated from the 1999 – 2000 National Health and Nutrition Examination Survey(1)

![Figure 1-1](image)

*Recommendations from MyPyramid, 2005
† Numbers in parentheses are combined recommendations for that sex-age group, in servings per day

**Barriers to increasing vegetable intake in children**

In order to increase children’s vegetable intake, it is important to understand why children are not currently meeting their recommended intake levels. One reason that children’s vegetable consumption is low may be due to the fact that children do not like the taste of vegetables (16-18). Children are born with innate likes and dislikes; for example, infants demonstrate an innate liking for sweet foods and disliking for bitter foods (19). Many vegetables, particularly dark green vegetables, have characteristic bitter flavors and therefore may be initially rejected by children. With experience, however, food preferences can change. Increasing the number of taste exposures of a disliked food has been shown to improve liking of that food in
adults and children (20-23). Studies in infants show as little as one exposure can increase liking, measured by increased intake of a target food (23, 24). For 2-year-olds, five to ten exposures were required to increase intake of novel fruits and cheeses (22, 25). In order to increase acceptability in 3- to 4-year old children, eight to 15 exposures were required (26), and up to 20 exposures were required for children 8- to 12-years old (27, 28). This data indicates that repeated exposure to vegetables is likely to increase children’s vegetable acceptability and that it is advantageous to begin this exposure at a young age.

Repeatedly exposing a child to an originally disliked vegetable can be challenging for caregivers (25). This may be particularly problematic with preschool-aged children because of the onset of neophobia, or the avoidance of unfamiliar foods. Neophobia is minimal during the first few months of life but increases from around 2- to 5-years-old (2). Therefore specific strategies may be needed to maximize vegetable intake in preschool-aged children.

This dissertation focuses on two specific strategies that have the potential to increase vegetable consumption in preschool-aged children. The first strategy that is discussed is increasing the portion size of vegetables served to children at the start of a meal to increase vegetable intake. The second strategy discussed is increasing children’s vegetable intake by covertly incorporating vegetables into foods. In addition to the possible effects on vegetable consumption, these strategies may play a role in moderating children’s energy intake.

The effect of portion size on intake - in adults

Increasing the portion size of foods has been shown to increase intake in adults. Research studies have found that portion size influences intake of various types of foods including amorphous foods such as macaroni and cheese, pre-packaged foods such as potato chips, pre-
portioned unit foods such as sandwiches, as well as restaurant meals and self-served meals (29-31). In one study, for example, increasing portion size by 50% led to a 43% increase in energy intake of the entrée (30). This effect was shown to last up to 11 days without declining over time (32).

While most portion size studies have varied the portions of energy-dense entrées, few have looked at the effects of increasing the portion size of vegetables. When all foods and caloric beverages served to adults over 11 days were increased in portion size, intake increased for all foods categories except fruits (as a side dish) and vegetables (32). In other words, when the portion size of other palatable, energy-dense foods increased, adults consumed more of those foods but not more of the low-energy-dense fruits and vegetables. The effect of increasing the portion size of a vegetable side dish, but not the other meal components, on vegetable intake was tested in a later pair of studies. In these studies, the amount of broccoli served at a meal increased in one of two ways: either by adding to the total amount of food served (the portion sizes of other meal components were held constant), or by substituting for other foods served (the portion sizes of other foods decreased) (33). In both cases, broccoli intake significantly increased with an increase in portion size. This indicates that portion size can be used in a beneficial way to increase vegetable intake in adults; however, the effect of portion size on intake in children is less clear.

The effect of portion size on intake – in children

The influence of children’s age

There have been a few studies that have investigated the effect of portion size on children’s intake, but the results have been inconsistent. One of the first studies that looked at the
effect of portion size on children’s intake found that increasing the portion size of an entrée significantly increased intake in 5-year-old children but not in 3-year-old children (Table 1-1) (34). This finding suggested that age may influence the effect of portion size on children’s intake, such that younger children are less susceptible to variations in portion size than older children. This result was supported by other studies that indicated that with development, environmental factors have a greater influence over children’s food intake (35-37).

Later studies did not replicate the findings that child’s age influences the effect of portion size on intake. In one study, 3- to 6-year-old were divided into 2 age groups, 3- to 4-years-old and 4- to 6-years-old. Each group was served two different portions sizes of macaroni and cheese, an age appropriate ‘reference’ portion and twice that amount (38). Contrary to expectations, both younger and older children increased their macaroni and cheese intake when the portion size was doubled. A subsequent study was specifically designed to investigate the influence of age on portion size effects (39). Children between the ages of 2- and 9-years-old were divided into 3 age groups (2- to 3-years old, 5- to 6-years old, and 8- to 9-years-old) and served two portion sizes of macaroni and cheese. Again, age was not found to significantly influence the effect of portion size on intake; children as young as 2-years-old increased their intake when the entrée portion size was doubled. The majority of studies indicate that the effect of portion size on food intake is apparent at a very young age, and that age does not influence the effect of portion on children’s intake.

The influence of children’s body mass index percentile

While child’s age did not have a consistent influence on the effect of portion size on intake, it is possible that a child’s responsiveness to portion size may be associated with their
weight; that is, children that are more susceptible to increases in portion size may be overweight or vice versa. Neither epidemiological nor experimental studies have supported this hypothesis. Using data from CSFII 1994 to 1996 and 1998, no association was found between BMI percentile and meal portion size for 3- to 5-year old children (40). Additionally, the experimental studies that have measured children’s responses to portion size have not found a relationship between responsiveness to portion size and BMI percentile (34, 38, 39, 41-43). These studies may not have been powered to find differences across a BMI range, therefore future studies that are designed and powered to detect differences in portion size responsiveness based on BMI percentile are needed.

**Comparing study findings and inconsistencies**

Several studies, but not all studies, have found a significant effect of portion size on children’s intake. The reason for the discrepancies is not likely due to child characteristics such as age or BMI but may more likely be the result of differences in study designs. Specific design factors that may have affected the outcome include: the reference portion size used, the relative change in portion size, and the type of food tested.

The portion size used as the reference amount can have a significant impact on whether or not a portion size effect is found. A reference portion that is too small can artificially limit intake. Increasing the portion size of a very small reference amount can consequentially create an effect of portion size on intake. This is the reason it is important to identify “plate-cleaners”, or those individuals who consume the entire portion of the test food, and run the statistical analyses with and without their data. On the other hand, if the reference portion is too large, increasing the portion size further is unlikely to affect intake. This is the likely explanation of why Fisher et
al. (41) did not find an effect of portion size on intake after doubling the portion size of macaroni and cheese served to 5-year-old children. In this study, the reference portion was very large (453 g); in fact, it was more than 200 g larger than the reference portion of macaroni and cheese served to 5-year-old children in other studies (34, 38, 39, 42). When more moderate reference portion sizes of macaroni and cheese were doubled, significant portion size effects were found. Therefore, determining an appropriate reference portion size for the age group being tested is important when designing a portion size study.

In addition to the size of the reference amount, the change in portion size is likely to affect whether a portion size effect is found. All studies that have found an effect of portion size on intake doubled the reference amount (38, 39, 41, 42). When the reference portion of pasta with tomato-based sauce was increased by only 33%, there was no significant increase in food intake (43). It is not clear if this lack of effect is the result of a smaller increase in portion size, or if it is the result of the type of food tested.

Most studies that have found a significant effect of portion size on children’s intake tested changes in portion size of macaroni and cheese, an energy-dense, palatable food (34, 38, 39, 42). Varying the portion size of other types of food has been tested with mixed results. Doubling the portion size of chicken nuggets and cereal increased intake in 5-year-old children; however, in the same study, doubling the portion size of graham crackers and apple juice did not increase intake (41). While all the foods tested were foods commonly consumed by children, differences in palatability may lead to different responses to variations in portion size. Increasing the portion size of foods is likely to have a greater effect on intake when the food is highly palatable.
The effect of portion size on vegetable intake

Previous research has provided evidence that portion size can affect children’s intake of highly palatable, energy-dense foods, but little is known about the effect of portion size on children’s intake of low-energy-foods, such as vegetables. In a study with 5- and 6-year old children, doubling the portion size of applesauce, cooked carrots, and cooked broccoli at a meal significantly increased intake of applesauce by 43%, but intake of the carrots or broccoli did not increase (44). The authors speculated that the effect of portion size may be largely influenced by preferences of the available foods. For example, children that rated broccoli as their most preferred food did increase their broccoli intake when the portion size was doubled. The majority of children, however, rated the vegetables as their least preferred food compared to the accompanying pasta entrée and applesauce. Therefore, preference for the vegetable tested in relation to the competing foods available may influence the effect of portion size. It is possible that portion size may have a greater effect on vegetable intake if the vegetable is well-liked and is served without the presence of competing foods. Varying the portion size of a vegetable served alone, such as at the start of a meal, would be a useful method to determine the effect of vegetable portion size on intake without the influence of other foods.

Effects of serving vegetables as a first course on children’s energy intake

Serving vegetables as a first course has the potential to increase vegetable intake, as well as to affect children’s feelings of satiety and to influence the amount of food consumed at the subsequent course. Satiety is the feeling of fullness that occurs after a food has been consumed. In satiety studies, a fixed amount of a food is consumed, like a first course, and subsequent consumption of a test meal is measured. In adults, consuming a high-energy-dense first course
has been shown to increase meal energy intake; however, consuming a low-energy-dense first course, such as soup or salad, has been shown to enhance satiety and reduce intake of the main course, as well as reduce overall energy intake at the meal (45-48). It is unknown how children would respond to consuming a low-energy-dense vegetable first course. Children are reportedly better at responding to changes in energy intake than adults (49-51). Some studies have shown that children compensate for energy consumed as a first course by adjusting intake of the subsequent course; yet the findings are mixed (52-54). Because these studies are designed for the first course food to be consumed in its entirety, the foods that have been tested are highly palatable, relatively energy-dense foods such as pudding (50, 55), yogurt (54, 56), muffins (52), and cereal (57). Little is known about the effect of serving a low-energy-dense vegetable first course on children’s food and energy intake.

**Incorporating vegetables into foods**

Increasing portion size of vegetables served to children, even when served as a first course, is likely to affect children’s vegetable intake only when the vegetable is well-liked. A more effective strategy to increase children’s vegetable intake may be to “covertly” incorporate puréed vegetables into foods. By using a covert technique, a substantial amount of a variety of vegetables can be added to foods without children noticing. Incorporating vegetables not only increases the vegetable content of the food, but also lowers the energy density, which can impact satiation and reduce energy intake.

Energy density is the amount of energy in a given weight of food (kcal/g) and is calculated based on the macronutrient and water contents of the food. Fat has the greatest energy density of 9 kcal/g, while water, which adds weight without energy, has an energy density of 0
kcal/g. Protein and carbohydrates have intermediate energy densities of 4 kcal/g. The energy density of a food can be manipulated by adjusting its macronutrient and water contents – with fat and water having the greatest influence. Adding water to foods is an effective way to reduce the energy density, however adding a substantial amount of water to many foods is not practical. Adding water-rich vegetables is another approach to reduce the energy density of a food.

Changing the energy density of a food can impact energy intake by influencing satiation, which is the process leading to the termination of eating during a meal. Satiation is measured by *ad libitum* intake of a test food. In a well designed satiation study, the palatability and appearance of the test foods are matched to prevent differences in intake due to differences in palatability. Several satiation studies have found that adults tend to eat a consistent weight of food and, therefore, reducing dietary energy density leads to a reduction in energy intake (58-60). Similar to the reasons mentioned previously for why children may respond differently than adults to consuming a first course on meal energy intake, it is possible that children might respond differently to changes in energy density on food intake in satiation studies. Over the past few years, however, more studies have emerged examining the effects of energy density on children’s energy intake.

**The effect of reducing energy density on children’s intake within a single meal**

Satiation studies in children have been conducted by altering the energy density of a food and allowing children to consume as much or as little as they like. Most satiation studies have measured the effect of reducing the energy density of an entrée on children’s intake at a single meal. In one study, when the energy density of macaroni and cheese was reduced by 28% and served to 53 5- and 6-year-old children, the children ate the same weight of food compared to the
control which resulted in a reduction of entrée energy intake by 33% and meal energy intake by 18% (Table 1-2) (42). A similar study in younger children found that when the energy density of macaroni and cheese was reduced by 30%, 2- to 5-year-old children consumed the same weight of food resulting in 25% less energy from the entrée and 18% less energy at the meal (61). In each of these studies, the energy density was manipulated by changing the fat and water content.

Only one study added puréed vegetables to an entrée to reduce the energy density. In a study by Leahy et al (43), the energy density of pasta with a tomato-based sauce was reduced by decreasing the fat content and increasing the vegetable content of the sauce. Similar to previous findings, 61 3- to 5-year-old children responded to the reduction in energy density by consuming a consistent weight of food which resulted in a 25% decrease in entrée energy intake and a 17% decrease in meal energy intake. An additional finding of this study was that children’s vegetable intake increased when they consumed the reduced energy density pasta that contained puréed vegetables. This study supports the hypothesis that incorporating puréed vegetables into foods, as the sole method for reducing energy density, can lead to a significant impact on children’s vegetable and energy intakes.

The effect of reducing energy density on children’s intake over multiple meals

Reducing the energy density of foods served to children reduced children’s energy intake within that meal, but children may adjust their intake at subsequent meals to compensate. In adults, several studies have found that reducing energy density can reduce energy intake beyond a meal (58-60, 62-64) and for up to 14 days (60). In children, however, only two studies have looked at the effect of reductions in energy density on energy intake beyond a single meal (Table 1-2) (65, 66). One of the first studies that examined the effect of reducing energy density on
children’s energy intake replaced fat with a fat substitute in foods served at breakfast, morning snack, and lunch to 2- to 5-year-old children (65). Across the manipulated foods, children could consume up to 16 g less fat (or 144 kcal less) in the fat-substituted foods compared to the standard foods. Over the three meals, children consumed a consistent weight of food and, on average, consumed about 100 kcal less, or 11% less energy, in the reduced fat/reduced energy density condition. Cumulative differences in energy intake of later meals converged and were no longer significant by the second day.

In a later study, reducing the energy density of several foods served to children resulted in a sustained reduction of energy intake for over a 2 day period. In this study, (66) all foods served at breakfast, lunch, and afternoon snack were reduced in energy density by an average of 27% using a combination of methods including decreased fat and sugar and increased fruit and vegetable content of the foods. Unmanipulated dinners and evening snacks were provided to allow children the opportunity to compensate for potential reductions in energy intake. At each meal, and cumulatively over 2 days, 26 3- to 5-year old children consumed a consistent weight of food regardless of the energy density. Energy intake over the 2 days was reduced by 14% with no evidence for compensation during the manipulated or unmanipulated meals. This study provides evidence that decreasing dietary energy density is an effective approach to moderating children’s energy intake beyond a single meal.

No single- or multiple-meal studies have tested the effect of reducing the energy density of foods served to children strictly through increasing the vegetable content. In order to test this, the palatability of the test foods needs to be matched. Adding large amounts of whole or chopped vegetables will affect the food’s appearance and other sensory properties like taste and texture.
Adding puréed vegetables to recipes can mask the presence of the vegetables and be used with several types of foods including pasta dishes, casseroles, and baked goods. It is of interest to understand how incorporating puréed vegetables into foods affects children’s vegetable and energy intake within a meal and over several meals.

**SUMMARY**

Based on the low number of children meeting their recommended vegetable intake levels, research is needed to identify strategies that can effectively increase vegetable consumption in young children. Increasing vegetable intake has the potential to moderate children’s energy intake. Therefore, this dissertation encompasses 3 studies with the primary objective of increasing children’s vegetable intake and a secondary objective of decreasing children’s energy intake. Specifically, the first 2 studies examine the effect of increasing the portion size of vegetables served to children at the start of the meal. The third study tests the strategy of incorporating vegetables into children’s entrées on children’s vegetable and energy intakes.

**Study 1: How does increasing the portion size of carrots served at the start of the meal affect children’s vegetable and energy intake?**

Evidence exists that increasing the portion size of foods served to children will increase intake. However, the only study that has tested the effect of portion size on children’s vegetable intake did so when other more-palatable foods were present. By measuring the effect of increasing the portion size of a well-liked vegetable, such as carrot sticks, served as a first course, the influence of competing foods is removed. Additionally, research suggests that serving a low-energy-dense first course can increase satiety and reduce energy intake in the subsequent
main course. Therefore, this strategy may have a positive impact on children’s vegetable and energy intake.

Specific aims and hypotheses for Study 1:

Aim 1: To test the effect of increasing the portion size of a low energy-dense vegetable on intake of that vegetable without the presence of competing foods

Hypothesis 1: Increasing the portion size of a low-energy-dense vegetable will increase children’s intake of that vegetable.

Aim 2: To test the effect of increasing the portion size of a low energy-dense vegetable on intake of a vegetable served in the subsequent course (and overall vegetable intake at the meal)

Hypothesis 2: Increasing the portion size of a low-energy-dense vegetable will not affect vegetable consumption at the main course, and will increase overall vegetable intake at the meal.

Aim 3: To test the effect of increasing the portion size of a low energy-dense vegetable on energy intake of the main course (and of the meal)

Hypothesis 3: Increasing the portion size of a low-energy-dense vegetable will decrease energy intake at the main course, and over the total meal (first + main course)

Study 2: How does increasing the portion size of tomato soup served at the start of the meal affect children’s vegetable and energy intake?

It is unclear how changes in portion size of a low-energy-dense vegetable soup will affect children’s soup intake and vegetable intake. Serving soup as a first course may also increase
satiety and affect energy intake of the meal. Studies in adults have shown that consuming a low-energy-dense soup at the start of a meal increases satiety and reduces energy intake of the main course and of the total meal (45-47), although this has never been tested in children.

**Specific aims and hypotheses for Study 2:**

**Aim 1:** To test the effect of increasing the portion size of a low energy-dense vegetable soup on soup intake without the presence of competing foods

**Hypothesis 1:** Increasing the portion size of a low-energy-dense vegetable soup will increase children’s soup intake.

**Aim 2:** To test the effect of increasing the portion size of a low energy-dense vegetable soup on intake of a vegetable served in the subsequent course (and overall vegetable intake at the meal)

**Hypothesis 2:** Increasing the portion size of a low-energy-dense vegetable soup will not affect vegetable consumption at the main course, and will increase overall vegetable intake at the meal.

**Aim 3:** To test the effect of increasing the portion size of a low energy-dense vegetable soup on energy intake of the main course (and of the meal)

**Hypothesis 3:** Increasing the portion size of a low-energy-dense vegetable soup will decrease energy intake at the main course, and over the total meal (first + main course).

**Study 3:** Can reducing the energy density by covertly incorporating puréed vegetables into entrées affect children’s vegetable and energy intakes over a day?
Studies have shown that children tend to eat a consistent weight of food, even when energy density is reduced. However, none of these studies have decreased energy density solely through the addition of vegetables. One study that used a combination of a vegetable addition and fat reduction to reduce energy density found that children decreased their energy intake and increased their vegetable intake at a meal (43). It is of interest to see how a strict vegetable manipulation affects children’s vegetable and energy intake over a single meal as well as over a day.

**Specific aims and hypotheses for Study 3:**

**Aim 1:** To test the effect of reducing entrée energy density by incorporating puréed vegetables into foods on vegetable intake in children over a day

**Hypothesis 1:** Reducing entrée energy density by incorporating vegetables into foods will increase children’s vegetable intake over a day.

**Aim 2:** To test the effect of reducing entrée energy density by incorporating puréed vegetables into foods on energy intake in children over a day

**Hypothesis 2:** Reducing entrée energy density by incorporating vegetables into foods will decrease children’s energy intake over a day.

**Aim 3:** To test the effect of incorporating vegetables into foods on consumption of vegetable side dishes, and total vegetable intake

**Hypothesis 3:** Intake of vegetable side dishes will not change based on the vegetable content of the entrées and total vegetable intake will increase as the vegetable content of entrées increases.
Table 1-1. Summary of studies examining the effect of portion size on children’s intake

<table>
<thead>
<tr>
<th>Publication</th>
<th>Subject ages</th>
<th>n</th>
<th>Manipulated Food</th>
<th>Portion sizes</th>
<th>ED (kcal/g)</th>
<th>Change in PS</th>
<th>Significant PS effect</th>
<th>Other nonmanipulated foods at meal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rolls, et al. (34)</td>
<td>3</td>
<td>16</td>
<td>Mac &amp; Cheese</td>
<td>150 g, 263 g, 376 g</td>
<td>1.4</td>
<td>250%</td>
<td>No</td>
<td>carrots, applesauce, milk</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>16</td>
<td>Mac &amp; Cheese</td>
<td>225 g, 338 g, 450 g</td>
<td>1.4</td>
<td>Doubled</td>
<td>Yes</td>
<td>carrots, applesauce, milk</td>
</tr>
<tr>
<td>Fisher, et al. (38)</td>
<td>3.5</td>
<td>11</td>
<td>Mac &amp; Cheese</td>
<td>125 g, 250 g</td>
<td>3.7</td>
<td>Doubled</td>
<td>Yes</td>
<td>carrots, applesauce, cookies, milk</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>18</td>
<td>Mac &amp; Cheese</td>
<td>175 g, 350 g</td>
<td>3.7</td>
<td>Doubled</td>
<td>Yes</td>
<td>carrots, applesauce, cookies, milk</td>
</tr>
<tr>
<td>Fisher, et al. (42)</td>
<td>5-6</td>
<td>53</td>
<td>Mac &amp; Cheese</td>
<td>250 g, 500 g</td>
<td>1.3, 1.8</td>
<td>Doubled</td>
<td>Yes</td>
<td>carrots, corn, applesauce, cookies, milk</td>
</tr>
<tr>
<td>Fisher, et al. (41)</td>
<td>5</td>
<td>58</td>
<td>Mac &amp; Cheese</td>
<td>453 g, 906 g</td>
<td>1.51</td>
<td>Doubled</td>
<td>No</td>
<td>carrots, applesauce, cookies, milk</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Apple juice</td>
<td>113 g, 226 g</td>
<td>0.47</td>
<td>Doubled</td>
<td>No</td>
<td>pears, corn, roll, milk</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Graham crackers</td>
<td>185 g, 370 g</td>
<td>4.62</td>
<td>Doubled</td>
<td>No</td>
<td>banana, bacon, orange juice, milk</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Chicken nuggets</td>
<td>368 g, 736 g</td>
<td>2.42</td>
<td>Doubled</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cereal</td>
<td>160 g, 320 g</td>
<td>4</td>
<td>Doubled</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>
Table 1-1. Summary of studies examining the effect of portion size on children’s intake, continued

<table>
<thead>
<tr>
<th>Publication</th>
<th>Subject ages</th>
<th>n</th>
<th>Manipulated Food</th>
<th>Portion sizes</th>
<th>ED (kcal/g)</th>
<th>Change in PS</th>
<th>Significant PS effect</th>
<th>Other nonmanipulated foods at meal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fisher (39)</td>
<td>2-3</td>
<td>18</td>
<td>Mac &amp; Cheese</td>
<td>200 g, 400 g</td>
<td>1.42</td>
<td>Doubled</td>
<td>Yes</td>
<td>carrots, corn, applesauce, cookies, milk</td>
</tr>
<tr>
<td></td>
<td>5-6</td>
<td>22</td>
<td>Mac &amp; Cheese</td>
<td>250 g, 500 g</td>
<td>1.42</td>
<td>Doubled</td>
<td>Yes</td>
<td>carrots, corn, applesauce, cookies, milk</td>
</tr>
<tr>
<td></td>
<td>8-9</td>
<td>25</td>
<td>Mac &amp; Cheese</td>
<td>450 g, 900 g</td>
<td>1.42</td>
<td>Doubled</td>
<td>Yes</td>
<td>carrots, corn, applesauce, cookies, milk</td>
</tr>
<tr>
<td>Leahy, et al.(43)</td>
<td>3-5</td>
<td>61</td>
<td>Pasta with sauce</td>
<td>300 g, 400 g</td>
<td>1.2, 1.6</td>
<td>133%</td>
<td>No</td>
<td>carrots, applesauce, milk</td>
</tr>
<tr>
<td>Kral, et al. (44)</td>
<td>5-6</td>
<td>43</td>
<td>Applesauce</td>
<td>122 g, 244 g</td>
<td>0.4</td>
<td>Doubled</td>
<td>Yes</td>
<td>pasta with tomato sauce, milk</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cooked carrots</td>
<td>75 g, 150 g</td>
<td>0.3</td>
<td>Doubled</td>
<td>No</td>
<td>pasta with tomato sauce, milk</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cooked broccoli</td>
<td>75 g, 150 g</td>
<td>0.3</td>
<td>Doubled</td>
<td>No</td>
<td>pasta with tomato sauce, milk</td>
</tr>
<tr>
<td>Looney &amp; Raynor (67)</td>
<td>2-5</td>
<td>17</td>
<td>Applesauce</td>
<td>150 g, 300 g</td>
<td>0.43</td>
<td>Doubled</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Chocolate pudding</td>
<td>150 g, 300 g</td>
<td>1.19</td>
<td>Doubled</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Publication</td>
<td>Subject ages</td>
<td>n</td>
<td>Meal</td>
<td>Manipulated foods</td>
<td>ED Manipulation</td>
<td>ED levels (reduction)</td>
<td>Results on food intake</td>
<td>Results on energy intake</td>
</tr>
<tr>
<td>----------------------</td>
<td>--------------</td>
<td>----</td>
<td>-----------------------------</td>
<td>-----------------------------------</td>
<td>-----------------</td>
<td>-----------------------</td>
<td>-------------------------------------------------------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>Birch et al. (65)</td>
<td>2-5</td>
<td>29</td>
<td>Breakfast (day 1)</td>
<td>Muffins, biscuits, Cookies, Chips</td>
<td>Fat reduction</td>
<td>Decr upto 144 kcal</td>
<td>No change in manipulated meals</td>
<td>Decr 11% in manipulated meals. No diff by end of day 2.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Snack (day 1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lunch (day 1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Measured intake</td>
<td>remainder of day 1 &amp; 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fisher et al. (42)</td>
<td>5-6</td>
<td>53</td>
<td>Dinner</td>
<td>Macaroni &amp; cheese, Fat reduction, water addition</td>
<td>1.8, 1.3 (28% reduction)</td>
<td>No effect</td>
<td>33% incr from entrée, 18% incr at meal</td>
<td></td>
</tr>
<tr>
<td>Leahy, et al. (61)</td>
<td>2-5</td>
<td>77</td>
<td>Lunch</td>
<td>Macaroni &amp; cheese, Fat reduction, water addition</td>
<td>2.0, 1.4 (30% reduction)</td>
<td>Incr LED entrée g intake</td>
<td>25% decr in entrée EI 18% decr in lunch EI</td>
<td></td>
</tr>
<tr>
<td>Leahy, et al. (43)</td>
<td>3-5</td>
<td>61</td>
<td>Lunch</td>
<td>Pasta with red sauce, Fat reduction, veg addition</td>
<td>1.6, 1.2 (25% reduction)</td>
<td>No effect</td>
<td>25% decr in entrée EI 17% decr in lunch EI</td>
<td></td>
</tr>
<tr>
<td>Leahy, et al. (66)</td>
<td>3-5</td>
<td>26</td>
<td>Breakfast (day 1&amp;2)</td>
<td>All foods at breakfast, lunch, &amp; afternoon snack, Fat reduction, sugar; Incr FV</td>
<td>27% decr in manip foods: 17% decr of all foods &amp; bev</td>
<td>No effect</td>
<td>14% decr in EI over 2 days</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lunch (1&amp;2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Afternoon snack (day 1&amp;2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Unmanip dinner &amp;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>evening snack (day 1&amp;2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
32. Rolls BJ, Roe LS, Meengs JS. The effect of large portion sizes on energy intake is sustained for 11 days. Obesity (Silver Spring) 2007;15:1535-43.
38. Orlet Fisher J, Rolls BJ, Birch LL. Children's bite size and intake of an entrée are greater with large portions than with age-appropriate or self-selected portions. Am J Clin Nutr 2003;77:1164-70.


44. Kral TV, Kabay AC, Roe LS, Rolls BJ. Effects of doubling the portion size of fruit and vegetable side dishes on children's intake at a meal. Obesity (Silver Spring) 2010;18:521-7.


49. Birch LL, McPhee L, Sullivan S. Children's food intake following drinks sweetened with sucrose or aspartame: time course effects. Physiol Behav 1989;45:387-95.


62. Rolls BJ, Roe LS, Meengs JS. Larger portion sizes lead to sustained increase in energy intake over two days. Journal of the American Dietetic Association 2006;106:543-549.


Chapter 2

Study 1:

Eating vegetables first: using portion size to increase vegetable intake in preschool children

INTRODUCTION

There is a clear need to identify strategies that will increase vegetable intake in children. While it has been established that fruits and vegetables are an important dietary component for many reasons, including the vital micronutrients they provide and their role in disease prevention (1-3), nationally representative data show that less than half of American children meet their daily recommended intake of fruits and vegetables (4). One strategy that has the potential to increase fruit and vegetable intake in children is to serve larger portions at meals. In adults, increasing the portion size of pasta, sandwiches, and snack foods has been shown to significantly increase intake of these foods (5 - 7). In children, several studies have shown that portion size can affect intake of a number of foods (8 - 11), but the effects of portion size have been less consistent than in adults. The aim of the current study was to determine whether increasing the portion size of a vegetable served as a first course at lunch influences vegetable intake in preschool children.

The effect on intake of varying the portion size of nutrient-dense foods such as vegetables has been investigated in several studies. One study in adults found that increasing the portion size of all foods served over 11 days led to increased intake in all food categories except fruits (as a side dish) and vegetables (12). In children, a recent study varied the portion size of the fruit and vegetable side dishes while the entrée portion was kept constant (13). The results showed that when the portion size of the fruit was doubled, intake increased, yet when the portion size of two vegetables was doubled there was no significant change in intake. Thus, larger portions did not influence vegetable intake when competing foods were available. It is not known whether serving larger portions of vegetables at the start of a meal in the absence of competing foods would affect vegetable intake.
Increased consumption of vegetables at the start of a meal could affect the type or amount of food eaten during the rest of the meal. In adults, adding a first course of vegetables has been shown to reduce meal energy intake. In one study, salads differing in portion size and energy content were served to women as a compulsory first course (14). The results showed that consuming a low-energy-dense salad decreased energy intake in the subsequent course and over the entire meal. There are no data in either adults or children to indicate whether providing different portions of vegetables as a first course to be consumed ad libitum will affect vegetable or energy intake at the meal. The purpose of the present study was to determine the effects of serving preschool children different portions of a vegetable as a first course at lunch on vegetable consumption and energy intake at the meal.

SUBJECTS AND METHODS

Experimental Design

A within-subject, crossover design was used to test the effect of varying the amount of carrots served to preschool-aged children as a lunch first course on food and energy intake. On one day a week for four weeks, children in a daycare setting were provided with a test lunch. Across the weeks, the portion size of carrots served in the first course was varied (30, 60, or 90 g) and during one week no first course was provided. The foods and beverages served in the main course were not varied in portion size. On test days, a standard breakfast was served approximately 3 hours prior to lunch in order to maintain a similar level of hunger before lunch. All foods and beverages were consumed ad libitum. During the week before the study, one day was used to acquaint the children and teachers with the test meal procedures; no data were collected on this day.
**Participant Recruitment**

Recruitment began in April 2008 by distributing letters to parents who had children within the age range of three to six years old enrolled in daycare at the Bennett Family Center at the University Park campus of The Pennsylvania State University. Children were enrolled from five classrooms; the order of the experimental conditions across study weeks was assigned to classrooms using a Latin square design. Parents and guardians provided informed written consent for both their own participation and that of their child. The Pennsylvania State University Office for Research Protections reviewed and approved all procedures.

A power analysis was performed to determine the number of children needed in the study, based on previous research in a similar population of children with similar foods (11). The minimal clinically relevant difference in meal energy intake was assumed to be 40 kcal, which is approximately 10 to 15% of typical meal intakes in this population (11). It was estimated that a sample of 44 children would allow the detection of this difference with >80% power using a 2-sided test with a significance level of 0.05.

**Test Foods & Meal Procedures**

The foods and amounts served at the test meal, which was served once a week for four weeks, are shown in Table 2-1. Raw carrots were chosen for the first course vegetable because they are popular among preschool children (15, 16). The smallest portion size of carrots (30 g) was selected based on the mean carrot intake per eating occasion for children in this age group (15); this amount was doubled and tripled to determine the larger two portion sizes. The 60 g portion is equivalent to one half-cup (118 ml) serving, which represents one-third of the
recommended daily vegetable intake for most children aged three to five years (17). The carrots were served with low-fat dip because studies in older children have shown that the preparation method influences the acceptability of vegetables, and in particular that children prefer vegetables served with dip or cooked with butter (18). The remaining items served at the test meal (pasta, broccoli, applesauce, and milk) were also familiar to the children in the daycare center. The portion sizes of these foods were based on consumption data from previous research with children in this age group (11, 19, 20). Cooked broccoli was served as the vegetable component of the main course in all test meals in order to comply with the National School Lunch Program (21); this also allowed the examination of the effects of the vegetable first course on vegetable intake in the main course.

Lunch was served to all children in the participating classrooms at the regularly scheduled time and eaten at tables with three to six children and one adult, which is the standard practice at this facility. Once children were seated at their tables they were served the first course of carrots. Ten minutes after serving the first course, the remaining carrots and dip were removed and the main course of the lunch was served. A 10-minute interval for the first course was selected based on teacher recommendations and the amount of time allotted for the lunch meal. In the condition with no first course, children were served the main course upon being seated. Incidents of food and drink spillage were recorded by researchers. Teachers were instructed to redirect conversations pertaining to food to non-food-related topics to minimize influence on lunch intake. When children finished their lunch, spilled or dropped food was returned to the correct dish and any spilled milk was recovered with paper towels. Uneaten items were removed and weights were recorded to the nearest 0.1g using digital scales (Mettler Toledo model XS4001S, Mettler-Toledo, Inc., Columbus, OH). Consumption of the foods and milk was
determined by subtracting post-meal weights from pre-meal weights. Information from food manufacturers and from a standard food composition database (22) was used to calculate energy content.

**Food Acceptability Assessment**

Within two weeks of completing all test meals, children’s acceptability of the experimental foods was assessed using a procedure developed by Birch et al. (16, 23, 24). Children were instructed on the use of three cartoon faces to indicate whether they thought a food was ‘yummy’, ‘okay’, or ‘yucky’. After instruction, each child was presented with a sample of carrots and dip. The child was asked to taste the carrots and indicate their acceptability by pointing to the appropriate face. The carrots and dip were then removed and the child was presented with a sample of pasta. The child was again asked to taste the food and point to the face that corresponded to their degree of acceptability.

**Demographic and Anthropometric Measures**

Parents were asked to complete a questionnaire with 19 questions assessing family demographics and the health status of their child. Body weight and height measurements of the children were taken within two weeks of the final test meal. Body weight was measured in duplicate using a portable digital scale (Seca Onda Model 843, Seca Corporation, Hanover, MD). If the two measurements differed by more than 0.1 kg, a third measurement was taken and the measurements were averaged. Height was measured to the nearest 0.1 cm, in duplicate using a portable stadiometer (Model 214, Seca Corporation, Hanover, MD). If the two measurements varied by more than 0.2 cm, a third measurement was taken and the measurements were
averaged. The children’s height, weight, and age were used to calculate their sex-specific body mass index-for-age percentile and z-score for body mass index-for-age using a software program from the Centers for Disease Control and Prevention (25).

**Statistical analysis**

Data were analyzed by using a mixed linear model with repeated measures (SAS version 9.1, SAS Institute, Cary, NC). The fixed factors in the model were carrot portion size (0, 30, 60, or 90 g) and session number; subjects were treated as a random factor. The factors of children’s food acceptability ratings and sex were also investigated. The main outcome measures were weight and energy intake of carrots and all other foods, as well as total vegetable intake and total food and energy intake at the meal. Total vegetable consumption at the meal (carrots + broccoli) was assessed in order to investigate the effect of vegetable intake in the first course on this outcome.

Children who consumed all of the carrots (≥ 95% of the weight served) at any meal were identified, and data were analyzed both with and without these children to determine whether they influenced the results. The effect of individual children who were influential on the main study outcomes was assessed using the procedure of Littell et al. (26).

T-tests were used to test differences between girls and boys in age, body weight, height, BMI percentile, and BMI z-score. Analysis of covariance was used to assess the influence of continuous variables (age, body weight, height, BMI percentile, and BMI z-score) on the relationship between carrot portion size and the main study outcomes. Data are reported as means ± SEM and results were considered significant at p < 0.05. The Tukey-Kramer method was used to adjust significance levels to account for multiple comparisons.
PHOTOGRAPH 2-1. The portion sizes of carrots served as a first course at lunch.

PHOTOGRAPH 2-2. Foods and beverage served as a main course at lunch.

TABLE 2-1. Items served at a test lunch in which the first course of carrots was varied in portion size

<table>
<thead>
<tr>
<th>Meal component</th>
<th>Amount served (g)</th>
<th>Energy density (kcal/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>First course</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carrot sticks</td>
<td>0, 30, 60, or 90 ¹</td>
<td>0.40</td>
</tr>
<tr>
<td>Ranch dip ²</td>
<td>30</td>
<td>0.67</td>
</tr>
<tr>
<td>Main course</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macaroni &amp; cheese ³</td>
<td>400</td>
<td>2.00</td>
</tr>
<tr>
<td>Steamed broccoli ⁴</td>
<td>60</td>
<td>0.28</td>
</tr>
<tr>
<td>Unsweetened applesauce ⁵</td>
<td>150</td>
<td>0.43</td>
</tr>
<tr>
<td>2%-fat milk ⁶</td>
<td>240</td>
<td>0.50</td>
</tr>
</tbody>
</table>

¹ Carrot portion size was varied across the experimental conditions
² The HV Foods Products Co, Oakland, CA; prepared with reduced-fat buttermilk, skim milk, and fat-free sour cream
³ Nestle USA, Inc, Solon, OH; prepared with butter and vegetable oil
⁴ Birds Eye Foods, Inc, Rochester, NY
⁵ Knouse Foods, Inc, Peach Glen, PA
⁶ Schneider Valley Farms, Williamsport, PA
RESULTS

Subject Characteristics

A total of 51 children were enrolled and all of them completed the study; participant characteristics are shown in Table 2-2. Study participants had a mean age of 4.4 ± 0.1 years and a mean sex-specific BMI-for-age percentile of 63.5 ± 3.7; 24% of the children were overweight (n = 6) or obese (n = 5). Mean age, body weight, height, and BMI percentile did not differ significantly between boys and girls. Of the 51 children in the study, 46 parents provided demographic information for their children. Of these 46 children, 28 (61%) were white, 14 (30%) were Asian, 3 (7%) were black or African American, and 1 (2%) was American Indian or Alaska Native. Parents of the children had above average education levels and household incomes; 90% of mothers and 85% of fathers had a college degree and 79% of households had an annual income above $50,000.

TABLE 2-2. Characteristics of children participating in a study testing the effects of increasing the portion size of a vegetable served as a first course on meal intake 1

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Boys (n = 22)</th>
<th>Girls (n = 29)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ± SEM</td>
<td>Range</td>
</tr>
<tr>
<td>Age (y)</td>
<td>4.3 ± 0.2</td>
<td>3.1 - 5.8</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>18.8 ± 0.8</td>
<td>13.8 - 24.6</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>106.4 ± 1.8</td>
<td>94.9 - 121.9</td>
</tr>
<tr>
<td>BMI z-score2</td>
<td>0.6 ± 0.3</td>
<td>-1.3 - 2.3</td>
</tr>
<tr>
<td>Sex-specific BMI-for-age percentile2</td>
<td>64.8 ± 6.8</td>
<td>10.5 - 99.0</td>
</tr>
</tbody>
</table>

1 There were no significant differences between boys and girls in any characteristics based on a t test.
2 Calculated from height, weight, and age (25)
**Vegetable Intake**

Intake of carrots in the first course was significantly affected by the portion of carrots served ($P < 0.0001$; **Figure 2-1**). Doubling the portion size from 30 to 60 g led to a significant increase in carrot consumption by 47%, or $12 \pm 2$ g. Tripling the portion size from 30 to 90 g led to a significant increase in carrot consumption by 54%, or $14 \pm 3$ g. There was no significant difference in carrot consumption as carrot portion size was increased from 60 to 90 g ($P = 0.61$).

Total vegetable consumption at the meal (carrots + broccoli) increased as the portion of carrots was increased ($P < 0.0001$; **Figure 2-1**). Broccoli consumption was not affected by serving carrots as a first course, regardless of their portion size. When no first course was served, the mean vegetable consumption was $20.5 \pm 2.6$ g, or about one-third of a half-cup serving. Vegetable consumption more than doubled to $44.4 \pm 3.2$ g when 30 g of carrots were served as a first course. When the carrot portion size increased to 60 g, vegetable consumption nearly tripled to an average intake of $58.2 \pm 4.3$ g compared to having no first course. This amount is equivalent to approximately one half-cup serving, or one-third of the recommended daily vegetable intake for most children in this age group (17).

Approximately 60%, or 31 of the 51 children tested, consumed $\geq 95\%$ of the carrots in the smallest portion size condition, and approximately 20%, or 11 children, consumed $\geq 95\%$ of the carrots in the middle condition. Only one child consumed $\geq 95\%$ of the carrots in the largest condition. When the 31 children who consumed all of the carrots in the smallest condition were removed from the analysis, the portion size effect on carrot consumption was no longer significant. When the 11 children who consumed all
the carrots in both the smallest and middle condition were removed from the analysis, the portion size effect on carrot consumption remained significant ($p = 0.001$). With these 11 children removed, the average carrot consumption in the middle and largest conditions was significantly greater than the average carrot consumption in the smallest condition; in the 30 g, 60 g, and 90 g conditions, the average carrot intake was $23.3 \pm 1.4$ g, $29.8 \pm 2.5$ g, and $31.8 \pm 2.9$ g, respectively.

While increasing the portion size of carrots led to an increase in carrot consumption, the larger portions were also associated with an increase in the amount of uneaten carrots ($P < 0.0001$). Of the 30 g portion, a mean of $5.3 \pm 1.1$ g carrot was uneaten. In the 60 g condition, the mean amount uneaten was $23.8 \pm 2.6$ g, and in the 90 g portion, this value was $51.9 \pm 3.2$ g.

**Meal Food Intake**

Food and beverage intake at the entire meal (first course + main course) is shown in Table 2-3. Providing a vegetable first course led to an increase in the weight of food consumed at the meal compared to having no first course ($P = 0.003$). Intake of the individual main course food items did not differ across the four conditions. Milk intake was greater in the 30 g carrot condition ($P = 0.0004$), which was attributable to increased milk consumption in one classroom at one meal. Although there was an increase in carrot intake with an increase in portion size, the amount of dip consumed did not differ significantly as the portion size of carrots was varied. In each condition, 30 g of dip was served and the mean intake was $6.1 \pm 0.8$ g, $7.7 \pm 1.0$ g, and $7.1 \pm 0.8$ g in the 30 g, 60 g, and 90 g conditions, respectively.
Meal Energy Intake

Despite an increase in vegetable consumption when carrots were served as a first course, there was no significant difference in total meal energy intake across the four conditions (Table 2-3). Energy intake of individual meal components did not differ, with the exception of milk ($P = 0.004$) which was greater in the smallest carrot condition than the other conditions. The average meal energy density was $1.18 \pm 0.05$ kcal/g when no carrots were served, which decreased to a mean of $1.07 \pm 0.03$ kcal/g when any portion of carrots was served ($P < 0.0001$). The average energy intake from the dip was less than 6 kcal in all conditions and did not change significantly across conditions.

Influence of Subject Characteristics

Acceptability ratings for the carrots and pasta were collected for 46 of the 51 children. Of these, 42 children (91%) rated the carrots and dip as acceptable (‘yummy’ or ‘okay’) and 43 children (93%) rated the pasta as acceptable. Ratings of acceptability of the carrots did not significantly influence the effect of portion size on carrot intake ($p = 0.51$ for interaction). There were no significant differences between boys and girls in total lunch food intake ($284 \pm 8$ versus $267 \pm 9$ g; $p = 0.18$) or energy intake ($366 \pm 15$ versus $374 \pm 17$ kcal; $p = 0.70$). Analysis of covariance showed that the effect of carrot portion size on lunch energy intake was not influenced by the children’s age, height, weight, BMI z-score, or age- and sex-specific BMI percentile (all $p > 0.36$).
TABLE 2-3. Food and energy intake of 51 children at the test lunch in which the first course of carrots was varied in portion size.

<table>
<thead>
<tr>
<th>Meal Component</th>
<th>Portion size of carrots</th>
<th>0 g</th>
<th>30 g</th>
<th>60 g</th>
<th>90 g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrots</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (g)</td>
<td>---</td>
<td>24.7 ± 1.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>36.2 ± 2.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>38.1 ± 3.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>---</td>
<td>8.7 ± 0.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>12.8 ± 0.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>13.5 ± 1.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Dip</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (g)</td>
<td>---</td>
<td>6.1 ± 0.8</td>
<td>7.7 ± 1.0</td>
<td>7.1 ± 0.8</td>
<td></td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>---</td>
<td>4.1 ± 0.6</td>
<td>5.2 ± 0.6</td>
<td>4.8 ± 0.5</td>
<td></td>
</tr>
<tr>
<td>Macaroni and cheese</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (g)</td>
<td>123.0 ± 11.1</td>
<td>114.1 ± 11.7</td>
<td>132.2 ± 11.2</td>
<td>123.3 ± 11.8</td>
<td></td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>246.6 ± 22.2</td>
<td>228.9 ± 23.5</td>
<td>265.1 ± 22.5</td>
<td>247.2 ± 23.7</td>
<td></td>
</tr>
<tr>
<td>Broccoli</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (g)</td>
<td>20.5 ± 2.6</td>
<td>19.7 ± 2.9</td>
<td>22.1 ± 2.9</td>
<td>18.4 ± 2.6</td>
<td></td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>5.8 ± 0.7</td>
<td>5.6 ± 0.8</td>
<td>6.2 ± 0.8</td>
<td>5.2 ± 0.7</td>
<td></td>
</tr>
<tr>
<td>Applesauce</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (g)</td>
<td>99.4 ± 7.4</td>
<td>99.9 ± 7.2</td>
<td>99.2 ± 7.1</td>
<td>103.6 ± 7.4</td>
<td></td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>42.8 ± 3.2</td>
<td>43.0 ± 3.1</td>
<td>42.7 ± 3.0</td>
<td>44.6 ± 3.2</td>
<td></td>
</tr>
<tr>
<td>Milk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (g)</td>
<td>122.7 ± 11.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>151.7 ± 11.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>106.1 ± 12.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>118.0 ± 11.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>61.4 ± 5.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>75.8 ± 5.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>53.0 ± 6.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>59.0 ± 5.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Total meal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (g)</td>
<td>365.6 ± 15.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>416.1 ± 18.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>403.4 ± 17.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>408.5 ± 18.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>356.6 ± 21.7</td>
<td>366.1 ± 24.6</td>
<td>385.0 ± 22.2</td>
<td>374.3 ± 24.5</td>
<td></td>
</tr>
</tbody>
</table>
1 All values are means ± SEMs
2 Means in the same row with different superscript letters are significantly different as assessed by a mixed linear model with repeated measures using a Tukey-Kramer adjustment for multiple comparisons (p < 0.003).

FIGURE 2-1. Mean (± SEM) weight of vegetables consumed at lunch by 51 preschool children who were served varying portions of carrots as a first course and 60 g of broccoli in the main course. Means for the same meal component with different superscript letters are significantly different as assessed by a mixed linear model with repeated measures using a Tukey-Kramer adjustment for multiple comparisons (p < 0.0001).
DISCUSSION

The findings of this study showed that increasing the portion size of a vegetable served as a first course led to increased vegetable intake in preschool children. Children consumed 47% more carrots when the portion size was doubled from 30 g to 60 g. This greater intake of vegetables at the start of the meal did not affect the amount of vegetables consumed at the main course, leading to significantly greater vegetable intake at the meal. The increase in vegetable intake from one-third serving to one serving at a single meal is substantial, particularly considering that most children consume less than half of the daily recommended amount of fruits and vegetables (4). The results of this study suggest that increasing the portion of a vegetable served at the start of meal is a useful strategy to increase vegetable intake in preschool children.

The effect on vegetable intake of serving additional vegetables at a meal may be influenced by factors such as the timing of serving the vegetables and the characteristics of the other available foods. In a recent study, Kral et al. (13) doubled the portion sizes of two vegetable side dishes and one fruit side dish at a meal and tested the effect on intake of 5- to 6-year-old children. The results differed from those of the present study in that doubling the portion of vegetables did not affect vegetable consumption, whereas doubling the portion of fruit did lead to increased fruit consumption. This suggests that in the present study serving vegetables at the start of the meal in the absence of competing foods was an important factor in promoting vegetable intake. In addition, the finding that increased vegetable intake in the first course did not affect vegetable consumption in the main course may be attributable to sensory differences between the vegetables served in the two courses. Providing a variety of foods has been shown to increase intake in 8- to
12-year-old children (27, 28) as well as adults (29). Serving vegetables with different sensory characteristics may reduce the effect of sensory-specific satiety, the phenomenon in which foods with similar sensory properties decline in perceived pleasantness as they are consumed (30, 31). The results of the present study suggest that vegetable consumption at a meal can be enhanced by serving vegetables alone at the start of the meal, and ensuring that they have contrasting sensory properties to vegetables served later in the meal.

There are several possible explanations for the finding that the increase in portion size did not continue to affect vegetable intake across the entire range of portions. The time available in the daycare center for consuming the first course may have been a limitation. It is possible that if more time had been provided, a greater amount of carrots would have been consumed when large portions were served. Another factor that may limit the consumption of large portions of vegetables in children is their preparation technique. For example, serving vegetables that are cooked or cut into bite-size pieces may reduce the amount of chewing and the time required for consumption, which could lead to increased intake. Although in the present study the carrots were well-liked, previous research has shown that enhancing the palatability of vegetables by cooking them with butter increases intake in older children (18) and this may also apply in young children. The variability in the results of portion size studies in children indicates that all of these factors require further attention.

While it is important to increase vegetable consumption in children, a concern regarding serving additional vegetables is that such strategies may also lead to greater amounts of uneaten food. It is unrealistic to expect childcare providers to serve large
portions if much of it will be discarded. The amount of uneaten food may be reduced by implementing some of the strategies previously mentioned, such as increasing consumption time or varying the preparation technique to make the vegetables more palatable and easier to consume. Another approach to reduce uneaten food may be to serve vegetables “family-style”, where children serve their own portion from a large serving bowl. This approach, however, may limit the beneficial impact of serving large portions of vegetables on vegetable intake. Fisher (32) found that when children served themselves an entrée they consumed 25% less than when they were served a large portion. Further research is needed to determine optimal vegetable portion sizes so that consumption is maximized while the amount of uneaten food is minimized, and also to understand how serving vegetables “family-style” influences vegetable intake in children.

The results of the present study did not support the hypothesis that consuming vegetables as a first course would affect energy intake at the meal. A few studies have shown that young children have some ability to compensate for food consumed in the first course of a meal by reducing energy consumed in the subsequent course (30, 33, 34). In those studies, however, the first course was a fixed amount of food that the children were asked to consume in full; thus the items tested were highly palatable foods such as pudding and muffins that were relatively high in energy density. None of the studies in children has examined the effect of serving a low-energy-dense food as a first course. In adults, research has shown that consuming 150 g to more than 500 g of a low energy-dense first course (salad, soup, or fruit) decreased intake of the higher-energy-dense main course and reduced meal energy intake (14, 35, 36). In the present study, intake of the low-energy-dense first course was a much smaller amount than the amount consumed in
previous studies in children and adults. It seems probable that this amount of food was insufficient to displace intake from the main course. It remains possible that if children consumed a larger amount of vegetables as a first course that this might lead to a reduction in energy intake at the meal.

Using portion size as a strategy to increase vegetable intake was found to be effective in preschool children who varied in individual characteristics such as body weight and age. Children with a body weight status across a wide range of BMI percentiles responded to the increase in portion size. This finding agrees with the conclusion of a recent review by Fisher and Kral (37), which states that there is insufficient evidence to suggest a relationship between portion size effects and body weight status in children. The influence of children’s age on the response to portion size has been found to be less consistent between studies. In one study, when the entrée portion size was doubled, intake increased in 5-year-old children, yet there was no effect on intake in 3-year-old children (8). In other studies (11, 38) as well as the present study, there was no significant influence of age on the relationship of portion size to intake of 3- to 5-year old children. A larger sample of children with a wider range of individual characteristics should be tested to further examine the influence of these individual characteristics on the response to portion size changes.

A strength of the present study was the paradigm used to test portion size effects on intake of a two-course meal in young children. Several previous studies testing a manipulated first course in children used a protocol in which a fixed amount of a first course was provided before an *ad libitum* main course (30, 33, 34). By having both the first and main courses consumed *ad libitum*, we were able to measure portion size effects
on both intake of the manipulated course and the subsequent course. An additional strength of the study was the ecological validity achieved by testing the children in their natural lunchtime environment with their peers, and by serving foods typically consumed by the children. A limitation of the study was the use of a convenience sample from a single childcare center on a university campus. Parents of the children had above average education levels and household incomes. A more diverse sample population should be assessed in order to generalize the results to a broader population. Additionally, the study examined a single meal. Further studies are required to explore the effects of vegetable portion size on intake over a longer period of time.

The present study has shown that increasing the portion size of vegetables served at the start of a meal, in the absence of competing foods, can lead to increased vegetable consumption in preschool children. Childcare providers can promote vegetable consumption in young children by serving large portions of vegetables at the start of a meal. The results strengthen those of previous studies showing that portion size can influence intake in children, and in addition indicate that, this effect can be used in a beneficial way to increase intake of vegetables in children.
REFERENCES


32. Fisher JO, Rolls BJ, Birch LL. Children's bite size and intake of an entrée are greater with large portions than with age-appropriate or self-selected portions. Am J Clin Nutr 2003;77:1164-70.


Chapter 3

Study 2:

Serving large portions of vegetable soup at the start of a meal affected children’s energy and vegetable intake

INTRODUCTION

In studies in adults, consuming low-energy-dense foods as a first course reduces energy intake of the main course and of the entire meal (Rolls, Bell, & Thorwart, 1999; Rolls, Roe, & Meengs, 2004; Flood-Obbagy and Rolls, 2009). A first course of low-energy-dense soup has been shown to be particularly effective for increasing satiety in adults (Flood & Rolls, 2007; Kissileff, Gruss, Thornton, & Jordan, 1984; Rolls et al., 1999; B. J. Rolls, Fedoroff, Guthrie, & Laster, 1990). It is not known, however, whether children will show a similar response to consumption of soup. Although it is thought that young children are better than adults at adjusting their energy intake in response to a first course, the results have varied among studies (Birch & Deysher, 1985; Cecil, Palmer, Wrieden, Murrie, Bolton-Smith, Watt, Wallis, & Hetherington, 2005; Johnson and Taylor-Holloway, 2006; Zandstra, Mathey, Graaf, & van Staveren, 2000). It is of interest to investigate serving vegetable soup to children at the start of a meal, because this has the potential both to reduce children’s energy intake and increase their vegetable intake. The aim of the present study was to determine the effects of serving different portion sizes of a low-energy-dense, vegetable-based soup on children’s energy and vegetable intake within a meal and over the next eating occasion.

Vegetable intake in children is well below recommended levels (Guenther, Dodd, Reedy, & Krebs-Smith, 2006; Lorson, Melgar-Quinonez, & Taylor, 2009) and effective strategies are needed to encourage consumption. Serving large portions of vegetables is a promising approach to increasing vegetable intake. Studies have shown that portion size affected intake of high-energy-dense foods in both children and adults (Wansink & Kim, 2005; Diliberti, Bordi, Conklin, Roe, & Rolls, 2004; Fisher, 2007; Fisher, Arreola, Birch, & Rolls, 2007; Fisher, Liu, Birch, & Rolls, 2007; Rolls, Morris, & Roe, 2002; Rolls, Roe, Kral, Meengs, & Wall, 2004;
Rolls, Roe, Meengs, & Wall, 2004), and serving a larger portion of a low-energy-dense vegetable at a meal increased vegetable intake in adults (Rolls, Roe, & Meengs, 2010). The effect of increasing the portion size of low-energy-dense vegetables on children’s intake is less clear. A recent study found that increasing the size of a vegetable side dish did not increase young children’s vegetable intake (Kral, Kabay, Roe, & Rolls, 2010); yet, in another study, vegetable consumption was increased by serving larger portions of vegetables at the start of a meal (Spill, Birch, Roe, & Rolls, 2010). Thus, it may be more effective to increase the portion size of vegetables served at the start of a meal, when children are hungry and when there are no competing foods present, rather than vegetables served as a side dish.

The hypothesis of the present study was that increasing the portion size of a familiar, low-energy-dense soup served at the start of the meal would increase soup intake and would lead to a reduction in meal energy intake. We also predicted that increasing the portion size of a vegetable-based soup would increase children’s vegetable intake at lunch and that this effect would be sustained over the next eating occasion.

**METHODS**

**Experimental Design**

A crossover design, using repeated measures within subjects, was used to test the effect on food and energy intake of varying the amount of tomato soup served to preschool-aged children as a lunch first course. On one day a week for four weeks, children in a daycare setting were provided with breakfast, lunch, and afternoon snack. Across the weeks, the portion size of soup served in the first course of lunch was varied (150, 225, or 300 g) and during one week no first course was provided. The foods and beverages served in the main course of lunch, as well
as the foods and beverages served at breakfast and snack, were not varied in portion size. On test days, a standard breakfast was served approximately 3 hours prior to lunch in order to maintain a similar level of hunger before lunch, and afternoon snack was served approximately 3 hours after lunch. The soup as well as other foods and beverages were consumed *ad libitum*. The order of the experimental conditions across study weeks was randomly assigned across classrooms. During the week before the study, one day was used to acquaint the children and teachers with the test meal procedures; no data were collected on this day.

**Participant Recruitment**

Recruitment began by distributing letters to parents who had children within the age range of three to six years enrolled in two daycare centers on the University Park campus of The Pennsylvania State University. Parents and guardians provided informed written consent for both their own participation and that of their child. The Pennsylvania State University Office for Research Protections reviewed and approved all procedures.

A power analysis was performed to determine the number of children needed in the study. The power analysis was based on the outcome of energy intake. In order to detect a difference in meal energy intake of 167 kJ (40 kcal), which is approximately 10-15% of typical meal intakes in this population, the required sample size was estimated to be 56 children using a significance level for a two-tailed test of 0.05 and a power of 80%.

**Test Foods & Meal Procedures**

The foods and amounts served at the test lunch and afternoon snack are shown in Table 3-1. Tomato soup was chosen as the first course because it is commonly served at daycare centers. The middle portion of 225 g was chosen because it is a typical portion of soup consumed by 2- to 5-year old children (Smiciklas-Wright, Mitchell, Mickle, Goldman, & Cook,
2003); this portion equates to approximately 1.5 half-cup vegetable servings based on information provided by the manufacturer. The other portion sizes selected, 150 g and 300 g, equate to approximately one and two vegetable servings, respectively. The items served as the main course of lunch (pasta with cheese sauce, broccoli, applesauce, and milk) were foods commonly served in the daycare centers. The portion sizes of these foods were based on consumption data from previous research with children in this age group (Leahy, Birch, Fisher, & Rolls, 2008; Leahy, Birch, & Rolls, 2008a, 2008b). Cooked broccoli was served as the vegetable component of the main course in all test meals in order to comply with the National School Lunch Program (U. S. Food and Dairy Administration & Food and Nutrition Service, 2009); this also allowed the examination of the effects of consuming a vegetable first course on vegetable intake in the main course.

Lunch was served to all children in the participating classrooms at the regularly scheduled time and was eaten at tables with three to six children and one teacher, which is the standard practice at these centers. Once children were seated at their tables, they were served the first course of tomato soup in insulated bowls at a temperature of approximately 130°F. Ten minutes after serving the first course, the remaining soup was removed and the main course of the lunch was served. A 10-minute interval for the first course was selected based on teacher recommendations and the amount of time allotted for the lunch meal. In the condition with no first course, children were served the main course upon being seated. Teachers were instructed to redirect conversations pertaining to food to other topics to minimize the influence on lunch intake.

On test days, breakfast and afternoon snack were served in each classroom at the regularly scheduled times. At breakfast, each child was served oatmeal, peaches, and milk. The
foods at the afternoon snack (raw carrots, cucumbers, and cherry tomatoes, and pita bread) were served family style; children served themselves as much or as little as they wanted from large bowls shared at each table. To calculate snack food intake, the weight of each item was kept within a narrow range (carrots and cucumber slices: 6.0-9.0 g; tomatoes: 6.0-11.0 g; pita wedges: 13.0-16.0 g) and researchers recorded the number of pieces of each food item that were taken by each child in the study.

Liking of the experimental foods was assessed using a procedure developed by Birch et al. (1979a; 1979b; 1980b). Liking assessments were done midday during the week after the test meals were completed. Children were instructed on the use of three cartoon faces to indicate whether they thought a food was ‘yummy’, ‘okay’, or ‘yucky’. After instruction, each child was presented with a sample of tomato soup followed by a sample of pasta. The child was asked to taste each sample and indicate their liking of the food by pointing to the appropriate face.

**Participant Characteristics**

Parents were asked to complete a 19 item questionnaire assessing family demographics and the health status of their child. Body weight and height measurements of the children were taken within two weeks of the final test meal. The children’s height and weight measurements were used to calculate their sex-specific body mass index-for-age percentile and z-score using a software program from the Centers for Disease Control and Prevention (Centers for Disease Control and Prevention, 2010).

**Statistical analysis**

Data were analyzed using a mixed linear model with repeated measures (SAS version 9.1, SAS Institute, Cary, NC). The fixed factors in the model were soup portion size (0, 150, 225, or 300 g), classroom, and test session; subjects were treated as a random factor. The factors
of the children’s sex and ratings of food acceptability were tested as factors in the model. The main outcome measures were soup intake, vegetable intake, and meal energy intake. To assess vegetable intake, soup consumption was converted into the equivalent vegetable content (80%) based on information provided by the manufacturer and a vegetable serving was considered to be approximately one-half cup (118 ml) of vegetables.

Meals in which children consumed ≥ 95% of the soup were identified and the main outcomes were analyzed both with and without these meals to determine whether consuming the entire portion of soup influenced the effect of portion size on intake. Individual children whose data were influential on the main outcomes in the mixed model were identified using the procedure of Littell et al. (2006).

Analysis of covariance was used to assess the influence of continuous subject variables (age, body weight, height, and BMI percentile,) on the relationship between soup portion size and the main study outcomes. T-tests were used to test differences between girls and boys in age, body weight, height, and BMI percentile. Data are reported as mean ± standard error and results were considered significant at p<0.05.
PHOTOGRAPH 3-1. The portion sizes of tomato soup served as a first course at lunch

PHOTOGRAPH 3-2. Foods and beverage served as a main course at lunch.
Table 3-1. Foods and beverages served to children during a study testing the effects of serving different portions of vegetable soup as a first course at lunch.

<table>
<thead>
<tr>
<th>Meal component</th>
<th>Amount served (g)</th>
<th>Energy density (kJ/g)</th>
<th>Energy density (kcal/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Breakfast</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oatmeal (^a)</td>
<td>250</td>
<td>2.38</td>
<td>0.57</td>
</tr>
<tr>
<td>Diced peaches (^b)</td>
<td>150</td>
<td>1.67</td>
<td>0.40</td>
</tr>
<tr>
<td>2%-fat milk (^c)</td>
<td>236</td>
<td>2.09</td>
<td>0.50</td>
</tr>
<tr>
<td><strong>Lunch first course</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tomato soup (^d)</td>
<td>0,150, 225, or 300 (^e)</td>
<td>1.55</td>
<td>0.37</td>
</tr>
<tr>
<td><strong>Lunch main course</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macaroni &amp; cheese (^f)</td>
<td>400</td>
<td>8.37</td>
<td>2.00</td>
</tr>
<tr>
<td>Steamed broccoli (^g)</td>
<td>60</td>
<td>1.17</td>
<td>0.28</td>
</tr>
<tr>
<td>Unsweetened applesauce (^h)</td>
<td>150</td>
<td>1.80</td>
<td>0.43</td>
</tr>
<tr>
<td>2%-fat milk (^c)</td>
<td>240</td>
<td>2.09</td>
<td>0.50</td>
</tr>
<tr>
<td><strong>Afternoon snack</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pita bread wedges (^i)</td>
<td>Served family-style (^j)</td>
<td>10.29</td>
<td>2.46</td>
</tr>
<tr>
<td>Carrot sticks</td>
<td>Served family-style (^j)</td>
<td>1.46</td>
<td>0.35</td>
</tr>
<tr>
<td>Cucumber slices</td>
<td>Served family-style (^j)</td>
<td>0.50</td>
<td>0.12</td>
</tr>
<tr>
<td>Grape tomatoes</td>
<td>Served family-style (^j)</td>
<td>0.75</td>
<td>0.18</td>
</tr>
<tr>
<td>Ranch dip (^k)</td>
<td>30</td>
<td>2.80</td>
<td>0.67</td>
</tr>
<tr>
<td>Water</td>
<td>236</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

\(^a\) Diamond Crystal Brands Inc, Savannah, GA (prepared with 67 g water and 1.9 g brown sugar per 10 g dry oatmeal)
\(^b\) Independent Marketing Alliance, Houston, TX
\(^c\) Schneider Valley Farms, Williamsport, PA
\(^d\) Campbell Soup Company, Camden, NJ
\(^e\) Soup portion size varied across conditions
RESULTS

Subject Characteristics

A total of 73 children from five classrooms were recruited. Data from one child was identified as having an undue influence on the results because of high variability across meals, and the data was therefore excluded from the analysis. The final group of 72 children had a mean age of 4.7 ± 0.1 years and a mean sex-specific BMI-for-age percentile of 59.8± 3.4; 27% of the children were overweight (n=10) or obese (n=8). Boys weighed significantly more than girls (p=0.024); otherwise, mean age, height, and BMI percentile did not differ significantly between girls and boys (Table 3-2). Parents provided demographic information for 66 of the 72 children; of these, 42 (67%) were white, 17 (27%) were Asian, and 4 (6%) were black or African American. Parents of the children had above average education levels and household incomes; approximately 95% of mothers and 88% of fathers had a college degree and 70% of households had an annual income above $50,000.
Table 3-2. Characteristics of children participating in a study testing the effects of serving different portions of vegetable soup as a first course at lunch.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Boys (n=31)</th>
<th>Range</th>
<th>Girls (n=41)</th>
<th>Range</th>
<th>Total (n=72)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>4.8 ± 0.1</td>
<td>3.4 – 5.7</td>
<td>4.6 ± 0.1</td>
<td>3.3 – 5.7</td>
<td>4.7 ± 0.1</td>
<td>3.3 – 5.7</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>19.4 ± 0.7*</td>
<td>13.6 – 29.2</td>
<td>17.9 ± 0.4*</td>
<td>14.2 – 27.5</td>
<td>18.6 ± 0.4*</td>
<td>13.6 – 29.2</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>109.2 ± 1.4</td>
<td>94.5 – 128.0</td>
<td>105.7 ± 0.9</td>
<td>94.0 – 117.3</td>
<td>107.2 ± 0.8</td>
<td>94.0 – 128.0</td>
</tr>
<tr>
<td>Sex-specific BMI-for-age percentile</td>
<td>59.3 ± 5.2</td>
<td>1.4 – 99.0</td>
<td>60.1 ± 4.4</td>
<td>1.8 – 98.4</td>
<td>59.8 ± 3.4</td>
<td>1.4 – 99.0</td>
</tr>
</tbody>
</table>

* p < 0.05

Meal Food and Energy Intake

Food and beverage intake at the entire lunch meal (first course + main course) is shown in Table 3-3. Providing vegetable soup as a first course led to an increase in the weight of food consumed at the meal compared to having no first course (p<0.0001). Consumption of the pasta entrée decreased significantly when any portion of soup was served (p<0.0001). Intake of the other main course food items did not differ across the four conditions.

Serving soup at the start of the meal affected energy intake of the main course (p<0.0001) and energy intake of the entire meal (p=0.008). Having tomato soup as a first course, regardless of the portion size, resulted in a reduction in energy consumed in the main course compared to having no first course (Table 3-3). Energy intake from the pasta entrée decreased when any portion size of soup was served compared to when no soup was served (p<0.0001). Energy intake of the other meal components was not
significantly affected by changes in soup portion size. When energy intakes for the soup and main course were combined, there was a difference in meal energy intake across the soup portion sizes. Serving 150 g of tomato soup led to a reduction in energy intake of the meal compared to either serving no soup or 300 g of soup. The average meal energy density was 4.8 ± 0.13 kJ/g (1.14 ± 0.03 kcal/g) when no soup was served, which decreased to a mean of 3.8 ± 0.08 kJ/g (0.92 ± 0.02 kcal/g) when any portion of soup was served (p<0.0001).

**Soup and Vegetable Intake**

Intake of tomato soup was significantly affected by the portion that was served (p<0.0001; Figure 3-1). Doubling the portion size from 150 g to 300 g led to a significant increase in soup consumption by 23%, or 25 g. Soup intake from the middle portion size was not significantly different than intake from either of the other portions.

Total vegetable consumption at the lunch meal (tomato consumed from the soup + broccoli from the main course) increased as the portion of soup was increased (p<0.0001; Figure 3-1). The amount of soup served as a first course did not affect broccoli consumption in the main course. When no first course was served, the mean vegetable consumption at lunch was 22.2 ± 2.5 g, or about one-sixth of a vegetable serving. Lunch vegetable consumption increased to 108.8 ± 5.7 g when 150 g of soup was served as a first course. When the soup portion size increased to 300 g, lunch vegetable consumption increased to 128.9 ± 9.2 g; this represents an increase in vegetable intake of approximately one serving compared to having no first course.

Consuming soup as a first course at lunch did not decrease vegetable intake at the afternoon snack. The amount of soup served at lunch did not significantly affect intake
of carrots, cucumber slices, or cherry tomatoes during the afternoon snack (Table 3-3). Total vegetable consumption across lunch and afternoon snack increased as the portion size of soup increased (p<0.0001).

Approximately 44%, or 32 of the 72 children included in the analysis, consumed ≥95% of the soup in the smallest portion condition, and approximately 24%, or 17 children consumed ≥95% of the soup in the middle portion condition. Only 6 children consumed ≥95% of the soup in the largest portion condition. After excluding from the analysis any intakes that comprised the entire portion of soup, the effect of portion size on intake was still evident (p =0.004).

Influence of Subject Characteristics

Liking ratings for the tomato soup and pasta were collected for 67 children. Of these children, 60 (90%) rated the soup as acceptable (‘yummy’ or ‘okay’) and 65 (97%) rated the pasta as acceptable. Ratings for soup liking affected soup intake (p=0.006); those who rated soup as ‘yummy’ (n=46) consumed significantly more soup than those who rated soup as ‘yucky’ (n=7). Because of the small number of children who rated soup as ‘yucky’, there was insufficient power to test the influence of soup liking on the effect of portion size. There were no significant differences in total food or energy intake at lunch based on the children’s classroom or sex. Children with higher sex-specific BMI percentiles had significantly greater energy intake at lunch across all conditions (p=0.025). Analysis of covariance showed that the effect of soup portion size on lunch energy intake was not influenced by the children’s age, height, weight, or age- and sex-specific BMI percentile.
**Table 3-3.** Food and energy intakes of 72 children in a study testing the effects of serving different portions of vegetable soup as a first course at lunch.

<table>
<thead>
<tr>
<th></th>
<th>No soup</th>
<th>150 g soup</th>
<th>225 g soup</th>
<th>300 g soup</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lunch first course intake</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tomato Soup</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (g)</td>
<td>---</td>
<td>108.4 ± 6.1(^{1,2,\text{a}})</td>
<td>122.1 ± 9.0(^{\text{ab}})</td>
<td>133.0 ± 10.3(^{\text{b}})</td>
</tr>
<tr>
<td>Energy (kJ)</td>
<td>---</td>
<td>166.5 ± 2.2(^{\text{a}})</td>
<td>187.4 ± 13.8(^{\text{ab}})</td>
<td>204.2 ± 15.9(^{\text{b}})</td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>---</td>
<td>39.8 ± 2.2(^{\text{a}})</td>
<td>44.8 ± 3.3(^{\text{ab}})</td>
<td>48.8 ± 3.8(^{\text{b}})</td>
</tr>
<tr>
<td><strong>Lunch main course intake</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Macaroni and cheese</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (g)</td>
<td>192.4 ± 12.1(^{\text{a}})</td>
<td>145.8 ± 10.9(^{\text{b}})</td>
<td>162.6 ± 11.2(^{\text{b}})</td>
<td>166.6 ± 10.8(^{\text{b}})</td>
</tr>
<tr>
<td>Energy (kJ)</td>
<td>1614.2 ± 101.3(^{\text{a}})</td>
<td>1223.4 ± 91.2(^{\text{b}})</td>
<td>1363.6 ± 94.1(^{\text{b}})</td>
<td>1397.5 ± 90.8(^{\text{b}})</td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>385.8 ± 24.2(^{\text{a}})</td>
<td>292.4 ± 21.8(^{\text{b}})</td>
<td>325.9 ± 22.5(^{\text{b}})</td>
<td>334.0 ± 21.7(^{\text{b}})</td>
</tr>
<tr>
<td><strong>Broccoli</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (g)</td>
<td>22.2 ± 2.5</td>
<td>19.9 ± 2.5</td>
<td>18.1 ± 2.4</td>
<td>19.8 ± 2.6</td>
</tr>
<tr>
<td>Energy (kJ)</td>
<td>26.4 ± 2.9</td>
<td>23.4 ± 2.9</td>
<td>21.3 ± 2.9</td>
<td>23.4 ± 2.9</td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>6.3 ± 0.7</td>
<td>5.6 ± 0.7</td>
<td>5.1 ± 0.7</td>
<td>5.6 ± 0.7</td>
</tr>
<tr>
<td><strong>Applesauce</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (g)</td>
<td>94.8 ± 6.3</td>
<td>86.2 ± 7.0</td>
<td>88.8 ± 6.7</td>
<td>88.4 ± 6.8</td>
</tr>
<tr>
<td>Energy (kJ)</td>
<td>170.7 ± 11.3</td>
<td>155.2 ± 12.6</td>
<td>159.8 ± 12.1</td>
<td>159.4 ± 12.1</td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>40.8 ± 2.7</td>
<td>37.1 ± 3.0</td>
<td>38.2 ± 2.9</td>
<td>38.1 ± 2.9</td>
</tr>
<tr>
<td><strong>Milk</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (g)</td>
<td>116.3 ± 9.1</td>
<td>123.3 ± 10.1</td>
<td>106.2 ± 9.6</td>
<td>104.7 ± 9.3</td>
</tr>
<tr>
<td>Energy (kJ)</td>
<td>243.5 ± 18.8</td>
<td>257.7 ± 20.9</td>
<td>222.2 ± 20.1</td>
<td>218.8 ± 19.7</td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>58.2 ± 4.5</td>
<td>61.6 ± 5.0</td>
<td>53.1 ± 4.8</td>
<td>52.3 ± 4.7</td>
</tr>
<tr>
<td>Total main course</td>
<td>Weight (g)</td>
<td>425.7 ± 17.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>375.2 ± 17.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>375.7 ± 17.3&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>--------------</td>
<td>---------------------------</td>
<td>---------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>Energy (kJ)</td>
<td>2054.3 ± 105.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1659.8 ± 95.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1767.3 ± 97.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1799.1 ± 99.6&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>491.0 ± 25.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>396.7 ± 22.8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>422.4 ± 23.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>430.0 ± 23.8&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total lunch intake (first course + main course)</th>
<th>Weight (g)</th>
<th>425.7 ± 17.1&lt;sup&gt;a&lt;/sup&gt;</th>
<th>483.6 ± 18.6&lt;sup&gt;b&lt;/sup&gt;</th>
<th>497.8 ± 18.1&lt;sup&gt;b&lt;/sup&gt;</th>
<th>512.5 ± 20.3&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kJ)</td>
<td>2054.3 ± 105.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1826.3 ± 97.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1954.8 ± 96.2&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>2003.3 ± 101.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>491.0 ± 25.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>436.5 ± 23.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>467.2 ± 23.0&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>478.8 ± 24.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Afternoon snack intake</th>
<th>Weight (g)</th>
<th>10.8 ± 2.1&lt;sup&gt;ab&lt;/sup&gt;</th>
<th>10.1 ± 1.9&lt;sup&gt;b&lt;/sup&gt;</th>
<th>11.5 ± 1.9&lt;sup&gt;ab&lt;/sup&gt;</th>
<th>16.7 ± 2.4&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kJ)</td>
<td>111.3 ± 21.8&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>104.2 ± 19.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>117.6 ± 19.7&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>171.5 ± 24.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>26.6 ± 5.2&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>24.9 ± 4.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>28.1 ± 4.7&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>41.0 ± 5.9&lt;sup&gt;a&lt;/sup&gt;</td>
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<table>
<thead>
<tr>
<th>Cherry tomatoes</th>
<th>Weight (g)</th>
<th>11.7 ± 3.4</th>
<th>9.7 ± 3.0</th>
<th>14.0 ± 3.4</th>
<th>9.5 ± 2.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kJ)</td>
<td>5.9 ± 1.7</td>
<td>5.0 ± 1.7</td>
<td>7.1 ± 1.7</td>
<td>4.6 ± 1.3</td>
<td></td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>1.4 ± 0.4</td>
<td>1.2 ± 0.4</td>
<td>1.7 ± 0.4</td>
<td>1.1 ± 0.3</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Cucumber slices</th>
<th>Weight (g)</th>
<th>6.8 ± 1.3</th>
<th>7.9 ± 2.0</th>
<th>6.9 ± 1.5</th>
<th>8.4 ± 2.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kJ)</td>
<td>3.3 ± 0.8</td>
<td>3.8 ± 0.8</td>
<td>3.3 ± 0.8</td>
<td>4.2 ± 1.3</td>
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<tr>
<td>Energy (kcal)</td>
<td>0.8 ± 0.2</td>
<td>0.9 ± 0.2</td>
<td>0.8 ± 0.2</td>
<td>1.0 ± 0.3</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Carrots</th>
<th>Weight (g)</th>
<th>8.6 ± 1.5</th>
<th>9.2 ± 1.8</th>
<th>12.8 ± 2.5</th>
<th>10.9 ± 1.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kJ)</td>
<td>12.6 ± 2.1</td>
<td>13.4 ± 2.5</td>
<td>18.8 ± 3.8</td>
<td>15.9 ± 2.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.0 ± 0.5</td>
<td>3.2 ± 0.6</td>
<td>4.5 ± 0.9</td>
<td>3.8 ± 0.7</td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
<td></td>
</tr>
<tr>
<td><strong>Ranch dip</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (g)</td>
<td>4.5 ± 0.9</td>
<td>5.3 ± 1.0</td>
<td>6.3 ± 1.1</td>
<td>6.5 ± 1.2</td>
<td></td>
</tr>
<tr>
<td>Energy (kJ)</td>
<td>12.3 ± 2.5</td>
<td>14.6 ± 2.5</td>
<td>18.0 ± 2.9</td>
<td>18.4 ± 3.3</td>
<td></td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>3.0 ± 0.6</td>
<td>3.5 ± 0.6</td>
<td>4.3 ± 0.7</td>
<td>4.4 ± 0.8</td>
<td></td>
</tr>
</tbody>
</table>

| Total afternoon snack intake | 42.5 ± 5.9 | 42.2 ± 5.2 | 51.5 ± 6.7 | 51.9 ± 6.1 |
| Energy (kJ)               | 146.0 ± 24.3 \(^a\) | 141.4 ± 21.8 \(^a\) | 164.8 ± 23.8 \(^{ab}\) | 214.6 ± 27.6 \(^b\) |
| Energy (kcal)             | 34.9 ± 5.8 \(^a\) | 33.8 ± 5.2 \(^a\) | 39.4 ± 5.7 \(^{ab}\) | 51.3 ± 6.6 \(^b\) |

1 All values are means ± SEM  
2 Means in the same row with different superscript letters are significantly different as assessed by a mixed linear model with repeated measures (p<0.05)

**Figure 3-1.** Weight (mean ± SE) of vegetables consumed at lunch by 72 preschool children who were served varying portions of tomato soup as a first course and 60 g of broccoli in the main course. Intake of tomato soup was converted into the equivalent vegetable content based on information provided by the manufacturer. Differing letters for tomato soup intake indicate a significant difference based on a mixed linear model with repeated measures (p<0.0001). Differing capital letters indicate a significant difference in total vegetable intake at lunch (p<0.0001).
DISCUSSION

The findings from this study showed that serving children a low-energy-dense, vegetable-based soup as a first course reduced energy intake from the more energy-dense main course entrée. Total meal energy intake, however, was reduced only when the smallest amount of soup was served. In addition to the effects on energy intake, serving a vegetable soup as a first course led to increased vegetable consumption. The vegetables from the tomato soup enhanced vegetable intake because soup consumption did not affect vegetable consumption at the main course or at the subsequent snack. Importantly, increasing the portion size of a low-energy-dense, vegetable-based first course increased vegetable intake. These results indicate that the amount of vegetables provided can influence children’s vegetable intake.

Consuming low-energy-dense vegetable soup could influence hunger, satiety, and energy intake. In adults, consuming soup as a first course has been shown to enhance satiety, reduce intake of the main course, and reduce overall energy intake at the meal (Flood & Rolls, 2007; Kissileff et al., 1984; Rolls et al., 1999; Rolls et al., 1990). The present study, which was the first to examine the effect of consuming soup as a first course on meal energy intake in children, found that after serving each of the portions of soup there was a reduction in energy intake of the more energy-dense main entrée compared to when no soup was served. However, total meal energy intake (soup + main course) was reduced significantly only when the smallest portion size of soup was served. With larger portions of soup the increased energy intake from soup added to that from the main course, so that meal energy intake did not differ significantly from when no soup was served. This study showed that vegetable intake in children can be increased while maintaining energy intake, and in some circumstances increased vegetable consumption can lead to a reduction in meal energy intake.
Several studies have shown that portion size affects children’s intake of energy-dense foods (Fisher, 2007a; Fisher et al., 2007b; Fisher et al., 2007c; Rolls, Engell, & Birch, 2000), but the few studies in children that have tested variations in the portion size of low-energy-dense foods have reported mixed results. In one study with 5- and 6-year-old children, doubling the portion size of one fruit and two vegetable side dishes increased fruit intake but not vegetable intake (Kral et al., 2010). The authors speculated that the presence of palatable, competing foods reduced the effect of portion size on vegetable intake. Serving vegetables as a first course removes the influence of competing foods, and may result in a greater influence of portion size on vegetable intake. Support for this suggestion comes from a recent study showing that doubling the portion size of a first course of raw carrots significantly increased carrot consumption in young children (Spill et al., 2010). Likewise, in the present study when soup was served to preschool children as a first course with no competing foods, doubling the portion size increased soup consumption significantly. These studies suggest that the timing of serving larger portions of vegetables could influence the response; however, the effects of varying portion sizes before or during a meal have not been compared in children. Portion size can be used strategically to increase vegetable intake, but factors such as the time of serving and the presence of competing foods may moderate the effect.

Because a goal of serving larger portions of vegetables as a first course is to increase daily vegetable intake, it is important to determine how vegetable intake at subsequent eating occasions is affected. In the present study, increasing the portion size of tomato soup at the start of the meal increased meal vegetable intake because consuming soup did not decrease vegetable consumption at the main course. It was previously found that serving larger portions of carrots as a first course increased meal vegetable intake, though the magnitude of the effect was smaller
The present study extended these findings by measuring intake during the afternoon snack several hours later. The amount of soup consumed did not affect vegetable intake at the snack and therefore increased vegetable intake over these two eating occasions. The vegetables available at these eating occasions varied considerably in their sensory characteristics (tomato soup, steamed broccoli, raw carrots, cucumbers, and cherry tomatoes). If the vegetables had been more similar, vegetable consumption at later occasions may have decreased due to sensory-specific-satiety, which refers to the decline in pleasantness as a food is consumed (Rolls, 1986). Increasing sensory variety has been shown to reduce sensory-specific satiety and to promote increased food intake in adults (Rolls, Meengs, & Roe, 2010; Rolls et al., 1981). Studies in 8- to 12-year old children have shown that increasing the variety of energy-dense foods at an eating occasion increased intake (Epstein et al., 2009; Temple, Giacomelli, Roemmich, & Epstein, 2008). More work is needed to understand how serving a variety of low-energy-dense foods affects preschool children’s intake within a meal and over several eating occasions.

Previous studies examining the effect of portion size on children’s intake have looked at palatable, high-energy-dense foods, such as chicken nuggets, pasta, and cereal (Fisher, 2007a; Fisher et al., 2007b; Fisher et al., 2007c). A recent study extended these findings by showing that increasing the portion size of a low-energy-dense vegetable led to increased consumption in young children (Spill et al., 2010). The present study supports the findings that portion size affects intake of low-energy-dense, vegetable-based foods. In both studies, the vegetables tested were well-liked by the children. The effect of portion size on intake may depend on the degree of liking for the food; if a food is not well-liked, it is probable that serving larger portions will not affect intake. In one study, when the portion size of a fruit and two vegetable side dishes
were increased, fruit intake increased but vegetable intake did not (Kral et al., 2010). The fruit was preferred to either vegetable, suggesting that the effect of portion size might be specific to liked foods. In order for portion size to be effective at increasing vegetable consumption, therefore, it may be necessary that the vegetable provided is well-liked. Methods have been identified to increase vegetable acceptability in children including repeated exposure and social modeling (Birch, 1980a; Birch & Marlin, 1982; Wardle, Cooke et al., 2003; Wardle, Herrera, Cooke, & Gibson, 2003), but further research is needed to identify strategies to increase acceptability of a wide range of vegetables in young children.

The present study had several strengths and limitations. First, the study was conducted in the children’s usual eating environment with their peers and teachers, and with familiar foods. Secondly, this study measured intake beyond a single eating occasion in order to examine whether children altered their vegetable intake several hours later in response to consuming more vegetables at lunch. The portion sizes selected for this study were appropriate considering the typical intake of soup in this age group; however, testing a wider range of portion sizes may have resulted in greater effects on vegetable and energy intake. This benefit has to be balanced against the likelihood that serving larger portions would probably increase the amount of uneaten food. Studies are needed to find optimal portion sizes of various vegetables that maximize intake while keeping waste to a minimum. A limitation of the study is the use of a convenience sample from daycare centers on a university campus. Parents of the children had above average education levels and household incomes; therefore, a more diverse sample of children would be needed to generalize these results to a broader population.

This study is the first to show that consuming a low-energy-dense soup as a first course can reduce entrée energy intake in young children. The study strengthens and builds on previous
research showing that portion size influences intake in young children and that increasing the portion size of vegetables served as a first course can increase children’s vegetable intake. Tomato soup is a particularly effective food for increasing vegetable intake because it is well-liked and easy for young children to consume. Providing vegetable soup to children at the start of a meal is a practical strategy that can be used by caregivers to increase children’s vegetable intake, and reduce energy intake from a more energy-dense main entrée.
REFERENCES


Kral, T. V., Kabay, A. C., Roe, L. S., & Rolls, B. J. (2010). Effects of doubling the portion size of fruit and vegetable side dishes on children’s intake at a meal. *Obesity (Silver Spring)*, 18, 521-527.


Chapter 4

Study 3:

Hiding vegetables to reduce energy density: an effective strategy to increase children’s vegetable intake and reduce energy intake

Spill MK, Birch LL, Roe LS, Rolls BJ. Hiding vegetables to reduce energy density: an effective strategy to increase children’s vegetable intake and reduce energy intake. Under review.
INTRODUCTION

Research has consistently shown that vegetable consumption in children is well below recommended levels (1-4). One reason suggested for low vegetable consumption is that many children do not like vegetables due to their inherent sensory properties, particularly taste and texture (5-8). Strategies, such as increasing vegetable portion size, have been shown to be effective at promoting vegetable intake in children when the vegetables are well-liked, such as carrot sticks or tomato soup (9, 10); however, strategies are needed to increase consumption of a wide variety of vegetables. Adding vegetables covertly to foods so that the palatability of the food is not affected may be an effective method to increase vegetable intake in children, regardless of their liking of vegetables. The present study examined the effect of increasing the proportion of vegetables in entrées served to children over a day on their vegetable and energy intakes.

Substituting low-energy-dense vegetables for more energy-dense meal components, such as starches or meat, will lower the energy density (kcal/g) of a food and can lead to a reduction in energy intake. Several studies have shown that people tend to eat a consistent weight of food and, therefore, reducing dietary energy density leads to a reduction in energy intake (11-13). This has been shown in studies with both adults (11-13) and children (14-17). In one study, decreasing the energy density of an entrée by 25% significantly reduced children’s energy intake of the entrée by 25% and decreased energy intake of the meal by 17% (16). Another study has shown that children reduced their energy intake by 14% over 2 days when meals were reduced in energy density by 25% (17). In these studies, energy density was modified using several techniques, including a reduction in fat and sugar and an increase in fruits and vegetables. The
present study is the first to test the effect on children’s energy intake of reducing entrée energy density solely by increasing the proportion of vegetables.

In the present study, the entrées at breakfast, lunch, and dinner were varied in energy density by increasing the proportion of puréed vegetables. Three levels of energy density (ED) were tested: 100% ED (the standard recipe), 85% ED, and 75% ED. Unmanipulated side dishes and snacks were provided at meals and snack times throughout the day so that children had opportunities to compensate for reductions in energy intake. We hypothesized that children would eat a consistent weight of the entrées across the conditions. Thus, as the energy density of the entrées was reduced by increasing the proportion of vegetables, vegetable intake would increase and energy intake would decrease. It was further hypothesized that despite opportunities for compensation, children would consume a consistent weight of the unmanipulated foods, and as a result the increase in vegetable consumption and the decrease in energy intake would persist over the day.

**METHODS**

**Experimental design**

A within-subject crossover design was used to test the effect of varying the vegetable content of entrées on vegetable and energy intake of preschool-aged children. Children were provided with all of their food, including breakfast, lunch, dinner, and snack foods, one day per week for 3 weeks. Across test days, the entrées at breakfast, lunch, dinner, and evening snack were varied in energy density (ED) through the incorporation of vegetables (100% ED, 85% ED, and 75% ED); unmanipulated side dishes and snacks were also provided. All foods and beverages were consumed *ad libitum*. The order of presentation of the three conditions was
randomly assigned to participants. During the week prior to the study, one day was used to acquaint children, parents, and teachers with the test day procedures; no data were collected on this day.

**Participants**

Recruitment began by distributing letters to parents who had children aged 3-6 years enrolled in daycare at the Bennett Family Center or the Child Development Lab at the University Park campus of The Pennsylvania State University. Parents and guardians provided informed written consent for both their own participation and that of their child. The Pennsylvania State University Office for Research Protections reviewed and approved all procedures.

A power analysis was performed to determine the number of children needed in the study based on a previous study in a similar population of children (17). The minimal clinically relevant difference in daily energy intake was assumed to be 120 kcal, which is approximately 10% of the recommended daily energy intake for children of this age group (18). It was estimated that 34 children would allow the detection of this difference with 80% power using a 2-sided test with a significance level of 0.05. Forty-nine children were enrolled in the study; however, nine children did not complete the study due to difficulty following the protocol. The final sample consisted of 40 children (19 boys and 21 girls).

**Experimental menu**

The three experimental entrées (Table 4-1) were manipulated by adding puréed vegetables to a standard recipe (100% ED condition) to reduce the energy density by either 15% (85% ED condition) or 25% (75% ED condition). The manipulated entrées were zucchini bread at breakfast, pasta with tomato-based sauce at lunch, and chicken noodle casserole at dinner and evening snack. These foods were chosen because they are similar to foods typically served at the
daycare facilities and the vegetable content could be manipulated while maintaining a similar appearance, taste, and texture. The reduction in energy density was achieved by substituting low-energy-dense vegetables (zucchini, cauliflower, broccoli, and tomatoes) for ingredients higher in energy density; therefore, as the vegetable content increased, the amount of other ingredients decreased. The average amount of puréed vegetables added to the entrées (per 100 g of entrée) was 6.0 g in the 100% ED condition, 22 g in the 85% ED condition, and 32 g in the 75% ED condition. A bomb calorimeter (Model 1261, Parr Instrument Co., Moline, IL) was used to confirm that the planned reduction in energy density was achieved.

In addition to the manipulated entrées, unmanipulated side dishes, snacks, and milk were served (Table 4-2) in order to provide nutritionally balanced meals in compliance with the Child Nutrition Program (19). Providing vegetable side dishes also allowed for the examination of the effects of vegetable intake from the entrée on intake of cooked vegetable side dishes. The portion sizes of all items served to the children were based on consumption data from previous studies with this age group (9, 17). Children were served more than enough food to meet their energy needs (18). Including all the foods and beverages served, the 100% ED condition provided 2992 kcal over the day, the 85% ED condition provided 2716 kcal, and the 75% ED condition provided 2548 kcal.

**Meal procedures**

Children enrolled in the study were served breakfast, lunch, and afternoon snack in the daycare centers at their usual times. Dinner was also served at the daycare center, which differed from the usual practice at the facilities. At meal time, children were escorted to a common room in the daycare facilities where they ate at a table with 2-6 other children and one adult. When children finished eating, spilled or dropped food was returned to the correct dish, and the items
were cleared. Food and beverage weights were recorded to the nearest 0.1 g by using digital scales (PR5001 and XS4001S; Mettler-Toledo, Inc., Columbus, OH). Consumption of the foods and beverages was determined by subtracting post-meal weights from pre-meal weights. The manufacturers’ nutrition information and a standard food composition database (20) were used to calculate energy and nutrient intakes and energy density.

Evening snacks were sent home with the children’s parents or guardians. Parents were instructed to allow their child to consume only the foods and beverages provided and to leave any remaining foods and beverages in the containers. Parents were also instructed not to let any other family members consume the provided foods and beverages. To minimize the likelihood that the children in the study would want to eat the foods served to their siblings, evening snacks were also provided for the siblings of study participants. Food and beverage containers were returned unwashed to the daycare center for post-meal weighing. A breakfast snack bar was provided to parents the evening before the test day for optional consumption the morning of the study day. Instructions regarding the breakfast snack were the same as those provided for evening snack.

**Food liking assessments**

Within one week of completing all test meals, the children’s liking of the three versions of each of the three experimental entrées was assessed by using a procedure developed by Birch et al. (21-23). Children were instructed on the use of 3 cartoon faces to indicate whether they thought a food was “yummy”, “okay”, or “yucky”. After instruction, each child was presented with a food sample. The child was asked to taste the food and indicate their liking of the food by pointing to the appropriate face. Samples were tested at typical meal times; each child was presented with the samples in a randomly assigned order. After children rated all three samples
of one entrée, a rank-order preference assessment was performed. Each child selected their most and least preferred sample resulting in samples being assigned a rank of 1 (favorite), 2, or 3 (least favorite).

**Demographic and anthropometric measures**

Parents were asked to complete a questionnaire with 19 questions assessing family demographics and the health status of their child. Body weight and height measurements of the children were taken within one week of the final test meal. The children’s height and weight measurements were used to calculate their sex-specific body mass index-for-age percentile and z-score using a software program from the Centers for Disease Control and Prevention (24).

**Statistical analysis**

Data were analyzed using a mixed linear model with repeated measures (SAS version 9.1, SAS Institute, Cary, NC). The fixed factors in the model were entrée energy density (100%, 85%, or 75%) and session number; subjects were treated as a random factor. The children’s sex, food acceptability ratings, and food preference rankings were tested as factors in the model. The main outcome measures were food intake, vegetable intake, and energy intake. Vegetable intake was reported as both weight and volume; the volume of one vegetable serving was defined as one-half cup (118 mL) of the chopped or sliced vegetable. Dietary energy density was a secondary outcome and was calculated based on food intake without beverages (25). Individual children whose data were influential on the main outcomes in the mixed model were identified using the procedure of Littell et al. (26).

Analysis of covariance was used to assess the influence of continuous subject variables (age, body weight, height, and BMI percentile) on the relationship between entrée energy density and the main study outcomes. T-tests were used to test differences between girls and boys in age,
body weight, height, BMI percentile, and BMI z-score. Data are reported as mean ± standard error and results were considered significant at p<0.05.

**PHOTOGRAPH 4-1.** Manipulated entrées served at breakfast, lunch, and dinner

<table>
<thead>
<tr>
<th></th>
<th>100% ED</th>
<th>85% ED</th>
<th>75% ED</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Breakfast entrée – Zucchini bread</strong></td>
<td>![Image]</td>
<td>![Image]</td>
<td>![Image]</td>
</tr>
<tr>
<td><strong>Lunch entrée – Pasta bake</strong></td>
<td>![Image]</td>
<td>![Image]</td>
<td>![Image]</td>
</tr>
<tr>
<td><strong>Dinner entrée – Chicken noodle casserole</strong></td>
<td>![Image]</td>
<td>![Image]</td>
<td>![Image]</td>
</tr>
</tbody>
</table>

**PHOTOGRAPH 4-2.** Manipulated entrée and unmanipulated side dishes served at breakfast, lunch, and dinner

<table>
<thead>
<tr>
<th></th>
<th>Breakfast</th>
<th>Lunch</th>
<th>Dinner</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Breakfast</strong></td>
<td>![Image]</td>
<td>![Image]</td>
<td>![Image]</td>
</tr>
<tr>
<td><strong>Lunch</strong></td>
<td>![Image]</td>
<td>![Image]</td>
<td>![Image]</td>
</tr>
<tr>
<td><strong>Dinner</strong></td>
<td>![Image]</td>
<td>![Image]</td>
<td>![Image]</td>
</tr>
</tbody>
</table>
TABLE 4-1. Manipulated entrées served on test days to preschool children in a study testing the effect of adding vegetables to reduce energy density of entrées on energy and vegetable intake.  

<table>
<thead>
<tr>
<th></th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100% ED (^2) (Standard)</td>
</tr>
<tr>
<td><strong>Breakfast:</strong> Zucchini bread (120 g)</td>
<td></td>
</tr>
<tr>
<td>Energy density (kcal/g)</td>
<td>4.0</td>
</tr>
<tr>
<td>Energy content (kcal)</td>
<td>480</td>
</tr>
<tr>
<td>Puréed vegetable content (^3) (g)</td>
<td>11</td>
</tr>
<tr>
<td><strong>Lunch:</strong> Pasta and sauce (300 g)</td>
<td></td>
</tr>
<tr>
<td>Energy density (kcal/g)</td>
<td>1.7</td>
</tr>
<tr>
<td>Energy content (kcal)</td>
<td>510</td>
</tr>
<tr>
<td>Puréed vegetable content (^4) (g)</td>
<td>10</td>
</tr>
<tr>
<td><strong>Dinner:</strong> Chicken noodle casserole (300 g)</td>
<td></td>
</tr>
<tr>
<td>Energy density (kcal/g)</td>
<td>1.6</td>
</tr>
<tr>
<td>Energy content (kcal)</td>
<td>480</td>
</tr>
<tr>
<td>Puréed vegetable content (^5) (g)</td>
<td>19</td>
</tr>
<tr>
<td><strong>Evening snack:</strong> Chicken noodle casserole (200 g)</td>
<td></td>
</tr>
<tr>
<td>Energy density (kcal/g)</td>
<td>1.6</td>
</tr>
<tr>
<td>Energy content (kcal)</td>
<td>320</td>
</tr>
<tr>
<td>Puréed vegetable content (^5) (g)</td>
<td>12</td>
</tr>
</tbody>
</table>

\(^1\) Recipe information for manipulated foods can be obtained by contacting the corresponding author.
\(^2\) ED: Energy density (kcal/g)
\(^3\) Zucchini bread contained puréed zucchini
\(^4\) Pasta and sauce contained puréed broccoli, cauliflower, and tomato
\(^5\) Chicken noodle casserole contained puréed cauliflower and zucchini
TABLE 4-2. Unmanipulated snacks, side dishes, and beverages served on test days to preschool children in a study testing the effect of adding vegetables to reduce energy density of entrées on energy and vegetable intake.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Portion served (g)</th>
<th>Energy content (kcal)</th>
<th>Energy density (kcal/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast and Afternoon snacks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cereal bar&lt;sup&gt;1&lt;/sup&gt;</td>
<td>37</td>
<td>130</td>
<td>3.5</td>
</tr>
<tr>
<td>Breakfast side dishes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mandarin oranges&lt;sup&gt;2&lt;/sup&gt;</td>
<td>150</td>
<td>65</td>
<td>0.4</td>
</tr>
<tr>
<td>Milk (1% fat)&lt;sup&gt;3&lt;/sup&gt;</td>
<td>236</td>
<td>100</td>
<td>0.4</td>
</tr>
<tr>
<td>Lunch side dishes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broccoli&lt;sup&gt;4&lt;/sup&gt;</td>
<td>60</td>
<td>17</td>
<td>0.3</td>
</tr>
<tr>
<td>Applesauce&lt;sup&gt;2&lt;/sup&gt;</td>
<td>150</td>
<td>63</td>
<td>0.4</td>
</tr>
<tr>
<td>Milk (1% fat)&lt;sup&gt;3&lt;/sup&gt;</td>
<td>236</td>
<td>100</td>
<td>0.4</td>
</tr>
<tr>
<td>Dinner side dishes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green beans&lt;sup&gt;5&lt;/sup&gt;</td>
<td>60</td>
<td>17</td>
<td>0.3</td>
</tr>
<tr>
<td>Pears&lt;sup&gt;2&lt;/sup&gt;</td>
<td>150</td>
<td>72</td>
<td>0.5</td>
</tr>
<tr>
<td>Milk (1% fat)&lt;sup&gt;3&lt;/sup&gt;</td>
<td>236</td>
<td>100</td>
<td>0.4</td>
</tr>
<tr>
<td>Evening snacks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>String cheese&lt;sup&gt;6&lt;/sup&gt;</td>
<td>28</td>
<td>70</td>
<td>2.5</td>
</tr>
<tr>
<td>Crackers&lt;sup&gt;1&lt;/sup&gt;</td>
<td>29</td>
<td>130</td>
<td>4.5</td>
</tr>
<tr>
<td>Peaches&lt;sup&gt;2&lt;/sup&gt;</td>
<td>150</td>
<td>60</td>
<td>0.4</td>
</tr>
<tr>
<td>Milk (1% fat)&lt;sup&gt;3&lt;/sup&gt;</td>
<td>236</td>
<td>100</td>
<td>0.4</td>
</tr>
</tbody>
</table>

<sup>1</sup> Kellogg Sales Co., Battle Creek, MI
<sup>2</sup> Sysco Corp., Houston, TX
<sup>3</sup> Schneider Valley Farms, Williamsport, PA
RESULTS

Subject characteristics

A total of 40 children (19 boys and 21 girls) completed the study. Data from one child was identified as having an undue influence on the results because of high variability across meals and the data was therefore excluded from the analysis. Participant characteristics are shown in Table 4-3. The final group of 39 children had a mean age of 4.7 ± 0.1 years and a mean sex-specific BMI-for-age percentile of 55.9± 5.1; 10% of the children were overweight (n=3) or obese (n=1). The mean BMI percentile and BMI z-score were significantly higher for girls than boys (p<0.05); otherwise, mean age, height, and weight did not differ significantly between girls and boys. Of the 39 children, 28 (72%) were white, 9 (23%) were Asian, and 2 (5%) were black or African American. Parents of the children had above average education levels and household incomes; approximately 90% of mothers and 80% of fathers had a college degree and 76% of households had an annual income above $50,000.
### TABLE 4-3. Characteristics of children participating in a study that tested the effect of reducing entrée energy density by adding vegetables.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Boys (n = 18)</th>
<th>Girls (n = 21)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ± SE</td>
<td>Range</td>
</tr>
<tr>
<td>Age (y)</td>
<td>4.6 ± 0.1</td>
<td>3.7 – 6.1</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>18.4 ± 0.9</td>
<td>15.6 – 28.2</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>107.9 ± 1.8</td>
<td>97.0 – 125.2</td>
</tr>
<tr>
<td>BMI z-score</td>
<td>-0.1 ± 0.1(^a)</td>
<td>-1.1 – 1.8</td>
</tr>
<tr>
<td>Sex-specific BMI-for-age percentile(^2)</td>
<td>46.0 ± 8.1(^a)</td>
<td>12.5 – 96.8</td>
</tr>
</tbody>
</table>

\(^1\) Different superscript letters within a row indicate a significant difference between sexes (p<0.05).

\(^2\) Calculated from height, weight, and age (24)

**Food intake**

There was no significant difference in food intake (g) of the manipulated entrées across the different energy density conditions (**Table 4-4**). Additionally, there was no difference in the weight of food consumed from the side dishes, snacks, or beverages across the conditions. The children, therefore, ate a consistent weight of food at each meal and over the day regardless of the energy density of the entrées.
TABLE 4-4. Food and energy intakes of 39 children over a day where all entrées served were 100%, 85%, or 75% of the standard energy density (ED)\(^1\).

<table>
<thead>
<tr>
<th></th>
<th>100% ED</th>
<th>85% ED</th>
<th>75% ED</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Food intake (g)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manipulated entrées</td>
<td>270.4 ± 26.5</td>
<td>295.0 ± 29.6</td>
<td>289.8 ± 26.7</td>
</tr>
<tr>
<td>Unmanipulated foods</td>
<td>403.0 ± 32.8</td>
<td>404.8 ± 33.5</td>
<td>354.8 ± 36.2</td>
</tr>
<tr>
<td>Total foods</td>
<td>694.7 ± 37.9</td>
<td>722.3 ± 47.9</td>
<td>664.5 ± 48.7</td>
</tr>
<tr>
<td><strong>Energy intake (kcal)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manipulated entrées</td>
<td>606.4 ± 50.9</td>
<td>572.9 ± 46.9</td>
<td>512.5 ± 40.0</td>
</tr>
<tr>
<td>Unmanipulated foods</td>
<td>375.0 ± 21.8</td>
<td>403.7 ± 19.6</td>
<td>353.3 ± 23.5</td>
</tr>
<tr>
<td>Total foods</td>
<td>1022.9 ± 52.4</td>
<td>1015.2 ± 53.5</td>
<td>889.4 ± 52.0</td>
</tr>
<tr>
<td><strong>Energy density (kcal/g)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manipulated entrées</td>
<td>2.35 ± 0.09</td>
<td>2.07 ± 0.07</td>
<td>1.88 ± 0.08</td>
</tr>
<tr>
<td>Unmanipulated foods</td>
<td>1.09 ± 0.09</td>
<td>1.17 ± 0.10</td>
<td>1.19 ± 0.09</td>
</tr>
<tr>
<td>Total foods</td>
<td>1.53 ± 0.07</td>
<td>1.48 ± 0.06</td>
<td>1.43 ± 0.07</td>
</tr>
</tbody>
</table>

\(^1\) All values are means ± SEMs. Values in the same row with different superscript letters are significantly different, \(p<0.05\) (mixed linear model with repeated measures with a Tukey-Kramer adjustment for multiple comparisons).

Vegetable intake

Incorporating vegetables into the entrées resulted in an increase in vegetable intake at each meal and over the day (\(p<0.01\); Figure 4-1). The amount of vegetables consumed daily from the entrées was on average 65 ± 6 g in the 100% ED condition, 109 ± 12 g in the 85% ED condition, and 132 ± 13 g, in the 75% ED condition. Compared to the standard vegetable intake from the entrées increased by 68% and 103% in the 85% ED and 75% ED conditions, respectively. The amount of vegetables consumed from the entrées is equivalent to 0.8 vegetable servings in the 100% ED condition, 1.5 vegetable servings in the 85% ED condition, and 1.9 vegetable servings in the 75% condition. Increasing vegetable intake from the entrée did not affect consumption of the vegetable side dishes served at lunch and dinner; therefore, vegetable consumption over the day increased as the vegetable content of the entrées was increased.
Average daily vegetable consumption was 101 ± 8 g, 152 ± 12 g, and 174 ± 13 g, in the 100% ED, 85% ED, and 75% ED conditions, respectively.

**Figure 4-1.** Mean (±SEM) weight of vegetables consumed from the entrées at breakfast, lunch, and dinner by 39 preschool children. Entrées were varied in energy density across conditions by incorporating additional vegetables. Different letters for means of the same outcome indicate a significant difference (p<0.001).

![Bar chart showing vegetable intake](image)

**Energy intake**

Because the children consumed a consistent weight of food across the conditions, reducing the energy density of the entrées had a significant effect on energy intake over the day (**Figure 4-2**). Reducing the energy density by 25% resulted in a difference in energy intake of 142 kcal (p=0.030). This equates to a reduction in daily energy intake of approximately 12%. Energy intake from the 85% ED condition was not significantly different from the other conditions (p>0.10). There was no difference in average energy intake from the unmanipulated
side dishes, snacks, and beverages across the conditions; therefore the reduction in energy intake was a result of the change in entrée energy density. The mean energy density of all foods consumed over the day decreased as the entrée energy densities decreased (p=0.003; Table 4-4).

**Figure 4-2.** Mean (±SEM) energy intake consumed from the entrées at breakfast, lunch, and dinner by 39 preschool children. Entrées varied in energy density across conditions. Different letters for means of the same outcome indicate a significant difference (p<0.05).

![Figure 4-2](image)

**Influence of food liking and subject characteristics**

Of the 39 children that completed the study, 30 completed the liking and preference assessments (Table 4-5). All versions of the entrées were generally well-liked, as indicated by more than 70% of the children rating them as “yummy” or “okay”. Children’s rating of liking for an entrée did not significantly influence their consumption of that entrée. Furthermore, ratings of liking for the entrée did not significantly influence the relationship between the energy density of the entrée and energy intake at the meal. Preference rankings of the entrées also indicated that the different versions of the entrées were liked; each entrée was rated as the favorite by approximately one-third of the children (Table 4-5). Preference rankings of the entrées did not
significantly influence consumption of the entrée or the relationship between entrée energy density and meal energy intake.

An analysis of covariance indicated that the effects of entrée energy density on food intake and energy intake were not significantly influenced by the children’s age, body weight, height, or BMI percentile.

**TABLE 4-5.** Liking ratings and preference rankings of each of the manipulated entrées varied in energy density and served to children (n=30).

<table>
<thead>
<tr>
<th></th>
<th><strong>Liking rating</strong></th>
<th></th>
<th><strong>Preference ranking</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yummy</td>
<td>Okay</td>
<td>Yucky</td>
</tr>
<tr>
<td><strong>Breakfast bread</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100% ED</td>
<td>69%</td>
<td>19%</td>
<td>12%</td>
</tr>
<tr>
<td>85% ED</td>
<td>78%</td>
<td>19%</td>
<td>3%</td>
</tr>
<tr>
<td>75% ED</td>
<td>69%</td>
<td>25%</td>
<td>6%</td>
</tr>
<tr>
<td><strong>Lunch pasta</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100% ED</td>
<td>63%</td>
<td>33%</td>
<td>3%</td>
</tr>
<tr>
<td>85% ED</td>
<td>67%</td>
<td>27%</td>
<td>6%</td>
</tr>
<tr>
<td>75% ED</td>
<td>63%</td>
<td>20%</td>
<td>17%</td>
</tr>
<tr>
<td><strong>Dinner and evening snack casserole</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100% ED</td>
<td>63%</td>
<td>17%</td>
<td>20%</td>
</tr>
<tr>
<td>85% ED</td>
<td>63%</td>
<td>30%</td>
<td>7%</td>
</tr>
<tr>
<td>75% ED</td>
<td>50%</td>
<td>23%</td>
<td>27%</td>
</tr>
</tbody>
</table>

**DISCUSSION**

The present study showed that incorporating puréed vegetables into foods can be an effective strategy to increase children’s vegetable intake and decrease their energy intake. When a substantial amount of vegetables was added to all of the entrées served over the day in order to reduce the energy density by 15% and 25%, children consumed a consistent amount of food. Consequently, vegetable intake from the entrées increased by 68% and 103% in the 85% ED and 75% ED conditions, respectively, and entrée energy intake decreased by 5% and 15% in the 85%
ED and 75% ED conditions, respectively. The decrease in energy intake persisted over the day even though children were given opportunities to compensate by consuming greater amounts of the unmanipulated side dishes and snacks. Using pureéd vegetables to reduce the energy density of foods has the potential to have a large impact on children’s vegetable consumption and energy intake.

Increasing children’s vegetable intake has been the objective of several recent studies (9, 10, 27). One strategy that has been successful at increasing vegetable intake is to increase the portion size of vegetables served to children (9). This method, however, appears to be limited by the palatability of the vegetables served; that is, if a vegetable is not liked by a child, increasing the portion size is unlikely to lead to greater intake (27). Strategies are needed that can increase vegetable intake for a variety of vegetables, including vegetables that are not commonly well-liked by children. In the present study, broccoli, cauliflower, tomatoes, and zucchini were added covertly to familiar entrées so that the appearance, flavor, and texture of the original recipes were maintained. The liking and preference assessments indicated that the palatability ratings of the entrées with added vegetables were similar to those of the standard recipes. Intake results also confirmed this, in that the children ate a consistent weight of the entrées even when there was a substantial increase in vegetable content. The total amount of vegetables consumed from the entrées was equivalent to 1.5 vegetable servings in the 85% ED condition, about half of the daily recommended vegetable intake for children of this age group, and 1.9 vegetable servings in the 75% ED condition, or about two-thirds of the daily recommended vegetable intake. This study has shown that substantial amounts of a variety of vegetables can be incorporated into foods without adversely affecting the amount of entrée eaten. This technique has the potential to make
a significant contribution to the number of children meeting their recommended intake of vegetables.

To foster healthy eating habits, it is important that children learn to like vegetables. Research has shown that repeated exposure can increase children’s liking of an originally disliked vegetable (28-30), but it is not known whether covert exposure to puréed vegetables incorporated in foods would affect vegetable liking or intake of other forms of vegetables. Because vegetable side dishes were served along with the entrées at lunch and dinner, it was possible to assess whether consuming puréed vegetables covertly incorporated into an entrée affected intake of other forms of vegetables. Consumption of the vegetable side dishes was not affected by the amount of vegetables consumed from the entrée; therefore, serving vegetables both within the entrée and as a side dish increased total vegetable intake at the meal. The effect of covert exposure to puréed vegetables on vegetable liking remains unknown. It is possible that exposure to the subtle vegetable flavors from the vegetable-enhanced entrées may increase children’s liking of vegetable flavors and lead to greater acceptance of other forms of vegetables. To maximize vegetable intake in children, incorporating puréed vegetables into entrées should be used in combination with other methods of serving vegetables. Long term studies are needed to understand how this can impact children’s vegetable liking and intake.

Using vegetables to reduce the energy density of foods has been studied in adults and children, but the present study is the first to test a reduction in the energy density of children’s entrées solely through the incorporation of vegetables. Previous studies have used a combination of techniques to reduce energy density of foods served to children. In one study, reducing the energy density of an entrée by 25% by substituting high-fat ingredients for low-fat versions of those ingredients as well as adding puréed vegetables resulted in a reduction in entrée energy
intake by 25% (16). In a study conducted in children over 2 consecutive days, a combination of energy density reduction techniques was used to reduce the energy density of foods and beverages by 27%, which resulted in a 14% decrease in energy intake (17). The present study showed that by incorporating vegetables into entrees, a 25% reduction in entrée energy density led to a 15% reduction in entrée energy intake and an 11% reduction in total energy intake over the day. This study is unique in that it is the first study conducted with children where unmanipulated snacks and side dishes were offered throughout the day to provide opportunities for energy compensation. Although intake of the unmanipulated foods was consistent across conditions, it is possible that energy compensation would occur over several days; therefore, longer term studies are needed.

The benefits of incorporating vegetables into entrees are not limited to children, but may apply to adults as well. A recent, complementary study was conducted in adults where the energy density of entrees served over a day was reduced by 15% and 25% strictly through the incorporation of vegetables (31). Similar to children, adults ate a consistent weight of food across the conditions which led to a significant increase in vegetable consumption and a significant decrease in energy intake over the day. In the adult study, the participants’ liking of vegetables was assessed. Dislike of the vegetables that were incorporated into the entrees did not affect consumption of the vegetable-enhanced entrees. This indicates that incorporating puréed vegetables into entrees can increase vegetable intake even when the added vegetable is disliked. Considering that a dislike for vegetable taste or texture is a substantial barrier to meeting recommended vegetable intakes, incorporating puréed vegetables into foods may be a key to overcome this barrier and increase vegetable intake in children and adults.
The present study has several strengths and limitations. First, rather than measuring intake at a single meal, which is standard in controlled feeding studies of this kind, this study measured intake over an entire day and also provided unmanipulated snacks and side dishes to allow the children to compensate for reductions in energy intake. A limitation of the present study is the use of a convenience sample from childcare centers on a university campus. Parents were highly educated and had an above-average family income, so the findings of the study cannot be generalized to all preschool children. Future work should include children from a more diverse population.

The present study has shown that incorporating puréed vegetables into foods is one strategy that can effectively increase children’s vegetable intake and also decrease energy intake. This simple technique can easily be applied to a variety of foods suitable for children and adults. The recipes in this study varied in their sensory properties (a sweet breakfast bread, a savory rich-colored pasta dish, and a creamy casserole), but all were able to have substantial amounts of various vegetables incorporated into them while maintaining palatability. Incorporating puréed vegetables into recipes can be implemented on a small scale by caregivers or on a larger scale by food service providers and by the food industry. This food preparation technique has the potential to make a significant impact on children’s vegetable and energy intake.
REFERENCES


Chapter 5

Conclusions
SUMMARY OF FINDINGS

The overall objective of the studies presented in this dissertation was to increase vegetable intake in young children. A secondary objective was to determine the effect of increased vegetable intake on children’s energy intake. Two strategies were examined: increasing the portion size of different forms of low-energy-dense vegetables served to children at the start of a meal, and covertly incorporating vegetables into children’s foods. Both strategies were effective at increasing vegetable intake, yet the effects on energy intake varied.

Increasing the portion size of energy-dense foods has been shown to increase children’s intake (1-5). Study 1 was the first study to show that portion size can have a beneficial role in increasing vegetable intake in young children. When the portion size of carrots served as a first course at lunch doubled from 30 g to 60 g, carrot intake increased significantly. There was no further increase in carrot intake as the portion size increased from 60 g to 90 g. Consuming carrot as a first course at lunch did not significantly affect intake of the foods served during the main course, including cooked broccoli. Therefore, consuming carrots as a first course added to total lunch vegetable intake. Energy intake was not significantly affected by consuming carrots at the start of the meal.

Study 2 extended the findings of study 1 by investigating the effect of varying the portion size of a different form of vegetable, tomato soup, served to children at the start of the meal on children’s vegetable and energy intakes. When the portion size of soup was doubled from 150 g to 300 g, children’s soup and vegetable intake increased significantly. Consuming tomato soup at the start of the meal did not affect intake of cooked broccoli served with the main course; therefore, consuming tomato soup at the start of the meal added to total meal vegetable intake.

Based on studies in adults (6-8), consuming soup as a first course has the potential to increase satiety and reduce children’s intake more energy-dense meal components. Consuming tomato soup at the start of a meal decreased energy intake of the more energy-dense main entrée, but total meal energy intake was reduced only when the smallest (150 g) of the three portions of soup were served. Energy intake from
consuming the two larger portions of soup (225 g & 300 g) added to main course energy intake. This resulted in no significant difference in meal energy intake compared to when no soup was served. Study 2 confirms previous findings that increasing the portion size of a low-energy-dense vegetable first course can increase children’s vegetable intake. Further studies are needed to understand the effect of consuming different portion sizes of a low-energy-dense soup at the start of a meal on meal energy intake.

In study 3, the energy density of entrées served to children was reduced by covertly incorporating puréed vegetables into the recipes. As seen in previous studies, children consumed a consistent weight of food even when the energy density was reduced (2, 9-11). In the present study, vegetable intake from within the entrées significantly increased as the energy density was reduced. Also, consuming vegetables from within the entrées did not decrease intake of the vegetable side dishes served at lunch and dinner and therefore added to total vegetable intake at a meal and over the day. When the energy density of all entrées served over a day was reduced by 25%, daily vegetable intake increased from approximately one-half of the daily recommended level to nearly the full recommended amount. Reducing entrée energy density through the incorporation of vegetables reduced energy intake. A 25% reduction in entrée energy density decreased daily energy intake by 11%. Children did not compensate for the reduction in energy by consuming more of the unmanipulated snacks and sides dishes. Incorporating puréed vegetables into foods served to children is an effective strategy to increase children’s vegetables intake and reduce their energy intake over a day.

**INCREASING THE PORTION SIZE OF VEGETABLES SERVED TO CHILDREN**

**Implications**

Studies 1 and 2 showed that portion size can be used in a beneficial way to increase children’s vegetable intake using two different forms of vegetables, carrot sticks and tomato soup. While studies have shown an effect of increasing the portion size of energy-dense foods such as macaroni and cheese on children’s intake (1-4, 12), few studies have investigated the effect of increasing the portion size of low-
energy-dense foods served to children. One study tested the effect of doubling the portion size of two vegetable side dishes and one fruit side dish served at a meal to 5- and 6-year-old children (5). Doubling the portion size of applesauce increased children’s intake, but doubling the portion size of cooked broccoli and carrots did not have a significant impact on intake. This lack of effect may have resulted from the presence of more palatable competing foods. In the present studies, when the influence of competing foods was removed by serving the vegetable at the start of the meal, doubling the portion size of carrot sticks and tomato soup resulted in increased intake. This highlights the significance of competing foods when trying to increase vegetable intake. Increasing the portion size of vegetables is not likely to impact vegetable consumption when other, more palatable foods are present.

Serving vegetables at the start of the meal, when children are hungry and no competing foods are present, is a strategy to increase children’s vegetable intake. The present studies showed that even small portion of vegetables, such as four carrot sticks or two-thirds of a cup of tomato soup, served at the start of a meal increased vegetable intake, however vegetable intake was increased further when portion size increased. Consuming vegetables at the start of the meal did not affect vegetable consumption within the main course; therefore, to maximize vegetable intake at a meal, vegetables should be served as a first course and in the main course. There may be additional opportunities to increase children’s vegetable intake by serving vegetables when children are hungry and without the presence of competing foods, such as at snack time.

The palatability of competing foods is not the only factor in the effectiveness of vegetable portion size on intake; the palatability of the vegetable itself plays an important role. If children like the vegetable, increasing the portion size is likely to increase intake. In the study by Kral et al (5), the children that ranked broccoli as their most preferred food at the meal increased their broccoli intake when the portion size was doubled, even when other foods were available. In the present studies, increasing the portion size increased intake of two well-liked vegetables. Approximately 90% of the children rated the
carrot sticks and tomato soup as acceptable. If children do not like a vegetable, it is unlikely that increasing the portion size would increase intake.

In addition to increasing vegetable intake, another aim of these studies was to investigate the effect of consuming a low-energy-density first course on meal energy intake. The hypothesis was that filling up on a low-energy-dense first course would reduce intake of the more energy-dense entrée and result in a reduction in total meal energy intake. In Study 1, consuming carrots at the start of the meal did not affect intake of the entrée or of total meal energy intake. In study 2, consuming soup at the start of the meal (when each of the portion sizes were served) reduced energy intake of the entrée compared to when no soup was consumed. Total meal energy intake decreased when a small (150 g) portion of soup was served compared to when no soup was served; yet, there was no significant change in total meal energy intake when the two larger portions of soup (225 g and 300 g) were served compared to when no soup was served. Consuming a larger volume of food at the start of the meal (soup compared to carrots) led to a reduction in entrée intake. The effect of this on meal energy intake varied based on the amount of energy consumed from the first course. When a smaller amount of energy was consumed from the soup, total meal energy intake decreased; however, when the amount of soup consumed increased and energy intake from the soup increased, total meal energy intake did not change significantly compared to the control. The effect of consuming a low-energy-dense vegetable at the start of a meal can have an effect on meal energy intake; however more research is needed to understand factors that may influence meal energy intake including the volume and energy content of the first course.

**Strengths, limitations, and future research**

These were the first studies to find that portion size can have a beneficial effect on children’s vegetable intake. There were several aspects of the study design making it unique. First, in order to minimize the influence of vegetable liking on the effect of portion size, these studies tested commonly-consumed, well-liked vegetables. Also, because studies have shown that competing foods can influence
the effect of portion size (5), vegetable portion size was varied at the start of a meal when no other foods were available. By serving vegetables as a first course, it was possible to measure the effect of consuming a low-energy-dense first course on meal intake. Specifically, the effect of consuming a vegetable first course on vegetable intake in the main course and energy intake of the main course was able to be examined.

These studies were designed to minimize the influence of vegetable palatability on portion size by selecting vegetables that were familiar and well-liked by the participating children. These children, however, may not be representative of children in the general population. The participating children were enrolled in daycare centers on Penn State’s campus that regularly provide a variety of vegetables and other healthy foods. Therefore, the eating habits and food preferences of these children may not be typical. These children were mostly Caucasian, of middle-to-upper SES, and had highly educated parents. A more diverse sample should be tested in order to generalize these results.

These studies measured food and energy intake at a single-meal, which is an important first step in understanding the principles of portion size on vegetable intake. However, longer-term studies are needed to see how these effects persist. It is possible that after increasing vegetable intake at a meal, children will consume fewer vegetables at a later meal. On the other hand, research has shown that exposure can increase food acceptability (13-15). Increasing exposure to vegetables by serving an additional course may lead to increased vegetable acceptability and increased vegetable intake over time.

One concern with serving large portions of vegetables to children, particularly in a daycare setting or outside of the home, is the economic issue of food waste. Although increasing the portion size served resulted in increased intake, it also generated more waste. To reduce the amount of waste, vegetables could be served family-style, although this may limit the beneficial effect of serving large portions. A study by Fisher et al. (1) showed that when children were able to serve themselves, they consumed about 25% less than when they were served a large portion of macaroni and cheese. Further work is needed to
determine the optimal vegetable portion size to encourage maximum intake with minimal waste, and also to understand how serving family-style affects vegetable consumption in children.

**COVERTLY INCORPORATING VEGETABLES INTO CHILDREN’S FOODS**

**Implications**

Incorporating puréed vegetables into entrées was shown to increase vegetable intake from consumption of the entrée alone. To have the greatest effect on vegetable intake, however, vegetable-enhanced entrées should be served along with other forms of vegetables. Consuming vegetables within the entrées did not affect children’s intake of vegetable side dishes, and therefore serving vegetable side dishes added to total vegetable intake at the meal and over the day. Serving vegetables separately provides an opportunity for children to learn about the appearance, flavor, and texture of different vegetables that would not be gained from consuming vegetable-enhanced entrées alone. Research has shown that increasing exposure to vegetables is likely to increase children’s vegetable liking (13-15). Exposing children to the subtle vegetable flavors in vegetable-enhanced entrées may also increase children’s liking of vegetable flavors and liking of vegetables in general. Vegetables should be served a variety of ways, including in an entrée as well as separately, to have the greatest impact on vegetable intake and vegetable liking.

Covertly incorporating vegetables into children’s entrées is an effective strategy to increase intake of a variety vegetables, including those that are not typically consumed by children, such as broccoli, cauliflower, tomatoes, squash, and zucchini. With creative cooking ideas, a variety of vegetables can be added to a several types of dishes that children like and are willing to eat. This was demonstrated in study 3 with the high acceptability ratings for the various types of vegetable-enhanced entrées. The entrées tested differed greatly in their sensory properties, including a baked-good, a rich-colored pasta, and creamy casserole. Puréed vegetables can be added covertly to many types of food to improve the nutritional profile while maintaining the palatability.
The benefits of consuming vegetable-enhanced entrées extend beyond children. A complementary study found that when puréed vegetables were incorporated into entrées served to adults, adults responded similarly by consuming a consistent weight of food and, therefore increasing their vegetable intake and decreasing energy intake (16). This strategy should not be limited to children’s food, but rather can and should be applied to foods intended for both children and adults. Incorporating vegetables into foods can be done by parents and caregivers when preparing meals for families. It can be implemented on a larger scale in schools, hospitals, and other institutions, and by food service providers and food manufacturers to have the greatest impact on vegetable and energy intake.

**Strengths, limitations, and future research**

A strength of study 3 was that, not only was it the first to decrease the energy density strictly through the incorporation of vegetables, it looked at the effects of entrée energy density on energy intake over a day, not just within a meal. This study supports the findings by Leahy et al (11) and provides additional evidence that children are not likely to compensate for reductions in energy density over a day. It has been suggested that it may take up to 4 days for the body to respond to changes in energy intake (17), therefore loner-term studies are needed.

A limitation of this study was the need to keep palatability of the test foods similar to the control. Because of this, a 25% reduction in energy density was the maximum that could be achieved. Reducing energy density beyond 25% would have caused sensory differences that could have increased or decreased the palatability. A similar study in adults showed that adults preferred carrot bread when it had a greater vegetable content (and reduced energy density) compared to the control carrot bread with a smaller amount of vegetables. This is likely due to changes in the texture of the bread; the vegetable-enhanced bread was more moist than the control. Preference for macaroni and cheese, however, dropped with the addition of puréed vegetables (16). Depending on the entrée, puréed vegetables can be incorporated to reduce the energy density beyond 25% without negatively affecting palatability.
Incorporating vegetables into foods has a beneficial impact on most children’s vegetable and energy intakes when considering that over 90% of children are not meeting their fruit and vegetable recommendations (18) and 21% of children between the ages of 2- and 5-years-old are considered overweight or obese (19). There is a concern, however, that reducing energy intake is not appropriate for all children. Approximating 4% of children are reportedly underweight (20). Therefore, this strategy may be particularly advantageous for children who are overweight or obese and may benefit from a reduction in energy intake. The long-term effects on energy intake of incorporating vegetables into entrées served to children of all weight classes are unknown and studies are needed to assess this.

Children in this study may not be representative of all American children. The children that participated in this study are from highly educated parents, middle-to-high SES, and are commonly exposed to a variety of vegetables and other healthy foods in their daycare center. This study should be replicated with a more diverse sample of children. Also, because of variation in children’s intake, designing studies to examine individual responses to reducing the energy density of foods by incorporating vegetables may provide additional insight on the effectiveness of this strategy.

Covertly incorporating vegetables into children’s foods has received criticism for being burdensome and impractical to implement. This technique is actually very simple. Puréeing vegetables can be done in the home using common kitchen appliances like a standard blender or food processor. For some, it may be easier to purée a large quantity of vegetables at one time and store them in the refrigerator or freezer for use at a later time. If the time required to purée vegetables is too burdensome, frozen, puréed vegetables can be purchased in grocery stores. To make cooking with vegetables more convenient, the food industry may respond by producing and selling a greater variety of puréed vegetables.

Considering the need for convenience, the food industry can also respond by producing more foods that incorporate vegetables into their products, such as frozen meals or canned foods. Depending on individual needs, there are several practical options for incorporating puréed vegetables into foods.
Another criticism about covertly incorporating vegetables into entrées is that this technique is deceptive to children. Creating foods with high vegetable contents that taste good provide parents and caregivers an opportunity to increase their children’s vegetable intake. It is the parent’s choice to decide if they want to tell their child that vegetables are used as an ingredient. Also, it is recommended that vegetables be served separate from the entrée to teach children the importance of incorporating vegetables into their diets. Studies are needed to investigate children’s response to foods knowing that foods contain puréed vegetables even though the vegetables cannot be seen or tasted.

**FINAL CONCLUSIONS**

Nearly all children need to increase their vegetable intake. This dissertation outlines strategies that have been shown to significantly increase children’s vegetable intake at a meal and over a day. Increasing the portion size of vegetables served to children is likely to have the greatest benefit on vegetable intake when the vegetables are well-liked and palatable, and when competing foods are not available. Incorporating vegetables into foods is a strategy that can increase intake of vegetables that children do not typically consume. A strength of each of these strategies is their ease of implementation. These techniques are simple and can be used in the home, as well as outside the home such as in schools, hospitals, and restaurants. Offering vegetables as a first course, providing large portions of well-liked vegetables, serving vegetable-enhanced entrée, and serving vegetable side dishes are all methods that parents and caregivers should incorporate into their daily meal routines to significantly increase children’s vegetable consumption. Used together these techniques are likely to have a substantial impact on the number of children meeting their recommended vegetable intake levels.
REFERENCES

1. Orlet Fisher J, Rolls BJ, Birch LL. Children's bite size and intake of an entrée are greater with large portions than with age-appropriate or self-selected portions. Am J Clin Nutr 2003;77:1164-70.
Appendix A

Parent Recruitment Letter

Study 1
Dear Parents:

The Bennett Family Center, Child Development Laboratory, and the Laboratory for the Study of Human Ingestive Behavior are getting ready to collaborate on new projects with child care centers in the Centre County region! The title of our new research project is “Lunchtime Eating Behavior in Children”. This research study is one of a series of studies being conducted by the Laboratory of Human Ingestive Behavior. The objective of this research is to understand the effects of different lunch components on children’s eating behavior during lunch. Ultimately, the purpose of these studies is to find strategies to improve diet quality in children.

This study will take place beginning in July, 2008. One day per week for four weeks, we will provide lunch to the children. The normal meal and snack schedules will be followed in each classroom. We do ask that if your child is participating in the study, and he or she regularly eats breakfast at home prior to arriving to daycare, you keep their breakfast foods as consistent as possible on test days (Wednesdays). Children will participate in the following activities:

- **Lunch**
  The lunches, which will be prescribed by the Laboratory of Human Ingestive Behavior, may consist of pasta with sauce, fruits, vegetables, milk, and soup. These meals will meet the same standards as the meals normally served.

- **The Tasting Game**
  “The Tasting Game” is used to assess children’s food preferences for menu items and involves interviewing children individually. Children are asked to taste a food that was served during the study and tell us about their preferences for the food. Your child will participate in the tasting game once at the end of the study.

- **Height and weight**
  These measurements will be taken once by a trained staff member.

In addition to the information obtained from your child, we would like you to complete a questionnaire which typically takes about 5 minutes, and asks about your background information.

Your participation in this research gives your child the opportunity to take part in these activities while also allowing them to decline participation at any time in the study. Each family will be given a $20 gift card to Giant for the completion of the questionnaires. All of the information that you and your child provide is completely confidential.

Your child must be at least 3 years of age and less than 7 years of age. If you are interested in participating, please read and sign the consent form attached to this letter. Please return the forms to the ‘Children’s Eating Behavior’ envelope in your child’s classroom. We would be happy to provide you with any additional information if you have questions regarding this research or other aspects of our work. If you have any questions, please contact Maureen Spill or Jennifer Meengs, R.D. at 863-8481.

Sincerely,

Barbara J. Rolls, Ph.D.
Principal Investigator
Appendix B

Informed Consent Form

Study 1
INFORMED CONSENT FORM FOR BIOMEDICAL RESEARCH  
The Pennsylvania State University

Title of Project:  Lunchtime Eating Behavior in Children-1

Principal Investigators:  Barbara J. Rolls, Ph.D.  
Telephone: 863-8481

Other Investigator(s):  Jennifer Meengs and Maureen Spill  
Telephone: 863-8482

1. Purpose of the study:  The purpose of this research is to investigate children’s responses to eating different meal components within a typical lunch.

2. Procedures to be followed:  If you agree to allow your child to take part in this research, your child will be a part of a project looking at how children respond to varying the amount of vegetable provided to them prior to eating their lunch. The activities will take place during the child’s regularly scheduled lunch period at school one day per week for four weeks. Children will meet one time with a research assistant for a brief interview that will involve assessing the child’s preferences for several of the foods used in the study. Your child’s height and weight will also be measured once during the study by a trained staff member.

In addition to the information obtained from your child, we would like you to complete several questionnaires (6 double-sided pages) regarding your own eating patterns, child feeding practices, and background information, such as age, ethnicity, occupation, height, weight, and education.

3. Discomforts and risks:  There are no risks involved in eating the test meals and filling out the questionnaires beyond those encountered in everyday life. It is possible that investigators will discover a participant's previously unknown food allergy during the course of the study. If this occurs, the parent(s) of the child will be notified immediately so that a quick decision about medical care can be made and action can be taken.

4. Benefits:  You and your child will be aiding in our understanding of human eating behavior.

5. Duration/time of the procedures and study:  The total time your child will spend participating in this project, including meals, brief interviews, and height and weight measurements, will be 6 sessions, no longer than 1 hour per session. The parent questionnaires typically require approximately 10-15 minutes to complete.

6. Statement of confidentiality:  The following may review and copy records related to this research:  
The Office of Human Research Protections in the U.S. Department of Health and Human Services, the Biomedical Institutional Review Board and the PSU Office for Research Protections.

Your participation and your child’s participation in this research are confidential. The investigators and their assistants will have access to your identity and your child’s identity and to information that can be associated with these identities. Children participating in the study will be assigned a number, color, and letter of the alphabet to protect their identity. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.
7. **Right to ask questions:** Please contact Jennifer Meengs or Maureen Spill at 863-8481 with questions, complaints or concerns about the research. You can also call this number if you feel this study has harmed you or your child. If you would like to learn more about your rights as a research subject, please call the Office for Research Protections at (814)865-1775.

8. **Compensation:** Your family will receive one payment of a $20 gift card to Giant for the completion of the study and of the questionnaires.

9. **Voluntary participation:** Your participation and your child’s participation are voluntary. You and your child can stop at any time. You do not have to answer any questions you do not want to answer, and your child does not have to eat any foods that he/she does not want to eat. Refusal to take part in or withdrawing from this study will involve no penalty or loss of benefits you would receive otherwise.

10. **Injury Clause:** In the unlikely event you or your child become injured as a result of your participation in this study, medical care is available but neither financial compensation nor free medical treatment is provided. By signing this document, you are not waiving any rights that you or your child have against The Pennsylvania State University for injury resulting from negligence of the University or its investigators.

If you agree to take part in this research study and to allow your child to take part in the study as well, please sign your name and indicate the date below.

You will be given a copy of this signed and dated consent for your records.

I give permission for my child. __________________________, to participate in this research project.

(Please print name of child)

______________________________________________  ____________________
Parent Signature                                      Date

______________________________________________  ____________________
Person Obtaining Consent                             Date
Appendix C

Parent Reminder

Study 1
Wednesday Evening:

This is just a friendly reminder that the Children’s Eating Behavior study starts tomorrow morning. Please do not allow your child to eat or drink anything (except water) before coming to the child care center Thursday morning for breakfast.

Thank you!
Maureen Spill and Jennifer Meengs
Appendix D

Parent Letter (to accompany Demographic Questionnaire)

Study 1
March 2008

Dear Parents,

Thank you very much for participating in our study! We have made a copy of your signed consent form for your records. We have also given you two questionnaires to complete about yourself and your child. Since most of our research focuses on mothers, these questionnaires should be completed by the mother of the study participant. If the mother is unavailable or is not the primary person in charge of making meals for the child, then please have the person with this responsibility fill out both questionnaires instead. If the person filling out the questionnaires is not the mother of the child, please cross out the word “mothers” and write the person’s relationship to the child at the top of each questionnaire. Some of you may have more than one child participating in our study. We would like you to fill out a set of questionnaires for each child participating in the study. If you are completing multiple sets of questionnaires, please keep one child in mind for each set of questionnaires that you complete. We ask that you complete the questionnaires at your convenience and that you return them to the envelope labeled “Lunchtime Eating Behavior in Children” in your child’s classroom. We will frequently check the envelopes in the classrooms and leave Giant gift cards for the parents who return the questionnaires.

Again, we really appreciate your participation! If you have any questions, please do not hesitate to call us! The telephone number is 863-8482. Thank you!

Sincerely,

Jennifer Meengs and Maureen Spill
Appendix E

Demographic/Background Information Questionnaire

Study 1 & 2
Demographic/Background Information

*Parent*, please complete this questionnaire and return it to the red “Children’s Eating Behavior” envelope in your child’s classroom. We will leave a Giant Gift card in an envelope with your name in your child’s mail slot. Thank you!

What is your child’s date of birth?

Please indicate who lives in your household, and if applicable how many (i.e. siblings 2)?

Mother  ____  Grandmothers  ____
Father  ____  Grandfathers  ____
Siblings  ____  Aunts  ____
Uncles  ____  Cousins  ____
Other  ____

What is your marital status:
___Married  ___Single  ___Widowed  ___Divorced
___Separated  ___Remarried  ___Living together (not married)

What is your total or combined family income, before taxes?
___Less than $20,000
___$21,000 - $35,000
___$36,000 - $50,000
___$51,000-$75,000
___$76,000-$100,000
__ $100,000+

What is the highest level of formal education for:

**MOM**
___High school (12 yrs)
___Associates (14 yrs)
___Technical/Vocational School (14 yrs)
___Bachelors (16 yrs)
___Masters (18 yrs)
___PhD (20 yrs)
___MD (20 yrs)
___JD (20 yrs)
___Other, describe____________

**DAD**
___High school (12 yrs)
___Associates (14 yrs)
___Technical /Vocational School (14 yrs)
___Bachelors (16 yrs)
___Masters (18 yrs)
___PhD (20 yrs)
___MD (20 yrs)
___JD (20 yrs)
___Other, describe____________
Are you currently employed?

**MOM**

<table>
<thead>
<tr>
<th></th>
<th>No</th>
<th>Retired</th>
</tr>
</thead>
<tbody>
<tr>
<td>__</td>
<td></td>
<td></td>
</tr>
<tr>
<td>___</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

**DAD**

<table>
<thead>
<tr>
<th></th>
<th>No</th>
<th>Retired</th>
</tr>
</thead>
<tbody>
<tr>
<td>__</td>
<td></td>
<td></td>
</tr>
<tr>
<td>___</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

_____Hrs per week at work (not traveling to & from)

On average, how frequently does your family eat-out or get take-out for dinner?

1) once a month or less
2) twice a month
3) once a week
4) two times a week
5) three times week
6) four or more times a week

On average, how many nights a week does your family eat dinner together as a group *(with most family members)*?

________ nights

Is your child on any medications?

YES | NO

☐ | ☐

If YES, please specify ________________________________

Does your child have any food allergies?

YES | NO

☐ | ☐

If YES, how does this affect his/her diet? ________________________________

Does your child suffer from lactose intolerance?

YES | NO

☐ | ☐

If YES, how does this affect his/her diet? ________________________________

Does your child have a special diet (anything that will affect what he/she can eat)?

YES | NO

☐ | ☐

If YES, please specify ________________________________

Has your child had any major illnesses?

YES | NO

☐ | ☐

If YES, please describe ________________________________
What ethnicity is your child (please check only one)?
Hispanic or Latino _____
Not Hispanic or Latino _____

What race is your child (please check only one)?
American Indian/Alaskan Native _____
Asian _____
Black or African American _____
White _____
Hawaiian/Pacific Islander _____

What is MOTHER’S (parent/guardian; not child) weight (in pounds)? ____________

What is MOTHER’S (parent/guardian; not child) height (in inches)? ____________
Appendix F

Lunch Script

Study 1 & 2
“Okay, today is restaurant day! We are going to pretend that we are in a restaurant today and everyone will be served meals at the table. Before we get started I wanted to let you know what we’re having for lunch today. For lunch today we’re having..... You can eat as much as you want, or as little as you want. Anything that you don’t eat, you can leave on your plate. Since it is restaurant day we are not going to be using the buckets after lunch. Since everybody has their own food, you don’t need to share. Okay?!”
Appendix G

Intake Sheets

Study 1
**Lunchtime Eating Behavior in Children – 1**

Subject ID: ____________

**Lunch Intake Sheet**

Classroom: ____________

Date: ____________

Week: 1 2 3 4 5

Session: 1 2 3 4

Condition: 0-control

<table>
<thead>
<tr>
<th>Food</th>
<th>Pre-weight (g)</th>
<th>Post-weight (g)</th>
<th>Amount Consumed (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrots (0g)</td>
<td>(without plate)</td>
<td>(with plate)</td>
<td>(with plate)</td>
</tr>
<tr>
<td>Dip (0g)</td>
<td>(without cup and lid)</td>
<td>(with cup and lid)</td>
<td>(with cup and lid)</td>
</tr>
<tr>
<td>Macaroni and Cheese (400g)</td>
<td>(without plate)</td>
<td>(with plate)</td>
<td>(with plate)</td>
</tr>
<tr>
<td>Broccoli (60g)</td>
<td>(without bowl)</td>
<td>(with bowl)</td>
<td>(with bowl)</td>
</tr>
<tr>
<td>Unsweetened applesauce (150g)</td>
<td>(without cup and lid)</td>
<td>(with cup and lid)</td>
<td>(with cup and lid)</td>
</tr>
<tr>
<td>2% Milk (236mL)</td>
<td></td>
<td>(with carton)</td>
<td>(with carton)</td>
</tr>
</tbody>
</table>

Initial: Pre-weight ____________ Post-weight ____________

Math Checklist: 1) ________ 2) ________

Entered data: 1) ________ 2) ________
<table>
<thead>
<tr>
<th>Food</th>
<th>Pre-weight (g)</th>
<th>Post-weight (g)</th>
<th>Amount Consumed (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrots (30g)</td>
<td>(without plate)</td>
<td>(with plate)</td>
<td>(with plate)</td>
</tr>
<tr>
<td>Dip (30g)</td>
<td>(without cup and lid)</td>
<td>(with cup and lid)</td>
<td>(with cup and lid)</td>
</tr>
<tr>
<td>Macaroni and Cheese (400g)</td>
<td>(without plate)</td>
<td>(with plate)</td>
<td>(with plate)</td>
</tr>
<tr>
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<td>(with bowl)</td>
<td>(with bowl)</td>
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<td>(without cup and lid)</td>
<td>(with cup and lid)</td>
<td>(with cup and lid)</td>
</tr>
<tr>
<td>2% Milk (236mL)</td>
<td></td>
<td>(with carton)</td>
<td></td>
</tr>
</tbody>
</table>

Initial: Pre-weight __________ Post-weight __________
Math Checklist: 1) ________ 2) _______
Entered data: 1) ________ 2) ________
**Lunch Intake Sheet**

<table>
<thead>
<tr>
<th>Food</th>
<th>Pre-weight (g)</th>
<th>Post-weight (g)</th>
<th>Amount Consumed (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrots (60g)</td>
<td>(without plate)</td>
<td>(with plate)</td>
<td>(with plate)</td>
</tr>
<tr>
<td>Dip (30g)</td>
<td>(without cup and lid)</td>
<td>(with cup and lid)</td>
<td>(with cup and lid)</td>
</tr>
<tr>
<td>Macaroni and Cheese (400g)</td>
<td>(without plate)</td>
<td>(with plate)</td>
<td>(with plate)</td>
</tr>
<tr>
<td>Broccoli (60g)</td>
<td>(without bowl)</td>
<td>(with bowl)</td>
<td>(with bowl)</td>
</tr>
<tr>
<td>Unsweetened applesauce (150g)</td>
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<td>(with cup and lid)</td>
<td>(with cup and lid)</td>
</tr>
<tr>
<td>2% Milk (236mL)</td>
<td></td>
<td>(with carton)</td>
<td>(with carton)</td>
</tr>
</tbody>
</table>

Initial:  

Math Checklist:  1) ________  2) ________

Entered data:  1) ________  2) ________
Lunchtime Eating Behavior in Children – 1

Subject ID: _____________

Lunch Intake Sheet

Classroom: _____________

Date: _____________

Week: 1 2 3 4 5

Session: 1 2 3 4

**Condition:** 3-large

<table>
<thead>
<tr>
<th>Food</th>
<th>Pre-weight (g)</th>
<th>Post-weight (g)</th>
<th>Amount Consumed (g)</th>
</tr>
</thead>
<tbody>
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<td>(with plate)</td>
<td>(with plate)</td>
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<tr>
<td>Dip (30g)</td>
<td>(without cup and lid)</td>
<td>(with cup and lid)</td>
<td>(with cup and lid)</td>
</tr>
<tr>
<td>Macaroni and Cheese (400g)</td>
<td>(without plate)</td>
<td>(with plate)</td>
<td>(with plate)</td>
</tr>
<tr>
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<td>(with cup and lid)</td>
</tr>
<tr>
<td>2% Milk (236mL)</td>
<td></td>
<td></td>
<td>(with carton)</td>
</tr>
</tbody>
</table>

Initial: Pre-weight _____________ Post-weight _____________

Math Checklist: 1) ________ 2) ________

Entered data: 1) ________ 2) ________
Appendix H

Height and Weight Script

Study 1 & 2
Height and Weight Script

“Hello! I am looking for (child’s name) to come out into the hallway with me.” Wait for child to appear and come into the hallway.

“Hello, (child’s name)! My name is Maureen/Jennifer/Amy and I will be measuring how tall you are. Please take off your shoes and step on this sticker with your heels all the way to the back of the board and your head nice and straight. Ok, I am just going to make sure that your chin is nice and straight.” Align heels, head, back, and chin properly. Tell measurement to assistant for recording.

“Ok, now please step on the sticker on this scale and we will wait for the numbers to stop moving.” Wait for numbers to stop flashing. Tell weight to assistant for recording.

“Ok, now Maureen/Jennifer/Amy is going to do both things with you again just to make sure that I did them correctly.” Child should go to other researcher.

“Hello, (child’s name)! My name is Maureen/Jennifer/Amy and I will also be measuring how tall you are. Please step on this sticker with your heels all the way to the back of the board and your head nice and straight. Ok, I am just going to make sure that your chin is nice and straight.” Align heels, head, back, and chin properly. Tell measurement to assistant for recording.

“Ok, now please step on the sticker on this scale and we will wait for the numbers to stop moving.” Wait for numbers to stop flashing. Tell weight to assistant for recording.

“Ok, now you can put your shoes back on and pick a sticker. Thank you for doing such a great job!” Allow child to put shoes back on and pick sticker.
Appendix I

Preference Assessment Script

Study 1, 2, & 3
Children’s Food Preference Assessment

1. Preference Assessment

Explain to the child how to play the Tasting Game again:

“I’d like to play the tasting game with you today. I’d like to know what you think about the foods that I have. I have three faces here. Do you see a face that looks like the face you make when you eat something that tastes yummy? Point to the face that you would make if you ate something that tasted yummy.”

The interviewer should either point to the yummy face or reinforce the child for picking the correct face.

“This is the yummy face, see how she’s smiling and licking her lips with her tongue like she’s thinking yummy!!? OK, now, do you see a face up here that looks like the face that you make when you eat something that tastes yucky?”

Again, either point to the yucky face or reinforce the child for picking the correct one.

“This is our yucky face. See how she’s frowning and sticking out her tongue like she’s saying yucky!!? Ok, now this other face is our just OK face. This is the face that you make when you taste something and it doesn’t taste yummy, but it doesn’t taste yucky, it tastes just kind of OK.

Now, I really like ___________. I think that ___________ tastes yummy. Show me the face that I would make if I ate ___________.”

Again, either reinforce the child for the correct choice or show them the correct face.

“Ok, now, I don’t like ___________. I think that ___________ tastes yucky. Show me the face that I would make if I ate ___________.”

Again, either reinforce the child for the correct choice or show them the correct face.

“Ok, now, I think that ___________ are just Ok. I think that ___________ tastes just Ok, it’s not yummy like ___________, but it’s not yucky like ___________. Show me the face that I would make if I ate ___________.”

Again, either reinforce the child for the correct choice or show them the correct face.

“Ok, now I’d like to play the game with real food. I have some snacks here and I’d like to know whether you think they taste yummy, yucky, or if they taste just Ok. I’d like you to taste each one and then put the cup in front of the face that you make when you eat it. Ok? Eat the food that you would like to taste first.”

Allow the child to take a taste. When the child is finished, point to each face and ask:

“What do you think? Did that taste yummy, yucky, or did it taste just ok? Put the cup in front of the face that you made when you tasted the ___________.”

Wait for the child to pace the cup in front of one of the faces. When the child is finished, mark the response on the preference sheet and respond:
“You thought that one was _appropriate face_!!! Ok, what would you like to taste next?”

Allow the child to take a taste of the second food. Again, pointing to the appropriate faces, ask the child:

“What do you think? Did that taste yummy, yucky, or did it taste just ok? Put the cup in front of the face that you made when you tasted the __________.”

Again, wait for the child to pace the cup in front of one of the faces. When the child is finished, mark the response on the data sheet. And repeat this step for the remaining foods. Periodically reinforce the child. Be careful to reinforce child for playing the game, not for the actual choices that he/she makes. Avoid reinforcement directly after the child places a food into a category and use phrases such as:

“You are really good at this game!”
“I’m having so much fun playing this game with you!”
Appendix J

Face Scale

Study 1, 2, & 3
Appendix K

Parent Recruitment Letter

Study 2
Dear Parents:

The Bennett Family Center, Child Development Laboratory, and the Laboratory for the Study of Human Ingestive Behavior are continuing their collaboration on projects with child care centers in the Centre County region! The title of this project is “Lunchtime Eating Behavior in Children”. This study is one of a series of research studies being conducted by the Laboratory of Human Ingestive Behavior. The objective of these studies is to understand the effects of different lunch components on children’s eating behavior. Ultimately, the purpose of these studies is to find strategies to improve diet quality in children.

One day per week for six weeks, we will provide breakfast, lunch and snack to all children in participating classrooms. The normal meal and snack times at the centers will be followed. Children will participate in the following activities:

- **Breakfast, Lunch, and Afternoon Snack in the Classroom**
  Breakfast, lunch, and afternoon snacks will be served to all children by the Laboratory of Human Ingestive Behavior. Meals will consist of foods typically served at the daycare center and may include: oatmeal, soup, pasta with sauce, fruits, vegetables, pita bread and milk. These meals will meet the same standards as the meals normally served.

- **The Tasting Game**
  “The Tasting Game” is used to assess children’s food preferences for menu items and involves interviewing children individually. Children are asked to taste a food that was served during the study and tell us about their preferences for the food. Your child will participate in the tasting game once at the end of the study.

- **Height and weight**
  These measurements will be taken once by a trained staff member.

In addition to the information obtained from your child, we would like you to complete a questionnaire packet which typically takes about 10-15 minutes, and asks about your own eating patterns, child feeding practices, and background information.

Your participation in this research gives your child the opportunity to take part in these “special” activities while also allowing them to decline participation at any time in the study. Each family will be given a $20 gift card to Giant for the completion of the questionnaires. All of the information that you and your child provide is completely confidential.

You must be at least 18 years of age to participate and provide consent for your child to take part in the research activities, and your child must be at least 3 years of age and less than 7 years of age. If you are interested in participating, please read and sign the consent form attached to this letter. Please return the forms to the ‘Children’s Eating Behavior’ envelope in your child’s classroom. We would be happy to provide you with any additional information if you have questions regarding this research or other aspects of our work. If you have any questions, please contact Maureen Spill or Jennifer Meengs, R.D. at 863-8482.

Sincerely,

Barbara J. Rolls, Ph.D.
Principal Investigator
Appendix L

Informed Consent Form

Study 2
INFORMED CONSENT FORM FOR BIOMEDICAL RESEARCH
The Pennsylvania State University

Title of Project: Lunchtime Eating Behavior in Children-1

Principal Investigators: Barbara J. Rolls, Ph.D.
226 Henderson Building
University Park, PA 16802
Email: bjr4@psu.edu
Telephone: 863-8481

Other Investigator(s): Jennifer Meengs and Maureen Spill
Telephone: 863-8482

1. Purpose of the study: The purpose of this research is to investigate children’s responses to eating different meal components within a typical lunch.

2. Procedures to be followed: If you agree to allow your child to take part in this research, your child will be a part of a project looking at how children respond to varying the amount of vegetable provided to them prior to eating their lunch. The activities will take place during the child’s regularly scheduled lunch period at school one day per week for six weeks. Although there will be no manipulation or altering of the breakfast and snack served on study days, we will be monitoring intake at these eating times. Children will meet one time with a research assistant for a brief interview that will involve assessing the child’s preferences for several of the foods used in the study. Your child’s height and weight will also be measured once during the study by a trained staff member.

In addition to the information obtained from your child, we would like you to complete several questionnaires (6 double-sided pages) regarding your own eating patterns, child feeding practices, and background information, such as age, ethnicity, occupation, height, weight, and education.

3. Discomforts and risks: There are no risks involved in eating the test meals and filling out the questionnaires beyond those encountered in everyday life. It is possible that investigators will discover a participant's previously unknown food allergy during the course of the study. If this occurs, the parent(s) of the child will be notified immediately so that a quick decision about medical care can be made and action can be taken.

4. Benefits: You and your child will be aiding in our understanding of human eating behavior.

5. Duration/time of the procedures and study: The total time your child will spend participating in this project, including meals, brief interviews, and height and weight measurements, will be 6 sessions, no longer than 1 hour per session. The parent questionnaires typically require approximately 10-15 minutes to complete.

6. Statement of confidentiality: The following may review and copy records related to this research: The Office of Human Research Protections in the U.S. Department of Health and Human Services, the Biomedical Institutional Review Board and the PSU Office for Research Protections. Your participation and your child’s participation in this research are confidential. The investigators and their assistants will have access to your identity and your child’s identity and to information that can be associated with these identities. Children participating in the study will be assigned a number, color, and
letter of the alphabet to protect their identity. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.

7. **Right to ask questions**: Please contact Jennifer Meengs or Maureen Spill at 863-8481 with questions, complaints or concerns about the research. You can also call this number if you feel this study has harmed you or your child. If you would like to learn more about your rights as a research subject, please call the Office for Research Protections at (814)865-1775.

8. **Compensation**: Your family will receive one payment of a $20 gift card to Giant for the completion of the study and of the questionnaires.

9. **Voluntary participation**: Your participation and your child’s participation are voluntary. You and your child can stop at any time. You do not have to answer any questions you do not want to answer, and your child does not have to eat any foods that he/she does not want to eat. Refusal to take part in or withdrawing from this study will involve no penalty or loss of benefits you would receive otherwise.

10. **Injury Clause**: In the unlikely event you or your child become injured as a result of your participation in this study, medical care is available but neither financial compensation nor free medical treatment is provided. By signing this document, you are not waiving any rights that you or your child have against The Pennsylvania State University for injury resulting from negligence of the University or its investigators.

If you agree to take part in this research study and to allow your child to take part in the study as well, please sign your name and indicate the date below.

You will be given a copy of this signed and dated consent for your records.

I give permission for my child, __________________________, to participate in this research project.

(Please print name of child)

______________________________________________  ______________________
Parent Signature                                      Date

______________________________________________  ______________________
Person Obtaining Consent                              Date
Appendix M

Intake Sheets

Study 2
### Lunch Intake Sheet

**Subject ID:** ____________  
**Classroom:** ____________  
**Date:** ____________  
**Week:** 1 2 3 4 5  
**Session:** 1 2 3 4  
**Condition:** 0-control

#### LUNCH

<table>
<thead>
<tr>
<th>Food</th>
<th>Pre-weight (g)</th>
<th>Post-weight (g)</th>
<th>Amount Consumed (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomato Soup (0g)</td>
<td>(without bowl and lid) N/A</td>
<td>(with bowl and lid) N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Macaroni and Cheese (400g)</td>
<td>(without plate)</td>
<td>(with plate)</td>
<td>(with plate)</td>
</tr>
<tr>
<td>Broccoli (60g)</td>
<td>(without bowl)</td>
<td>(with bowl)</td>
<td>(with bowl)</td>
</tr>
<tr>
<td>Unsweetened applesauce (150g)</td>
<td>(without cup and lid)</td>
<td>(with cup and lid)</td>
<td>(with cup and lid)</td>
</tr>
<tr>
<td>2% Milk (236mL)</td>
<td></td>
<td>(with carton)</td>
<td>(with carton)</td>
</tr>
</tbody>
</table>

**Initial:**  
Pre-weight ____________  
Post-weight ____________

**Math Checklist:**  
1) ________  
2) ________

**Entered data:**  
1) ________  
2) ________
Lunchtime Eating Behavior in Children – 1

Subject ID: ____________

Breakfast/Snack Intake Sheet

Classroom: ____________

Date: ____________

Week: 1 2 3 4 5 Session: 1 2 3 4

Condition: 0-control

### BREAKFAST

<table>
<thead>
<tr>
<th>Food</th>
<th>Pre-weight (g)</th>
<th>Post-weight (g)</th>
<th>Amt Consumed (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oatmeal (250 g)</td>
<td>(without bowl and lid)</td>
<td>(with bowl and lid)</td>
<td>(with bowl and lid)</td>
</tr>
<tr>
<td>Peaches (150g)</td>
<td>(without bowl and lid)</td>
<td>(with bowl and lid)</td>
<td>(with bowl and lid)</td>
</tr>
<tr>
<td>2% Milk (236mL)</td>
<td>(with carton)</td>
<td>(with carton)</td>
<td></td>
</tr>
</tbody>
</table>

### AFTERNOON SNACK

<table>
<thead>
<tr>
<th>Food</th>
<th>Pre-weight (g)</th>
<th>Post-weight (g)</th>
<th>Amt Consumed (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pitas (3: 40-45 g) # taken</td>
<td>X 14.5 g = Pre-weight</td>
<td>(without plate)</td>
<td></td>
</tr>
<tr>
<td>Carrots (4: ~30g) # taken</td>
<td>X 7.5 g = Pre-weight</td>
<td>(without plate)</td>
<td></td>
</tr>
<tr>
<td>Cucumbers (4: ~30g) # taken</td>
<td>X 7.5 g = Pre-weight</td>
<td>(without plate)</td>
<td></td>
</tr>
<tr>
<td>Tomatoes (4: ~30g) # taken</td>
<td>X 8.5 g = Pre-weight</td>
<td>(without plate)</td>
<td></td>
</tr>
<tr>
<td>Dip (30g)</td>
<td>(without cup and lid)</td>
<td>(with cup and lid)</td>
<td>(with cup and lid)</td>
</tr>
<tr>
<td>Water (1 bottle)</td>
<td>(with bottle and lid)</td>
<td>(with bottle and lid)</td>
<td></td>
</tr>
</tbody>
</table>

Initial: Pre-weight ____________ Post-weight ____________

Math Checklist: 1) ________ 2) ________

Entered data: 1) ________ 2) ________
Lunch Intake Sheet

Subject ID: _____________
Classroom: _____________
Date: _____________
Week: 1 2 3 4 5  Session: 1 2 3 4
Condition: 1-small

<table>
<thead>
<tr>
<th>Food</th>
<th>Pre-weight (g)</th>
<th>Post-weight (g)</th>
<th>Amount Consumed (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soup (150 g)</td>
<td>(without bowl and lid)</td>
<td>(with bowl and lid)</td>
<td>(with bowl and lid)</td>
</tr>
<tr>
<td>Macaroni and Cheese (400g)</td>
<td>(without plate)</td>
<td>(with plate)</td>
<td>(with plate)</td>
</tr>
<tr>
<td>Broccoli (60g)</td>
<td>(without bowl)</td>
<td>(with bowl)</td>
<td>(with bowl)</td>
</tr>
<tr>
<td>Unsweetened applesauce (150g)</td>
<td>(without cup and lid)</td>
<td>(with cup and lid)</td>
<td>(with cup and lid)</td>
</tr>
<tr>
<td>2% Milk (236mL)</td>
<td>(with carton)</td>
<td>(with carton)</td>
<td></td>
</tr>
</tbody>
</table>

Initial: Pre-weight _____________ Post-weight _____________
Math Checklist: 1) ________ 2) ________
Entered data: 1) ________ 2) ________
Lunchtime Eating Behavior in Children – 1

Subject ID: _____________

Lunch Intake Sheet

Classroom: _____________

Date: _____________

Week: 1 2 3 4 5

Session: 1 2 3 4

Condition: 1-small

**BREAKFAST**

<table>
<thead>
<tr>
<th>Food</th>
<th>Pre-weight (g)</th>
<th>Post-weight (g)</th>
<th>Amt Consumed (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oatmeal (250 g)</td>
<td>(without bowl and lid)</td>
<td>(with bowl and lid)</td>
<td>(with bowl and lid)</td>
</tr>
<tr>
<td>Peaches (150g)</td>
<td>(without bowl and lid)</td>
<td>(with bowl and lid)</td>
<td>(with bowl and lid)</td>
</tr>
<tr>
<td>2% Milk (236mL)</td>
<td>(with carton)</td>
<td></td>
<td>(with carton)</td>
</tr>
</tbody>
</table>

**AFTERNOON SNACK**

<table>
<thead>
<tr>
<th>Food</th>
<th>Pre-weight (g)</th>
<th>Post-weight (g)</th>
<th>Amt Consumed (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pitas (3: 40-45 g)</td>
<td># taken X14.5 g =</td>
<td>Pre-weight (without plate)</td>
<td></td>
</tr>
<tr>
<td>Carrots (4: ~30g)</td>
<td># taken X 7.5 g =</td>
<td>Pre-weight (without plate)</td>
<td></td>
</tr>
<tr>
<td>Cucumbers (4: ~30g)</td>
<td># taken X 7.5 g =</td>
<td>Pre-weight (without plate)</td>
<td></td>
</tr>
<tr>
<td>Tomatoes (4: ~30g)</td>
<td># taken X 8.5 g =</td>
<td>Pre-weight (without plate)</td>
<td></td>
</tr>
<tr>
<td>Dip (30g)</td>
<td>(without cup and lid)</td>
<td>(with cup and lid)</td>
<td>(with cup and lid)</td>
</tr>
<tr>
<td>Water (1 bottle)</td>
<td></td>
<td></td>
<td>(with bottle and lid)</td>
</tr>
</tbody>
</table>

Initial: Pre-weight _____________ Post-weight _____________

Math Checklist: 1) ________ 2) ________

Entered data: 1) ________ 2) ________
Subject ID: _____________

Classroom: _____________

Date: _____________

Week:  1  2  3  4  5  Session:  1  2  3  4

Condition:  2-medium

**LUNCH**

<table>
<thead>
<tr>
<th>Food</th>
<th>Pre-weight (g)</th>
<th>Post-weight (g)</th>
<th>Amount Consumed (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Soup</strong> (225 g)</td>
<td>(without bowl and lid)</td>
<td>(with bowl and lid)</td>
<td>(with bowl and lid)</td>
</tr>
<tr>
<td>Macaroni and Cheese (400g)</td>
<td>(without plate)</td>
<td>(with plate)</td>
<td>(with plate)</td>
</tr>
<tr>
<td>Broccoli (60g)</td>
<td>(without bowl)</td>
<td>(with bowl)</td>
<td>(with bowl)</td>
</tr>
<tr>
<td>Unsweetened applesauce (150g)</td>
<td>(without cup and lid)</td>
<td>(with cup and lid)</td>
<td>(with cup and lid)</td>
</tr>
<tr>
<td>2% Milk (236mL)</td>
<td></td>
<td>(with carton)</td>
<td>(with carton)</td>
</tr>
</tbody>
</table>

Initial:  Pre-weight _____________  Post-weight _____________

Math Checklist:  1) ________  2) ________

Entered data:  1) ________  2) ________
Lunchtime Eating Behavior in Children – 1  Subject ID: ____________

Lunch Intake Sheet  Classroom: ____________

Date: ____________

Week: 1 2 3 4 5  Session: 1 2 3 4

Condition: 2-medium

## BREAKFAST

<table>
<thead>
<tr>
<th>Food</th>
<th>Pre-weight (g)</th>
<th>Post-weight (g)</th>
<th>Amt Consumed (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oatmeal (250 g)</td>
<td>(without bowl and lid)</td>
<td>(with bowl and lid)</td>
<td>(with bowl and lid)</td>
</tr>
<tr>
<td>Peaches (150g)</td>
<td>(without bowl and lid)</td>
<td>(with bowl and lid)</td>
<td>(with bowl and lid)</td>
</tr>
<tr>
<td>2% Milk (236mL)</td>
<td>(with carton)</td>
<td>(with carton)</td>
<td></td>
</tr>
</tbody>
</table>

## AFTERNOON SNACK

<table>
<thead>
<tr>
<th>Food</th>
<th>Pre-weight (g)</th>
<th>Post-weight (g)</th>
<th>Amt Consumed (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pitas (3: 40-45 g)</td>
<td># taken</td>
<td>X14.5 g =</td>
<td>Pre-weight (without plate)</td>
</tr>
<tr>
<td>Carrots (4: ~30g)</td>
<td># taken</td>
<td>X 7.5 g =</td>
<td>Pre-weight (without plate)</td>
</tr>
<tr>
<td>Cucumbers (4: ~30g)</td>
<td># taken</td>
<td>X 7.5 g =</td>
<td>Pre-weight (without plate)</td>
</tr>
<tr>
<td>Tomatoes (4: ~30g)</td>
<td># taken</td>
<td>X 8.5 g =</td>
<td>Pre-weight (without plate)</td>
</tr>
<tr>
<td>Dip (30g)</td>
<td>(without cup and lid)</td>
<td>(with cup and lid)</td>
<td>(with cup and lid)</td>
</tr>
<tr>
<td>Water (1 bottle)</td>
<td>(with bottle and lid)</td>
<td>(with bottle and lid)</td>
<td></td>
</tr>
</tbody>
</table>

Initial:  Pre-weight ____________  Post-weight ____________

Math Checklist:  1) ________  2) ________

Entered data:  1) ________  2) ________
# Lunch Intake Sheet

**Subject ID:** _____________  
**Classroom:** ____________  
**Date:** ____________  
**Week:** 1 2 3 4 5  
**Session:** 1 2 3 4  
**Condition:** 3-large

## LUNCH

<table>
<thead>
<tr>
<th>Food</th>
<th>Pre-weight (g)</th>
<th>Post-weight (g)</th>
<th>Amount Consumed (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soup (300 g)</td>
<td>(without bowl and lid)</td>
<td>(with bowl and lid)</td>
<td>(with bowl and lid)</td>
</tr>
<tr>
<td>Macaroni and Cheese (400g)</td>
<td>(without plate)</td>
<td>(with plate)</td>
<td>(with plate)</td>
</tr>
<tr>
<td>Broccoli (60g)</td>
<td>(without bowl)</td>
<td>(with bowl)</td>
<td>(with bowl)</td>
</tr>
<tr>
<td>Unsweetened applesauce (150g)</td>
<td>(without cup and lid)</td>
<td>(with cup and lid)</td>
<td>(with cup and lid)</td>
</tr>
<tr>
<td>2% Milk (236mL)</td>
<td></td>
<td>(with carton)</td>
<td></td>
</tr>
</tbody>
</table>

**Initial:** Pre-weight ____________ Post-weight ____________

**Math Checklist:** 1) ________ 2) ________

**Entered data:** 1) ________ 2) ________
Lunchtime Eating Behavior in Children – 1

Subject ID: ____________

Lunch Intake Sheet

Classroom: ____________

Date: ____________

Week: 1 2 3 4 5  
Session: 1 2 3 4

Condition: 3-large

**BREAKFAST**

<table>
<thead>
<tr>
<th>Food</th>
<th>Pre-weight (g)</th>
<th>Post-weight (g)</th>
<th>Amt Consumed (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oatmeal (250 g)</td>
<td>without bowl and lid</td>
<td>with bowl and lid</td>
<td>with bowl and lid</td>
</tr>
<tr>
<td>Peaches (150g)</td>
<td>without bowl and lid</td>
<td>with bowl and lid</td>
<td>with bowl and lid</td>
</tr>
<tr>
<td>2% Milk (236mL)</td>
<td>(with carton)</td>
<td>(with carton)</td>
<td></td>
</tr>
</tbody>
</table>

**AFTERNOON SNACK**

<table>
<thead>
<tr>
<th>Food</th>
<th>Pre-weight (g)</th>
<th>Post-weight (g)</th>
<th>Amt Consumed (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pitas  # taken</td>
<td>X14.5 g =</td>
<td>Pre-weight</td>
<td>(without plate)</td>
</tr>
<tr>
<td>Carrots # taken</td>
<td>X 7.5 g =</td>
<td>Pre-weight</td>
<td>(without plate)</td>
</tr>
<tr>
<td>Cucumbers # taken</td>
<td>X 7.5 g =</td>
<td>Pre-weight</td>
<td>(without plate)</td>
</tr>
<tr>
<td>Tomatoes # taken</td>
<td>X 8.5 g =</td>
<td>Pre-weight</td>
<td>(without plate)</td>
</tr>
<tr>
<td>Dip (30g) (without cup and lid)</td>
<td>(with cup and lid)</td>
<td>(with cup and lid)</td>
<td></td>
</tr>
<tr>
<td>Water (1 bottle) (with bottle and lid)</td>
<td>(with bottle and lid)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Initial: Pre-weight ____________  Post-weight ____________

Math Checklist: 1) ________  2) ________

Entered data: 1) ________  2) ________
Appendix N

HHD Research Request

Study 3
REQUEST TO CONDUCT RESEARCH
Human Development & Family Studies Children’s Programs:
Child Development Laboratory & Bennett Family Center
The Pennsylvania State University

The Research Request Process

Step 1 (optional): Informal contact with Directors of Children’s Programs. Before completing your request, it is often helpful to initiate informal contact with the Director(s) of the Children’s Program where you plan to conduct your research. The Directors can provide you with useful information about the number and ages of children enrolled in the program, can help you to anticipate any logistical challenges that may arise in your research, and can help you build support for your research among teachers and parents.

Step 2: Complete and submit the request form. Complete the attached Research Request Form and send it via email to Eva Lefkowitz (EXL20@psu.edu), Research Coordinator, HDFS Children’s Programs and Associate Professor, HDFS. Sending your request via email will speed the process because it allows the review process to be conducted electronically.

Step 2: Respond to any questions during the review process. Your request will be reviewed by the Director of the Child Development Laboratory (Linda Duerr), the Director of the Bennett Family Center (Wendy Whitesell) and an HDFS faculty representative (Eva Lefkowitz). The review process focuses on the logistical feasibility of the proposed study given practical constraints at each Center (numbers and ages of children, space, schedules). As part of this process, we may request additional information from you to clarify logistical issues. The review process typically takes from several days (for simpler studies) to one to two weeks (for more complex studies or if questions arise).

Step 4: Provide copies of clearances and IRB approval. When your request is approved, you must provide the following information to the Directors of each Center where you will be conducting your research before you begin to collect data.

• Originals and photocopies of child abuse and criminal background clearance for any research staff who will take children out of the classroom for data collection. (Originals will be returned to you.)
• A hard copy of the Human Subjects Approval letter from the Office of Regulatory Compliance.
• Copies of all IRB-approved consent letters and copies of all questionnaires that will be completed by teachers or parents.
• Please do not provide copies of your full grant proposal or your full set of IRB application materials. We only require enough information to document that your study has IRB approval and to answer questions that parents or teachers may ask.

Step 5: Contact Center(s) to arrange for the start of your study.

Step 6: Follow-up. At the conclusion of your research project, we may contact you to get feedback from you on your experience and to request a summary of your findings. The summary can be brief and need not be based on a final/definitive analysis of your data. We will share these summaries with parents in order to foster an appreciation for the research that takes place at the Child Development Laboratory and the Bennett Family Center.
# REQUEST TO CONDUCT RESEARCH

<table>
<thead>
<tr>
<th>Human Development &amp; Family Studies Children’s Programs:</th>
<th>Internal Use Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child Development Laboratory &amp; Bennett Family Center</td>
<td>Date Received:</td>
</tr>
<tr>
<td>The Pennsylvania State University</td>
<td>Date Approved:</td>
</tr>
</tbody>
</table>

1. **Contact Information:**
   - Principal Investigator(s): Dr. Barbara Rolls
   - College Affiliation: Health and Human Development
   - Department/Center Affiliation: Nutritional Sciences
   - Campus Address: 226 Henderson Building
   - E-mail: bjr4@psu.edu
   - Telephone: 3-8481

   *If research is being conducted under faculty supervision, please provide the following:*
   - Faculty supervisor's name:
   - Campus Address:
   - E-mail:
   - Telephone:

2. **Purpose of Research Project**
   - Undergraduate Student: __ Honors Thesis __ Other________
   - Graduate Student: __ M.A. Thesis X Ph.D. Dissertation __
   - Other:
     - Postdoctoral Fellow: __ Research Project
     - Faculty: __ Research Project

3. **Is this project grant-related?**
   - ☐ No
   - ☐ Yes, pilot data will be used to develop/support a grant proposal
   - ☐ Yes, pilot testing/training final procedures for a funded project (Funding Source: )
   - X Yes, these are core data for a funded project (Funding Source: NIH )

4. **Project Overview:**
   - Title of Proposal: Children’s Vegetable Intake Study
   - Proposed Starting Date: November 2, 2009
   - Anticipated Completion Date: May 2010
   - Location of proposed data collection: X Bennett Family Center
   - X Child Development Lab
   - Total number of children needed: 50
   - Age of children needed: (specify numbers in age ranges as relevant): 3-6
   - Type(s) of data to be collected: __ Classroom Observations
   - __ Classroom Activity/Demonstration
   - __ Individual Interview/Assessment
Number of sessions (per child): All meals will be provided to participants over 3 1-week test sessions.
Approximate length of each session: 1-week (breakfast, lunch, afternoon snack, dinner, take home snacks each day)
Will you be using one of the rooms available for research scheduling? __ No ___ Yes

5. Office of Regulatory Compliance Information:
   Human Subjects Project Number: tbd
   Human Subjects Approval Date: tbd (IRB submitted 9/17/09)

6. Have you spoken to the Director(s) of the Children’s Programs? If so, please briefly describe whom you spoke to and what was discussed.
Yes, There was a meeting between myself (lead graduate student), Jennifer Meengs (Lab Manager), Wendy Whitesell, and Gail Guss from the BFC. We discussed the purpose of the study as well as the methods and logistics of carrying out the study. Resources were also discussed. Wendy and Gail fully support this research and have agreed to have the BFC participate in the study.

7. Project Details
   a. Briefly summarize the nature and purpose of the proposed study. (Something similar to the abstract for a grant proposal):

       The rapid increase in childhood obesity in recent years suggests that environmental factors associated with increased energy intake and reduced energy expenditure play an important role. According to nationally representative data, nearly 20% of children aged 2 to 5 years are overweight or obese. Understanding the factors that affect eating behavior and promote a positive energy balance in children is necessary in order to develop effective approaches to moderate their influence as well as to design strategies to prevent the development of obesity. The preschool years are an important period for the implementation of obesity prevention strategies; during these early years, children are introduced to different foods, develop food acceptance patterns, and transition from eating primarily in response to biological cues to responding to environmental cues about food. Previous studies conducted in adults indicate that several properties of foods affect energy intake; for example, increases in the energy density, portion size, and variety of available foods are all associated with increased consumption. Data are more limited in children and many of the findings in adults have not been extended to children. Where there are parallel studies, however, it is clear that energy intake in children is affected by these properties of foods, although not always in the same way as in adults. The proposed study will extend these findings to determine how properties of food can be used strategically to influence energy intake in preschool children, as well as to improve diet quality. The specific focus will be on increasing children's vegetable intake in order to reduce energy density and to moderate energy intake.

   b. Briefly describe the Procedures to be employed in carrying out the study. (It may be easiest to cut-and-paste the relevant sections from your IRB proposal).

       During three 5-day test periods, participating children attending the daycare center will have all of their meals and snacks provided by the researchers, beginning with breakfast on Monday and ending with lunch on Friday. The entrées served at lunch, afternoon snack, and dinner will be varied by incorporating different amounts of puréed vegetables. Children will be allowed to consume as much or
as little of the foods and beverages as desired. Breakfast, lunch, and afternoon snack will be served in the daycare center at the usual times, and dinner will be served in the daycare center at a time selected by the parents. Children enrolled in the study will consume these meals in a separate room, in the presence of a staff member who has been approved for the required child clearances. At the end of each test day, an evening snack and a morning snack will be sent home with the parents for their child to eat if desired. The test periods will be separated by nine days in which children will follow their usual routine and none of their food will be provided by the researchers. All foods provided to the children will be weighed before and after consumption to determine the amount consumed. Parents will be asked to complete questionnaires assessing the demographic and health status of their child. After completing the three test periods, children's preference for the test foods will be assessed at the daycare center using a standard procedure developed for children, and their heights and weights will be measured.

c. Please explain where you expect the study to take place (e.g., in the classroom, on the playground, in a separate room in the Center).

Meals will be served to the children in the Blue Room within the daycare center.

d. Please summarize any other staff support or Center resources your project requires (e.g., staff assistance, equipment, materials/supplies).

We hope to serve all meals to the participating children in the Bennett Family center Blue Room. We would like to have a teacher in the room with the children at all times and are prepared to provide financial support for this resource. All other materials will be provided by our lab.

e. Please list the names of all research staff who will interact with children as part of this project.

Jennifer Meengs, RD – Study coordinator/lab manager – design of questionnaires and informed consent, collection of data, subject recruitment. Jennifer has been managing the lab, including all lab studies, at the Laboratory for Human Ingestive Behavior since May 2001.

Maureen Spill, MS – Lead graduate student for study – aid in recruitment, data collection, data analysis, food preparation, coordination of reimbursement. Maureen has an MS in sensory research and over 4 years of industry experience with consumer research and has been a graduate student since Fall 2007.


Rachel Williams, RD – Graduate student – assist with data collection, food preparation. PhD student since Fall 2008.


Jackie Vernarelli, PhD - assist with data collection, data analysis. Post-Doc since September 2009.

Stephanie Anzman - Graduate student – assist with data collection. Graduate student since Fall 2006.

Brandi Rollins - Graduate student – assist with data collection. Graduate student since Fall 2006.

Melissa Wortman, BS - assist with food preparation, data collection. Research technician since January 2009.

Audrie Kapinus - Undergraduate - assist with data collection.
Christy Gregg - Undergraduate - assist with data collection.
Christine Simcox - Undergraduate - assist with data collection.
Christine Vavala - Undergraduate - assist with data collection.
Jess Kim - Undergraduate - assist with data collection.
Kate Giere - Undergraduate - assist with data collection.
Laura Dombrosky - Undergraduate - assist with data collection.
Melanie Cirangle - Undergraduate - assist with data collection.
Nicole Lucey - Undergraduate - assist with data collection.
Rena Donatelli - Undergraduate - assist with data collection.
Sam Scott - Undergraduate - assist with data collection.
Appendix O

Parent Recruitment Letter

Study 3
Dear Parents:

The Bennett Family Center, the Child Development Laboratory, and the Laboratory for the Study of Human Ingestive Behavior have collaborated on a series of short-term studies examining strategies to increase vegetable consumption and improve diet quality in children. The results of these studies have been very promising, and we are excited to begin another study looking at these strategies over several meals. Results from this study will be instrumental in influencing recommendations for childcare providers, the food industry, and policy makers.

Because of the duration of the study and required parental support, parents will be compensated with gift cards up to $50. Upon completion of the 5th and final test day, parents can select a $50 gift card for: Giant, Target, Lowes, Barnes and Noble, or Walmart.

Study details:

- The study involves 5 test weeks. One day a week during each test week, your child will have all meals, including dinner, provided by our lab and served at the child care facility. We will provide evening snacks to be eaten at home and ask that during each test day, your child only eat the foods that we provide when they are outside the child care center.

- Testing will take place each week on Wednesdays and Thursdays beginning on January 20th. Your test day will be assigned based on the child’s classroom. If you have a conflict on a particular day, such as swim lessons every Wednesday evening, your child may participate on the alternate day.

- All foods served will be foods similar to those typically served at the daycare center, and therefore will be familiar to the children. These foods include: chicken noodle casserole, Italian pasta bake, zucchini bread and carrot muffins.

- Breakfast, lunch, afternoon snack, and dinner will be served to the children enrolled in the study. Children will eat in the Blue Room with other children enrolled in the study. A BFC staff member or a researcher from the Laboratory of Human Ingestive Behavior with all required child clearances will be present for all meals.

- Children in the study will be required to have dinner at the BFC. Two dinner times will be available for you to choose from, either 5:15pm or 5:45pm. We ask that you plan to pick up your child 30 minutes after their scheduled dinner time.

- An evening snack will be sent home with you each evening. All containers and uneaten food will need to be returned to the BFC the following day. The day before each test day, we will provide a light breakfast snack for your child to have before arriving at school if they regularly eat something at home each morning.
● After the testing weeks, children will be invited to play the “Tasting Game” where they will indicate how much they like the foods in the study by using a cartoon face scale.

● Height and weight measurements will be taken of each child enrolled in the study upon completion of the study.

● Parents will be asked to complete a brief questionnaire which typically takes about 10-15 minutes and asks about your demographic and background information. Additionally, a brief questionnaire will be sent home every night with the snack foods asking about the general health of your child that day and should take no more than 5 minutes.

● All of the information that you and your child provide is completely confidential.

You must be at least 18 years of age to participate and provide consent for your child to take part in the research activities, and your child must be at least 3 years of age and less than 7 years of age. If you are interested in participating, please read and sign the consent form attached to this letter. Please return the forms to the ‘Children’s Eating Behavior’ envelope at the Receptionist’s desk. We would be happy to provide you with any additional information if you have questions regarding this research or other aspects of our work. If you have any questions, please contact Maureen Spill or Jennifer Meengs, R.D. at 863-8482.

Sincerely,

Barbara J. Rolls, Ph.D.
Principal Investigator
Appendix P

Informed Consent Form – Bennett Family Center

Study 3
Informed Consent Form for Biomedical Research
The Pennsylvania State University

Title of Project: Children’s Vegetable Intake

Principal Investigators: Barbara J. Rolls, Ph.D.
226 Henderson Building, University Park, PA 16802
Telephone: 863-8481
Email: bjr4@psu.edu

Other Investigator(s): Jennifer Meengs and Maureen Spill
Telephone: 863-8482

1. Purpose of the study: The purpose of this research is to investigate children’s responses to incorporating vegetables into selected entrees and snacks over several days.

2. Procedures to be followed: If you agree to allow your child to take part in this research, your child will be a part of a project looking at how children respond to having vegetables incorporated into entrees and snacks. The activities will take place during the child’s regularly scheduled meal times at the daycare center for breakfast, lunch and snack. Dinner will be served at the daycare center at either 5:15 or 5:45. Parents will choose the time slot they desire for their child and will be required to pick up their child 30 minutes after the start of the meal. An evening snack will be provided for at home, and we ask that you return any uneaten snacks the following morning. Children will meet with a research assistant for a brief interview that will involve assessing the child’s preferences for several of the foods used in the study. Your child’s height and weight will also be measured once during the study by a trained staff member.

During the test days we will ask that your child only eat the foods provided by the lab. The day before each test day, you will be provided with a small morning snack that your child may eat before the start of the school day if he or she regularly eats something before arriving at school.

In addition to the information obtained from your child, we will ask you to complete a brief questionnaire regarding your own demographic and background information, such as age, ethnicity, occupation, height, weight, and education. A short questionnaire will be sent home daily to assess your child’s general health status.

3. Discomforts and risks: There are no risks involved in eating the test meals and filling out the questionnaires beyond those encountered in everyday life. It is possible that investigators will discover a participant's previously unknown food allergy during the course of the study. If this occurs, the parent(s) of the child will be notified immediately so that a quick decision about medical care can be made and action can be taken.

4. Benefits: You and your child will be aiding in our understanding of eating behavior, particularly strategies to increase vegetable intake.

5. Duration/time of the procedures and study: The duration of this study is 5 weeks, consisting of one day of test meals each week. During each test week your child will participate in 4 meal sessions at the daycare, each lasting less than 30 minutes. Your child will also participate in sessions for assessing food preference and measuring their height and weight. Each of these sessions should take less than 10 minutes. The parent questionnaires typically require approximately 10-15 minutes to complete.
6. **Statement of confidentiality:** The following may review and copy records related to this research: The Office of Human Research Protections in the U.S. Department of Health and Human Services, the Institutional Review Board and the PSU Office for Research Protections.

Your participation and your child’s participation in this research are confidential. The investigators and their assistants will have access to your identity and your child’s identity and to information that can be associated with these identities. Children participating in the study will be assigned a number, color, and letter of the alphabet to protect their identity. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.

7. **Right to ask questions:** Please contact Jennifer Meengs or Maureen Spill at 863-8481 with questions, complaints or concerns about the research. You can also call this number if you feel this study has harmed you or your child. If you have any questions, concerns, problems about your rights as a research participant or would like to offer input, please contact Penn State University’s Office for Research Protections (ORP) at (814) 865-1775. The ORP cannot answer questions about research procedures. Questions about research procedures can be answered by the research team.

8. **Compensation:** Your family will receive a $50 gift card upon completing all 5 test days. If you or your child withdraws before completing all 5 weeks, you will receive $5 for each week completed.

9. **Voluntary participation:** Your participation and your child's participation are voluntary. You and your child can stop at any time. You do not have to answer any questions you do not want to answer, and your child does not have to eat any foods that he/she does not want to eat. Refusal to take part in or withdrawing from this study will involve no penalty or loss of benefits you would receive otherwise.

10. **Injury Clause:** In the unlikely event you or your child become injured as a result of your participation in this study, medical care is available but neither financial compensation nor free medical treatment is provided. By signing this document, you are not waiving any rights that you or your child have against The Pennsylvania State University for injury resulting from negligence of the University or its investigators.

You must be 18 years of age or older to take part in this study. If you agree to take part in this research study and to allow your child to take part in the study as well, please sign your name and indicate the date below.

You will be given a copy of this signed and dated consent for your records.

I give permission for my child, __________________________, to participate in this research project.

(Please print name of child)

______________________________________________  ____________________
Parent Signature  Date

______________________________________________  ____________________
Person Obtaining Consent  Date
Appendix Q

Informed Consent Form – Childhood Development Laboratory

Study 3
Title of Project: Children’s Vegetable Intake

Principal Investigators: Barbara J. Rolls, Ph.D.
226 Henderson Building, University Park, PA 16802
Telephone: 863-8481
Email: bjr4@psu.edu

Other Investigator(s): Jennifer Meengs and Maureen Spill
Telephone: 863-8482

1. Purpose of the study: The purpose of this research is to investigate children’s responses to incorporating vegetables into selected entrees and snacks over several days.

2. Procedures to be followed: If you agree to allow your child to take part in this research, your child will be a part of a project looking at how children respond to having vegetables incorporated into entrees and snacks. The activities will take place during the child’s regularly scheduled meal times at the daycare center for breakfast, lunch and snack. Dinner will be served at the daycare center at 5:00 pm. Parents will choose the time slot they desire for their child and will be required to pick up their child 30 minutes after the start of the meal. An evening snack will be provided for at home, and we ask that your return any uneaten snacks the following morning. Children will meet with a research assistant for a brief interview that will involve assessing the child’s preferences for several of the foods used in the study. Your child’s height and weight will also be measured once during the study by a trained staff member.

During the test days we will ask that your child only eat the foods provided by the lab. The day before each test day, you will be provided with a small morning snack that your child may eat before the start of the school day if he or she regularly eats something before arriving at school.

In addition to the information obtained from your child, we will ask you to complete a brief questionnaire regarding your own demographic and background information, such as age, ethnicity, occupation, height, weight, and education. A short questionnaire will be sent home daily to assess your child’s general health status.

3. Discomforts and risks: There are no risks involved in eating the test meals and filling out the questionnaires beyond those encountered in everyday life. It is possible that investigators will discover a participant's previously unknown food allergy during the course of the study. If this occurs, the parent(s) of the child will be notified immediately so that a quick decision about medical care can be made and action can be taken.

4. Benefits: You and your child will be aiding in our understanding of eating behavior, particularly strategies to increase vegetable intake.

5. Duration/time of the procedures and study: The duration of this study is 5 weeks, consisting of one day of test meals each week. During each test week your child will participate in 4 meal sessions at the daycare, each lasting less than 30 minutes. Your child will also participate in sessions for assessing food preference and measuring their height and weight. Each of these sessions should take less than 10 minutes. The parent questionnaires typically require approximately 10-15 minutes to complete.
6. **Statement of confidentiality:** The following may review and copy records related to this research: The Office of Human Research Protections in the U.S. Department of Health and Human Services, the Institutional Review Board and the PSU Office for Research Protections.

Your participation and your child’s participation in this research are confidential. The investigators and their assistants will have access to your identity and your child’s identity and to information that can be associated with these identities. Children participating in the study will be assigned a number, color, and letter of the alphabet to protect their identity. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.

7. **Right to ask questions:** Please contact Jennifer Meengs or Maureen Spill at 863-8481 with questions, complaints or concerns about the research. You can also call this number if you feel this study has harmed you or your child. If you have any questions, concerns, problems about your rights as a research participant or would like to offer input, please contact Penn State University’s Office for Research Protections (ORP) at (814) 865-1775. The ORP cannot answer questions about research procedures. Questions about research procedures can be answered by the research team.

8. **Compensation:** Your family will receive a $50 gift card upon completing all 5 test days. If you or your child withdraws before completing all 5 weeks, you will receive $5 for each week completed.

9. **Voluntary participation:** Your participation and your child's participation are voluntary. You and your child can stop at any time. You do not have to answer any questions you do not want to answer, and your child does not have to eat any foods that he/she does not want to eat. Refusal to take part in or withdrawing from this study will involve no penalty or loss of benefits you would receive otherwise.

10. **Injury Clause:** In the unlikely event you or your child become injured as a result of your participation in this study, medical care is available but neither financial compensation nor free medical treatment is provided. By signing this document, you are not waiving any rights that you or your child have against The Pennsylvania State University for injury resulting from negligence of the University or its investigators.

You must be 18 years of age or older to take part in this study. If you agree to take part in this research study and to allow your child to take part in the study as well, please sign your name and indicate the date below.

You will be given a copy of this signed and dated consent for your records.

I give permission for my child, __________________________, to participate in this research project.
(Please print name of child)

____________________________________________  __________________________________
Parent Signature                                  Date

____________________________________________  __________________________________
Person Obtaining Consent                          Date
Appendix R

Parent Letter

Study 3
Thank you for enrolling your child, [NAME] in the Children’s Vegetable Intake Study.

[NAME] will be participating with other children from his class and Iguana Garden starting this Wednesday, January 27. Would you like [NAME] to have dinner at 5:15 or 5:45?

Also, does [NAME] have other siblings at the Bennett Family Center that you would like to have dinner with him? If so, what is their name and classroom?

To help parents remember study days, we would like to email you weekly reminders. If you are willing to receive emails from us, please give us the best email address to contact you.

Thank you!
Maureen Spill and Jennifer Meengs from the Food Lab

Dinner time: ______________
Siblings name & classroom: _________________
Email address: ______________
(Please fill out and return to ‘Children’s Vegetable Intake’ envelope or email info to mks148@psu.edu)
Appendix S

Parent Email Reminders

Study 3
Hello Parent,

This is a friendly reminder that your child is enrolled in the ‘Children’s Vegetable Intake’ study starting tomorrow at the Bennett Center!

When you pick up your child tonight there will be a breakfast bar in your child’s cubby. In the morning before school you are welcome to provide that to your child if (s)he is hungry. Please return any uneaten food as well as the wrapper to the box labeled ‘Children’s Vegetable Study’ at the front desk.

Breakfast, lunch, and afternoon snack will be served at the normal times.

You child is scheduled to have dinner at **5:15 pm** at the center. Please pick your child up approximately 30 minutes after this time. When you pick your child up, we will provide a small cooler containing cheese, crackers, fruit and milk. **Please provide only these snacks to your child for the remainder of the day.**

**Please return all uneaten foods and beverages as well as wrappers and containers in the box labeled ‘Children’s Vegetable Study’ that will be in front of Sandy’s desk the next morning.**

Since this study is different to the routine your child is accustomed to, you may want to talk to your child and remind them that they will be eating dinner at the center with other children.

Thank you! Your participation is very important to us.
Maureen Spill and Jennifer Meengs

**FOLLOWING WEEKS:**

Hello Parent,

This is a friendly reminder that when you pick up your child tonight there will be a breakfast bar in your child’s cubby. In the morning before school you are welcome to provide that to your child if (s)he is hungry.

You child is scheduled to have dinner at **5:15 pm**. Please pick your child up approximately 30 minutes after this time. Evening snacks and milk will be given to you when you pick your child up. **Please provide only these snacks to your child for the remainder of the day.**

**Please return all uneaten foods and beverages as well as wrappers and containers in the box labeled ‘Children’s Vegetable Study’ that will be in front of Sandy’s desk the next morning.**

Thank you! Your participation is very important to us.

Maureen Spill and Jennifer Meengs
Appendix T

Parent Breakfast Instructions

Study 3
Tonight your child will be taking home a Nutrigrain bar to be provided as a breakfast snack if (s)he is hungry in the morning.

- **Other than water**, please do not allow your child to eat or drink anything other than the provided snack.
- Please do not try to influence your child’s food and drink consumption, but allow your child to eat and drink as much or as little of the provided foods and beverages as they would like to consume.
- Remember that the foods and beverages are **for the study participant only**.
- Please **return left over foods and wrappers** to your child’s child care facility in the morning. There will be a box in the lobby to place these in.

Thank you!
Maureen Spill and Jennifer Meengs
Appendix U

Parent Evening Snack Instructions

Study 3
Tonight your child will be taking home evening snacks.

- *Other than water*, please do not allow your child to eat or drink anything other than the provided snacks.
- Chicken noodle casserole (in Rubbermaid container) should be heated thoroughly to an internal temperature should reach 165°F before serving.
- Please do not try to influence your child’s food and drink consumption, but allow your child to eat and drink as much or as little of the provided foods and beverages as they would like to consume.
- Remember that the foods and beverages are for the study participant only (unless marked ‘sibling’).
- If you remove the foods from the containers, please make sure to return any uneaten foods to their original containers.
- Please return left over foods and beverages in their containers along with any wrappers to your child’s child care facility in the morning. There will be a box in the lobby to place these in.

Again, we really appreciate your participation!
Maureen Spill and Jennifer Meengs

**All perishable food items should be refrigerated as soon as possible or within 2 hours.**

PLEASE MAKE SURE TO RETURN:

- Uneaten entrée
- Entrée container & lid
- Uneaten cheese
- Cheese wrapper
- Uneaten crackers
- Cracker bag
- Uneaten peaches
- Peach cup & lid
- Unconsumed milk
- Milk container & lid

THANK YOU!
Appendix V

Compensation Request Form

Study 3
Dear Parent,
Please complete the following questionnaire and return it to the envelope in the lobby called “Children’s Vegetable Intake”. Once the study is completed and your questionnaire is received, we will place a $50 gift card (to the venue of your choice) in your child’s cubbie.
Thank you so very much for participating in our study. If you have any questions or comments at any time please feel free to contact us in the Nutrition Food Lab at 863-8481.
Thank you,
Maureen Spill and Jennifer Meengs

PLEASE SELECT YOUR GIFT CERTIFICATE PREFERENCE:

O Giant
O Target
O Lowes
O Barnes & Nobles
O Walmart
Appendix W

Demographic/Background Information Questionnaire – Cover Letter

Study 3
October 2009

Dear Parents,

Thank you very much for participating in our study! We have made a copy of your signed consent form for your records. We have also given you a questionnaire to complete about yourself and your child. Since most of our research focuses on mothers, these questionnaires should be completed by the mother of the study participant. If the mother is unavailable or is not the primary person in charge of making meals for the child, then please have the person with this responsibility fill out both questionnaires instead. If the person filling out the questionnaires is not the mother of the child, please cross out the word “mothers” and write the person’s relationship to the child at the top of each questionnaire. Some of you may have more than one child participating in our study. We would like you to fill out a set of questionnaires for each child participating in the study. If you are completing multiple sets of questionnaires, please keep one child in mind for each set of questionnaires that you complete. We ask that you complete the questionnaires at your convenience and that you return them to the envelope labeled “Children’s Eating Behavior” at the front desk. We will frequently check the envelopes and leave gift cards for the parents who return the questionnaires in your child’s cubby.

Again, we really appreciate your participation! If you have any questions, please do not hesitate to call us! The telephone number is 863-8482. Thank you!

Sincerely,

Jennifer Meengs and Maureen Spill
Appendix X

Demographic/Background Information

Study 3
Demographic/Background Information

*Parent*, please complete this questionnaire and return it to the red “Children’s Eating Behavior” envelope in the lobby. Thank you!

What is your child’s date of birth?


Please indicate who lives in your household, and if applicable how many (i.e. siblings 2)?

Mother _____  Grandmothers ____
Father _____  Grandfathers ____
Siblings _____  Aunts ____
Uncles _____  Cousins ____
Other _____

What is your marital status:

___Married  ___Single  ___Widowed  ___Divorced
___Separated  ___Remarried  ___Living together (not married)

What is your total or combined family income, before taxes?

___Less than $20,000
___$21,000 - $35,000
___$36,000 - $50,000
___$51,000-$75,000
___$76,000-$100,000
___$100,000+

What is the highest level of formal education for:

**MOM**

___High school (12 yrs)
___Associate (14 yrs)
___Technical/Vocational School (14 yrs)
___Bachelors (16 yrs)
___Masters (18 yrs)
___PhD (20 yrs)
___MD (20 yrs)
___JD (20 yrs)
___Other, describe____________

**DAD**

___High school (12 yrs)
___Associate (14 yrs)
___Technical/Vocational School (14 yrs)
___Bachelors (16 yrs)
___Masters (18 yrs)
___PhD (20 yrs)
___MD (20 yrs)
___JD (20 yrs)
___Other, describe____________
Are you currently employed?

MOM
- No
- Yes

DAD
- No
- Yes

_____ Hrs per week at work
(not traveling to & from)

On average, how frequently does your family eat-out or get take-out for dinner?

1) once a month or less
2) twice a month
3) once a week
4) two times a week
5) three times week
6) four or more times a week

On average, how many nights a week does your family eat dinner together as a group (with most family members)?

_____ nights

Is your child on any medications?

If YES, please specify ____________________________________________________

Does your child have any food allergies?

If YES, how does this affect his/her diet? ______________________________________

Does your child suffer from lactose intolerance?

If YES, how does this affect his/her diet? ______________________________________

Does your child have a special diet (anything that will affect what he/she can eat)?

If YES, please specify ____________________________________________________

Has your child had any major illnesses?

If YES, please describe ____________________________________________________
What ethnicity is your child (please check only one)?
Hispanic or Latino _____
Not Hispanic or Latino _____

What race is your child (please check only one)?
American Indian/Alaskan Native _____
Asian _____
Black or African American _____
White _____
Hawaiian/Pacific Islander _____

What is MOTHER’S (parent/guardian; not child) weight (in pounds)? ______________

What is MOTHER’S (parent/guardian; not child) height (in inches)? ______________

What is FATHER’S (parent/guardian; not child) weight (in pounds)? ______________

What is FATHER’S (parent/guardian; not child) height (in inches)? ______________
Appendix Y

Breakfast Script

Study 3
Children’s Eating Behavior

“Okay, today is restaurant day! We are going to pretend that we are in a restaurant today and everyone will be served meals at the table. Before we get started I wanted to let you know what we’re having for breakfast today. For breakfast today we’re having ...... You can eat as much as you want, or as little as you want. Anything that you don’t eat, you can leave on your plate. Since it is restaurant day we are not going to be using the buckets after breakfast. Since everybody has their own food, you don’t need to share. Okay?!”
Appendix Z

Lunch Script

Study 3
Children’s Eating Behavior

“Okay, today is restaurant day! We are going to pretend that we are in a restaurant today and everyone will be served meals at the table. Before we get started I wanted to let you know what we’re having for lunch today. For lunch today we’re having….. You can eat as much as you want, or as little as you want. Anything that you don’t eat, you can leave on your plate. Since it is restaurant day we are not going to be using the buckets after lunch. Since everybody has their own food, you don’t need to share. Okay?!”
Appendix AA

Afternoon Snack Script

Study 3
Children’s Eating Behavior

“Okay, today is restaurant day! We are going to pretend that we are in a restaurant today and everyone will be served meals at the table. Before we get started I wanted to let you know what we’re having for snack today. For snack today we’re having...... You can eat as much as you want, or as little as you want. Anything that you don’t eat, you can leave on your plate. Since it is restaurant day we are not going to be using the buckets after snack. Since everybody has their own food, you don’t need to share. Okay?!”
Appendix BB

Dinner Script

Study 3
“Okay, today is restaurant day! We are going to pretend that we are in a restaurant today and everyone will be served meals at the table. Before we get started I wanted to let you know what we’re having for dinner today. For dinner today we’re having….. You can eat as much as you want, or as little as you want. Anything that you don’t eat, you can leave on your plate. Since it is restaurant day we are not going to be using the buckets after dinner. Since everybody has their own food, you don’t need to share. Okay?!”
Appendix CC

Intake Sheets

Study 3
<table>
<thead>
<tr>
<th>Breakfast Snack Food</th>
<th>Pre-Weight</th>
<th>Post-Weight</th>
<th>Amt Consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutrigrain Bar (1)</td>
<td>with wrapper</td>
<td>with wrapper</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Breakfast Food</th>
<th>Pre-Weight</th>
<th>Post-Weight</th>
<th>Amt Consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zucchini Bread (4 pcs, 120g)</td>
<td>w/o plate</td>
<td>with plate</td>
<td>with plate</td>
</tr>
<tr>
<td>Mandarin Oranges (150 g)</td>
<td>w/o bowl &amp; lid</td>
<td>with bowl &amp; lid</td>
<td>with bowl &amp; lid</td>
</tr>
<tr>
<td>1% Milk (236 mL)</td>
<td>with carton</td>
<td></td>
<td>with carton</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lunch Food</th>
<th>Pre-Weight</th>
<th>Post-Weight</th>
<th>Amt Consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pasta Bake (300 g)</td>
<td>w/o plate</td>
<td>with plate</td>
<td>with plate</td>
</tr>
<tr>
<td>Broccoli (60 g)</td>
<td>w/o bowl</td>
<td>with bowl</td>
<td>with bowl</td>
</tr>
<tr>
<td>Applesauce (150 g)</td>
<td>w/o bowl &amp; lid</td>
<td>with bowl &amp; lid</td>
<td>with bowl &amp; lid</td>
</tr>
<tr>
<td>1% Milk (236 mL)</td>
<td>with carton</td>
<td></td>
<td>with carton</td>
</tr>
<tr>
<td>Afternoon Snack Food</td>
<td>Pre-Weight</td>
<td>Post-Weight</td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>Nutrigrain Bar (1)</td>
<td>with wrapper</td>
<td>with wrapper</td>
<td></td>
</tr>
<tr>
<td>Bottled Water (1)</td>
<td>with bottle &amp; lid</td>
<td>with bottle &amp; lid</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dinner Food</th>
<th>Pre-Weight</th>
<th>Post-Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicken Noodle Cass (300 g)</td>
<td>w/o plate</td>
<td>with plate</td>
</tr>
<tr>
<td>Green Beans (60 g)</td>
<td>w/o bowl</td>
<td>with bowl</td>
</tr>
<tr>
<td>Pears (150 g)</td>
<td>w/o bowl &amp; lid</td>
<td>with bowl &amp; lid</td>
</tr>
<tr>
<td>1% Milk (236mL)</td>
<td>with carton</td>
<td>with carton</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evening Snack Food</th>
<th>Pre-Weight</th>
<th>Post-Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorrento String Cheese (1)</td>
<td>with wrapper</td>
<td>with wrapper</td>
</tr>
<tr>
<td>Keebler Snack Sticks (12)</td>
<td>w/o bag</td>
<td>with bag</td>
</tr>
<tr>
<td>Peaches (150 g)</td>
<td>w/o bowl &amp; lid</td>
<td>with bowl &amp; lid</td>
</tr>
<tr>
<td>1% Milk (236mL)</td>
<td>with carton</td>
<td>with carton</td>
</tr>
<tr>
<td>Chicken Noodle Cass (200 g)</td>
<td>w/o bowl &amp; lid</td>
<td>with bowl &amp; lid</td>
</tr>
</tbody>
</table>
**VITA: Maureen K. Spill**

**Education**

2011  Ph.D. Nutritional Sciences, The Pennsylvania State University, University Park, PA
2002  M.S. Food Science/Sensory Evaluation, University of California – Davis, Davis, CA
2000  B.S. Food Science, The Pennsylvania State University, University Park, PA

**Publications**

**Original Research:**


Spill, MK, Birch, LL, Roe, LS, and Rolls, BJ. Serving large portions of vegetable soup at the start of a meal affected children’s energy and vegetable intake. *Appetite.* Accepted for publication.

Spill, MK, Birch, LL, Roe, LS, and Rolls, BJ. Hiding vegetables to reduce energy density: an effective strategy to increase children’s vegetable intake and reduce energy intake. Submitted.

**Published Abstracts:**


**Presentations**

April 2011: Covertly incorporating vegetables into foods increased children’s vegetable intake and decreased energy intake. Oral presentation, Experimental Biology, ASN Clinical Emerging Leader Finalist Oral Competition. Washington, D.C.

March 2011: Covertly incorporating vegetables into foods increased children’s vegetable intake and decreased calorie intake. Poster presentation, The Pennsylvania State University Graduate Student Exhibition. University Park, PA.


