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Increasing Knowledge and Consumption of Fruits and Vegetables in Children: Does the Type of Exposure Matter?

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Increasing Knowledge and Consumption of Fruits and Vegetables in Children: 
Does the Type of Exposure Matter?

A thesis submitted in partial fulfillment of the requirement 
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by 
Chelsea Leigh Osborne

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Increasing Knowledge and Consumption of Fruits and Vegetables in Children:

Does the Type of Exposure Matter?

Chelsea Osborne

Advisor: Dr. Catherine Forestell

The College of William and Mary
There are many people I would like to thank for providing me with assistance and encouragement throughout the entire course of my project. First, I would like to thank my research advisor, Dr. Catherine Forestell, for her guidance. I truly appreciate all her direction, support, and dedication over the past year. I would also like to thank the lab members of the Eating Behavior and Child Development Center for lending me a hand from the very beginning of the study, most especially Kristin Reardon, Sarah Brooks, and Kelsey Otton for helping run participants and providing assistance in any way possible. I sincerely appreciate all the hard work these people put into my project, which could not have been completed without them! Finally, I would like to thank Dr. Danielle Dallaire and Dr. Erica Jackson for offering to be a part of my defense committee, as well as all the mothers and children who participated in this study.
Abstract

This study sought to determine how an eight-day home exposure to health information and/or a variety of fruits and vegetables would affect 4- to 8-year-old children’s knowledge about and willingness to try healthy foods. Using a 2 x 2 x 2 mixed design, 40 children were randomly assigned to one of four treatment groups, which differed according to the type of home exposure they received. Half of the children were sent home with books about healthy eating (Book Group), while the remaining children did not receive books (No Book Group). These groups were further broken down according to whether they received a variety of healthy foods to try at home (Food Group) or not (No Food Group). Before and after the home exposure period, children’s knowledge of these foods was tested in a laboratory setting using simple card games, in which children were asked to identify and categorize pictures of various foods. This was followed by a buffet task, which measured their willingness to eat a range of foods. Mothers reported on their children’s neophobia and daily food consumption in order to determine how these constructs affected children’s responses to the foods over the course of the experiment. Results indicated that, overall, children who were more food neophobic consumed less healthy foods at home, were less knowledgeable about healthy foods, and were less likely to try and to consume the foods presented during the buffet before and after the home exposure. Children who were exposed to information generally increased their knowledge but not their consumption of the healthy foods, while those who were exposed to food over the home exposure period were less likely to try and to consume novel foods in the buffet. These findings demonstrate the challenges involved in enhancing children’s fruit and vegetable consumption and highlight the need for research to investigate the
efficacy of intervention strategies that promote healthy eating in young children.
Increasing Knowledge and Consumption of Fruits and Vegetables in Children:

Does the Type of Exposure Matter?

Intake of fruits and vegetables is associated with a decreased risk for respiratory symptoms, type 2 diabetes, obesity, stroke, cardiovascular disease, and certain types of adulthood cancer (Antova et al., 2003; Maynard, Gunnell, Emmett, Frankel, & Smith, 2003). Therefore, from a public health standpoint, it is a priority to encourage a diet rich in fruits and vegetables. In the *Dietary Guidelines for Americans 2005*, the United States Department of Agriculture (USDA) recommended between 2.5 to 6.5 cups of fruits and vegetables per day, equivalent to five to 13 servings, based on diets ranging from 1,200 to 3,200 calories (2005). Despite these recommendations, however, most adults’ and children’s diets are deficient in the amounts of fruits and vegetables consumed.

In 1998, the national average of fruit, juice, and vegetables consumed among two- to five-year-olds was 2.2 servings, which is significantly less than the five recommended servings for a 1,200 calorie diet (Dennison, Rockwell, & Baker, 2001; USDA, 1995). In 2004, the Feeding Infants and Toddlers Study, sponsored by the Gerber Products Company to report on the eating habits of more than 3,000 American infants and toddlers, found that children were not consuming sufficient amounts of fruits (23% to 33% consumed no fruits) and vegetables (18% to 33% consumed no vegetables), and a substantial amount of children did not consume any fruits or vegetables on a single day (Fox, Pac, Devaney, & Jankowski, 2004). Among 15- to 18-month-old children, french fries were the most commonly eaten vegetable, and many children were consuming sweet or fatty snack foods. Although many believe that these dietary habits are specific to
Americans, similar results have been reported in Europe. For example, a British study found that more than 72% of adults and 69% of two- to six-year-old children ate one or less fruit or vegetable per day, with boys consuming less than girls (Wardle, Carnell, & Cooke, 2005).

As a result of these unhealthy eating habits, many more children and adults are struggling with obesity. Between 1976 and 2000, and especially after 1990, the prevalence of overweight for two- to five-year-old children increased from 5% to more than 10% (Ogden, Flegal, Carroll, & Johnson, 2002). Similarly, Jahns, Siega-Riz, and Popkin report that the prevalence of overweight has grown among children from 8% to 14% and among adolescents from 6% to 12% between 1976 and 1994 (2001). Children younger than three-years-old are especially at risk of becoming overweight if they have at least one obese parent (Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). This is alarming because children who are obese tend to become obese adults, thereby increasing the risk of adult morbidity and mortality (Guo & Chumlea, 1999; Must, Jacques, Dallal, Bajema, & Dietz, 1992). An overweight three-year-old child is almost eight times as likely to become an overweight young adult as a normal weight peer (Whitaker et al., 1997).

Because eating fruits and vegetables has a protective effect against adulthood obesity, healthy eating strategies have targeted methods to increase the amounts of fruits and vegetables consumed. In order to effectively increase fruit and vegetable servings, researchers must understand the factors that influence the development of flavor preferences and effective methods to encourage children to try new foods. It is especially important to target eating behaviors early because research suggests that childhood eating habits continue into adulthood (Kelder, Perry, Klepp, & Lytle, 1994; Singer, Moore,
Garrahie, & Ellison, 1995). In a six year study of 95 children, Singer et al. found that the number of nutrients children consumed when they were three to four years of age correlated with nutrient consumption at seven to eight years.

When we consider our evolutionary history, it is perhaps not surprising that children have a natural predisposition to prefer sweet-tasting, high calorie foods, while avoiding more healthful choices, which are sometimes bitter-tasting. It is hypothesized that these preferences for sweet tastes evolved to draw children to energy-dense foods, whereas bitter and sour taste rejection functions to discourage consumption of toxins (Desor, Maller, & Greene, 1977; Kaijura, Cowart, & Beauchamp, 1992). As a result, infants are born with a genetic predisposition to prefer sweet tastes and to avoid bitter tastes. This has been demonstrated in infants soon after birth by Rosenstein and Oster (1988), who found that newborn infants were not only able to distinguish between various taste solutions by showing differential facial expressions, but they also displayed a preference for sweet tastes and a rejection of bitter and sour tastes. Although children’s hedonic responses to these basic tastes become more tempered over time (e.g., Beauchamp, Cowart, Mennella, & Marsh, 1994), they generally continue to prefer sweet, fatty, and starchy foods over more healthful foods such as vegetables and fruits (Cooke & Wardle, 2005).

Prenatal and Postnatal Influences on Flavor Preference Development

Though genetics plays an important role in determining infants’ hedonic responses and their development throughout childhood, the environment and the culture in which the child lives also affect flavor preference development. Research has shown that infants may be exposed to the flavors of their culture even before birth through their
amniotic fluid. For example, the odor of garlic has been detected in the amniotic fluid of women consuming oil of garlic capsules (Mennella, Johnson, & Beauchamp, 1995), and the smells of cumin and curry have been distinguished in the amniotic fluid of women consuming spicy food (Hauser, Chitayat, Berns, Bauer, & Muhlbauer, 1985). Research suggests that these early flavor exposures may influence postnatal flavor preferences. This has been demonstrated in an experimental study in which mothers were asked to consume either carrot juice or water each day for three weeks during their last trimester of pregnancy. Mennella, Jagnow, and Beauchamp found that infants who had been exposed to the flavor of carrots in utero displayed fewer negative facial responses to cereal prepared with carrot juice than did the infants whose mothers drank water (2001).

Early exposures to the flavors within the mother’s diet continue if the mother decides to breastfeed her infant. Like amniotic fluid, odors from the mothers’ diets are transmitted to their breast milk. This has been demonstrated in studies in which adult sensory panels could detect the smells of garlic, alcohol, and vanilla in the breast milk of mothers who had consumed these flavors (Mennella & Beauchamp, 1991a, 1991b, 1996). Mennella et al. further showed that when mothers consumed carrot juice each day for two weeks during the first two months of lactation (2001), their infants displayed fewer negative facial reactions to carrot-flavored cereal relative to plain cereal. No such preference was shown by infants whose mothers consumed water instead of carrot juice.

Early exposure to the varying flavors in mothers’ breast milk may serve to facilitate breastfed infants’ acceptance of the flavors of their culture and may even encourage the acceptance of new foods relative to bottle-fed infants. Forestell and Mennella (2007) found that breastfed infants who were introduced to a fruit for the first
time ate more of this food than infants who were bottle-fed, and the amount consumed by the breastfed infants correlated with their mother’s fruit consumption. Interestingly, this finding did not extend to a bitter green vegetable, possibly because all of the mothers reported consuming green vegetables infrequently. Compared to bottle-fed infants, who experience a constant set of flavors from milk-based formulas, breastfed infants experience a wide range of constantly changing flavors that are revered by their culture.

The culturally distinct combinations that characterize foods from different cultures, such as the flavors of olive oil, garlic, and tomato that characterize Italian food, have been defined as “flavor principles” by E. Rozin (1973). Although children learn about the flavor principles of their cultures in various ways, socialization within the family may be one of the primary influences of food preferences and eating habits once children begin eating solid food. Stafleu, Van Staveren, de Graaf, Burema, and Hautvast gathered data about beliefs and eating habits for 97 adult women, their mothers, and their grandmothers and found significant correlations between mother-daughter pairs, but no relation between grandmothers and granddaughters. There was a correlation of 0.17 for the younger and middle generations, which was higher than the correlation between the older and middle generations, possibly because the younger two generations had spent less time living apart from one another. This correlation matches the 0.17 correlation found by Borah-Giddens and Falciglia between parents’ and children’s food preferences (1993). Additionally, parents who talk about healthy eating instill greater nutritional knowledge in their children (Anliker, Laus, Samonds, & Beal, 1990). Simply being exposed to the eating habits and behaviors of family has lasting effects on children’s food
preferences and habits. These early flavor experiences serve to lay the foundation for children’s later eating behaviors (Skinner, Carruth, Bounds, & Ziegler, 2002).

**Barriers to Healthy Eating in Childhood**

Despite children’s early experiences with the flavors of their culture, there are several barriers that impede their acceptance of new foods and that hinder their consumption of healthy foods, especially fruits and vegetables. Skinner et al. found that although the number of foods children tried increased between two- to eight-years of age, the number of foods that they liked did not change significantly during this same time period (2002). Instead, the number of foods disliked increased significantly. During this period of development, children naturally display symptoms of food neophobia (literally, fear of novel foods), which rises dramatically around two-years-old and begins to decrease with age (Cashdan, 1994; Nicklaus, Boggio, Chabanet, & Issanchou, 2005). P. Rozin (1976) described neophobia as part of the “Omnivore’s Dilemma,” explaining that while humans show interest in new foods and desire to expand the variety in their diets, they also show a reluctance to try new foods, possibly because of fear of poisoning, which may subsequently lead to nutritional deficiencies. Similarly, the learned safety hypothesis claims that rejection of novel food results from a fear of bodily harm (Kalat & E. Rozin, 1973).

High levels of neophobia tend to be associated with lower frequency of consumption of fruits and vegetables, but not sweet, fatty, or starchy foods (Cooke, Wardle, & Gibson, 2003; Pelchat & Pliner, 1995). Wardle et al. indicated that neophobia accounts for 5.5% of the variance in children’s fruit and vegetable consumption, more strongly predicting boys’ consumption than girls’ (2005). In a study of 546 mothers of
two- to six-year-old children in which researchers questioned mothers about their feeding practices and their children’s eating behaviors, Cooke et al. found that higher levels of neophobia among children predicted lower consumption of fruit, vegetables, and meat, but not sweet and fatty snack foods or carbohydrate-dense foods (2003). These findings are consistent with the belief that neophobia evolved to be protective against poisoning because many plant and animal products frequently cause food poisoning. Similar results were found in a study of 109 parents of four- to five-year-old children (Cooke, Carnell, & Wardle, 2006). High levels of neophobia also predict the variety of foods served in children’s diets, with fewer uncommon foods eaten and fewer foods tried (Koivisto & Sjoden, 1996). Koivisto and Sjoden found that children were more neophobic than their parents, but there was a marked decrease in the level of neophobia at 14- to 15-years-old. Additionally, high neophobia is associated with fewer foods liked and more foods disliked, as well as fewer calories eaten than less neophobic peers (Cooke et al., 2006; Skinner et al., 2002). In summary, neophobia is a major determinant of flavor preferences because it prevents people, especially children, from experiencing new foods.

Another barrier to acceptance of fruits and vegetables is picky/fussy eating, which is described as a tendency to consume a smaller variety of foods than non-picky eaters and to reject many familiar foods despite repeated exposure (Birch, Johnson, Andresen, Peters, & Schulte, 1991; Carruth et al., 1998). Other researchers describe picky/fussy eating as intake of an insufficient amount of food (Rydell, Dahl, & Sundelin, 1995).

While neophobia may be a component of picky/fussy eating, picky/fussy eating is not a component of neophobia (Pelchat & Pliner, 1986). Picky/fussy eaters continue to reject familiar foods, no matter how many times the foods are exposed to them;
neophobic children, conversely, may initially reject a food but then may accept the food after a certain number of exposures. Picky/fussy eating is not as well understood as neophobia, yet some researchers consider picky/fussy eaters as more problematic than neophobic children because picky/fussy eaters do not consume nutritious diets and do not respond well to interventions (Dovey, Staples, Gibson, & Halford, 2008).

Part of the difficulty of researching this construct is that no reliable questionnaire for measuring picky/fussy eating has been created, and therefore measurement of this construct relies on maternal reports of their children’s daily intake. These studies have found that for three- to five-year-old children, most especially boys, pickiness predicted consumption of fewer foods, especially vegetables (Galloway, Lee, & Birch, 2003; Jacobi, Agras, Bryson, & Hammer, 2003). Galloway, Fiorito, Francis, and Birch note that picky/fussy children also consumed fewer vitamins, folate, and fiber than other children, probably because of their inadequate consumption of fruits and vegetables (2005). Furthermore, Marchi and Cohen found that although picky/fussy eaters tend to have lower BMIs than their peers, they are typically not underweight (1990).

**Strategies to Increase Fruit and Vegetable Consumption**

As discussed above, children are not consuming adequate amounts of fruits and vegetables due to their genetic taste predispositions and barriers like food neophobia. In an attempt to promote children’s fruit and vegetable intake, parents often resort to various strategies to improve their children’s eating behaviors. As will be described below, research shows that the effectiveness of these strategies is mixed.

**Rewards.** While offering rewards for eating novel foods is a common parenting technique, it may actually have unintended effects. Birch et al. assert that while offering
rewards may encourage children to eat more of a food, the rewards teach children to like
the food less (1982). In a study of 49 five- to seven-year-old children, researchers
compared the effects of exposure to exposure plus rewards (Wardle, Herrera, Cooke, &
Gibson, 2003b). Researchers offered children sweet red pepper and invited them to eat as
much as they wanted and to rate how much they liked it. For eight days, researchers
continued to offer the children the red pepper, offering them a sticker for at least one
piece eaten in the reward condition. Researchers found that there was a significant
increase in liking only for the exposure group. There was also significant increase in
consumption for both groups, with the exposure group consuming significantly more than
the reward group. Overall, Wardle et al. found that the reward condition had
intermediate effects, somewhat limiting the effect of the exposure. Nevertheless, the
children ate more than the amount required for the reward and did not decrease in their
liking for the pepper, indicating that while exposure is more effective overall, reward
may be useful in encouraging a child to overcome initial food neophobia.

Preparation method. Another common parenting technique used to increase
children’s acceptance of foods is to vary preparation. Stallberg-White and Pliner
employed a flavor principle construct to see if combining novel foods with familiar and
palatable sauces would increase willingness to try novel foods (1999). Sixty-four
undergraduate students rated their willingness to try four food/sauce combinations (novel
or familiar foods, sauce or no sauce), which they were under the impression would guide
which foods they would actually try. Researchers found that adding a sauce to an
unfamiliar food increased willingness to taste it, but adding sauce to a familiar food had
no effect or decreased willingness to taste it, possibly because of combinatorial
inappropriateness. Varying preparation style may be useful in developing methods to
soften the bitter taste of vegetables and make them more palatable.

**Information.** While many programs focus on increasing knowledge of healthy
eating and changing attitudes about healthy foods, they generally have not resulted in
increased liking or consumption of these foods (Domel et al., 1993). Other data indicate
that children are more concerned about how their foods taste rather than how healthy they
are, and research has found that although children can understand the connection of
nutrition to health by the sixth grade, they are generally not concerned about their health
(Wellman & Johnson, 1982). Additionally, there is evidence that adults and children
believe that healthy foods are unpalatable (Wardle & Huon, 2000). Wardle and Huon
conducted a study of 40 nine- to 11-year-old children and found that a drink labeled as
healthy was liked significantly less than the same drink not labeled as healthy.
Additionally, children stated they would be less likely to ask their parents to buy the
healthy labeled drink (2000). Strategies to increase consumption of fruits and vegetables
should take this into consideration when encouraging children to consume healthy foods.

Researchers have also learned that providing taste information rather than
nutritional information can increase the chances of trying a novel food (Pelchat & Pliner,
1995). Forty-one three- to five-year-old children and 40 six- to eight-year-old children
were shown either kasha (buckwheat groats) or gjetost (smoked Norwegian goat’s milk
cheese), and they were either asked, “Would you like to try it?” or “Would you like to try
it? It tastes good.” There was an interaction with food and condition, with children more
willing to try the kasha when offered information about taste and the gjetost when not
offered taste information. Researchers suppose that this was because gjetost looks
somewhat like candy, and perhaps the children were suspicious when encouraged to eat it because of taste. Nevertheless, these results indicate that information can be used to increase willingness to consume novel foods.

Pelchat and Pliner (1995) expanded these results into two more studies with high school and college students. They found that providing taste information consistently increased willingness to consume and the overall intake of novel foods. Although providing nutrition information seemed to somewhat increase willingness to try and consumption of novel foods, it did not reach statistical significance, possibly because people tend to associate healthy foods with bad taste (Wardle & Huon, 2000). These results indicate that children and adolescents are generally not convinced to eat new foods based on learning health information, but are more convinced based on learning about taste information.

Food exposure (looking vs. tasting). Zajonc first proposed the mere exposure hypothesis, which claims that exposure to a novel stimulus, whether a food or a non-food, is adequate to increase liking for that novel stimulus (2001). In a study by Birch, McPhee, Shoba, Pirok, and Steinberg, children were exposed to novel foods over a 30 day exposure period in either “taste” or “look” trials (1987). During look trials, children were able to look at and smell the foods. The taste trials involved both visual and olfactory input in addition to taste. Foods were exposed to the children five, 10, or 15 times. Birch et al. found that the taste exposures were significantly more effective than the look exposures at increasing preference, regardless of whether the children were judging visual or taste dimensions. These findings demonstrate that to increase taste preference, children must not only look at the novel food but must also taste it.
In a similar study of 156 two- to six-year-old children, Wardle et al. compared the effects of two treatment groups (exposure and information) on children’s liking for a disliked vegetable (2003a). In the information condition, parents were given recommendations about increasing their children’s fruit and vegetable consumption, and in the exposure condition, parents offered their children a taste of the disliked vegetable for 14 days. Daily exposure to the vegetable actually significantly increased liking and consumption of that vegetable more than the information condition. In fact, no children in the exposure condition decreased liking for the vegetable relative to 15% of the information condition, and almost 30% of the exposure group picked their vegetable as the most liked out of six vegetables during a post-exposure ranking, compared to only 2% of the information group. Follow-up with the parents indicated that the intervention seemed to be lasting and even generalized to willingness to try other foods and attempts to eat more healthily. These results demonstrate that if parents are patient enough and willing to repeatedly expose their children to healthy foods, children’s liking and consumption of these foods will increase.

Exposure (variety). Another strategy to increase acceptance of novel foods involves exposure to a variety of flavors. In a study by Gerrish and Mennella (2001) infants were fed either a target vegetable or a variety of vegetables for nine days. Both exposure groups increased their consumption of the target vegetable after the home exposure, with no significant differences between groups. However, infants exposed to a variety of vegetables consumed significantly more of a novel food compared to the infants exposed only to the target vegetable. Mennella, Nicklaus, Jagolino, and Yourshaw (2008) extended these findings by showing that to exposure to a variety of
fruits, also resulted in greater consumption of a target fruit when compared to exposure only to one fruit. However, it is unknown whether these findings extend to older children.

The Present Study

The purpose of the present study was two-fold. First, we were interested in determining whether exposure to information about healthy eating and/or a variety of fruits and vegetables would affect children’s knowledge about and willingness to eat these foods. Before and after a home exposure period, children’s knowledge of these foods was tested in a laboratory setting using a simple card game in which children were asked to identify and categorize the pictures of various foods. Their willingness to eat healthful fruits and vegetables was also tested by offering these foods in the form of a “buffet.” Because previous research has shown that children need to try foods in order to enhance their liking (Birch et al., 1987; Pelchat & Pliner, 1995; Wardle et al, 2003a), we hypothesized that exposure to a variety of foods at home would increase children’s willingness to eat the foods in the buffet. Alternatively, we predicted that exposure to information about healthful foods and healthy eating would improve performance on the card game, but not consumption of the buffet foods. The second goal of the current study was to determine whether children’s food neophobia and the frequency with which they eat healthful foods at home affected their initial consumption (i.e., on Day 1) of the fruits and vegetables. We hypothesized that children’s neophobia would be negatively correlated with their knowledge about and their intake of fruits and vegetables.
Method

Participants

Mothers and their 4- to 8-year-old children (N = 40) were recruited. Mothers were recruited through ads placed in local newspapers, posted flyers, and mass mailings available throughout the general Tidewater area of Virginia, including Williamsburg, Hampton Roads, James City County, and other surrounding counties. Mothers were given twenty dollars for participating in the study.

During a telephone interview, mothers were told that we were recruiting participants for a 10-day-long study on the development of food and flavor preferences. We explained the general procedure to the mothers, but the mothers and children were unaware of the hypothesis of the study. Children with allergies to the foods in our study, children with medical conditions affecting their food intake, and children taking medication that suppressed their appetite were not eligible for participation. The ethnicity of the participants was 90.0% white and 10.0% black/other ethnicity. Mothers were well-educated, with 87.5% of mothers having at least college degrees. The College of William & Mary Protection of Human Subjects Committee approved all procedures, and informed consent was obtained from each mother.

Test Stimuli

Food cards. Children were presented with 22 different cards (approximately 13.5 cm x 11 cm in size) that had color pictures of healthy foods (fruits and vegetables), as well as unhealthy foods (see Appendix A). Cards with healthy foods depicted commonly eaten fruits (e.g., apple), less commonly eaten fruits (e.g., starfruit), commonly eaten vegetables (e.g., carrots), and less commonly eaten vegetables (e.g., Brussel sprouts).
Cards with unhealthy foods depicted foods derived from fruits or vegetables (e.g., French fries, apple pie). Cards were shuffled and presented in a random order. Only 15 participants viewed the card depicting broccoli, as it was added later in the study; the other 25 participants viewed a total of 21 cards.

**Buffet foods.** Children were presented with six foods during the buffet: apple, banana, orange, broccoli, baby carrots, and red pepper. The foods were held in individual clear rectangular plastic containers (approximately 13 cm x 7 cm x 7 cm) in two larger clear plastic bins with flip-up lids (approximately 38 cm x 13 cm x 10 cm), one for fruits and one for vegetables. The foods were presented raw, and all foods were presented in bite-site portions. Because each food was a different density, enough of each food was presented to fill the plastic containers halfway to three-fourths to the top. The foods were presented in a random order, and the placement of the bins in front of the children was counterbalanced. On Day 10, children were again presented with the original six foods, as well as two more novel fruits (papaya, kiwi, starfruit, or another exotic fruit) and two more novel vegetables (baby corn, snap peas, or water chestnuts). Children given food during the home exposure period were presented with one novel fruit and one novel vegetable which they brought home, as well as one completely novel fruit and one completely novel vegetable.

**Take home books.** Approximately half the children brought home two books about fruits and vegetables and healthy eating. The two books were *Eat Healthy, Feel Great* by William Sears, Martha Sears, and Christie Watts Kelly (1989) and *Eating the Alphabet* by Lois Ehlert (2002).
Take home foods. Approximately half the children brought home food. The children were randomly assigned to take home four fruits and four vegetables of the following foods, with the restriction that two of the fruits and two of the vegetables sent home were novel foods the children did not receive during the buffet on Day 1: apple, banana, orange, blueberries, pineapple, papaya, kiwi, baby carrots, broccoli, red pepper, cauliflower, celery, baby corn, and snap peas. The foods were sent home in clear quart-size plastic bags, and they were assigned in a random order, taking into account food expiration rates. Apples, oranges, bananas, and kiwis were sent home whole and uncut. All other foods were sent home in bite-size pieces.

Procedure

Mothers and children participated in a 10-day experimental study. Mothers brought their children for approximately one hour to the Eating Behavior and Child Development Center at the College of William & Mary on the day before (Day 1) and the day after (Day 10) an eight-day home exposure period. To minimize the effect of satiation, children did not eat for at least one hour before arriving. Following a brief acclimatization period to the testing room and to the researcher, informed consent was obtained from each mother. On Days 1 and 10, children participated in three tasks. In Task 1, children were presented with the food cards to determine their knowledge of the healthfulness and their liking of various foods. In Task 2, children were presented with only the healthy food cards to determine their knowledge of fruits and vegetables, as well as their experience with these foods. Finally, in Task 3, children were presented with fruits and vegetables and given the opportunity to taste them. On each of the test days,
mothers completed a variety of questionnaires about their eating habits and child feeding practices, as well as demographic information.

**Task 1: Identifying and categorizing healthy and unhealthy foods.** In the first card game, children were shown the food cards one at a time. They were asked to identify each of the foods and to indicate whether each food was healthy or unhealthy, including a justification for their answer. Children were then asked if they would like to eat each food and again to provide a justification (data not shown).

**Task 2: Categorizing fruits and vegetables.** In the second card game, the cards showing unhealthy foods were removed from the deck, and the cards were again shuffled. Children were shown the remaining healthy cards and were asked to indicate whether each food was a fruit or vegetable. They were then asked details about their experience with the foods (data not shown).

**Task 3: Food buffet.** At the end of the test session, children were presented with the food stimuli in the form of a buffet and were given the opportunity to taste them. Children’s willingness to taste the foods was measured through recording the number and amount of the foods they ingested.

**Home exposure period.** At the end of the first test session, the mother-child pairs were randomly assigned using a 2 x 2 between-subjects design into one of four groups that received exposure either to children’s books about healthy eating and/or to a variety of healthy foods. Mothers who received books were asked to read them to their children everyday over the eight-day home exposure period, alternating the books each day. Mothers who received food were asked to offer their children one food each day and to keep a log of the foods their children ate. If the children did not accept the food during
the first offer, mothers were instructed to try again later in the day. Mothers froze and returned the remaining food on Day 10.

**Mother Questionnaires**

*Mother Food Frequency Questionnaire.* Mothers were asked the frequency they ate 34 different fruits and vegetables (see Appendix B), including the foods depicted on the cards.

*Child Food Frequency Questionnaire.* Mothers were asked the frequency their children ate 31 different foods (see Appendix C), including the foods found on the cards.

**Neophobia.** All mothers completed a 10-item scale that measured their approach and avoidance of novel foods (see Appendix D), and an eight-item scale that measured general neophobia (see Appendix E; Pliner & Hobden, 1992). Mothers responded on a seven-point Likert scale from “extremely disagree” (1) to “extremely agree” (7). Scores ranged from 10 to 70 on the *Food Neophobia Scale (FNS).* Pliner and Hobden (1992) reported good internal consistency (Cronbach’s alpha coefficient of .88) and satisfactory test-retest reliability for this test. Scores ranged from 8 to 56 on the *General Neophobia Scale (GNS).* Pliner and Hobden (1992) reported Cronbach’s alpha coefficients of .78 and .88 for this test.

*Food-Craving Inventory (FCI).* This questionnaire (see Appendix F), developed by White, Whisenhunt, Williamson, Greenway, and Netemeyer (2002), assessed general and specific food cravings. Mothers rated the frequency that they craved 37 foods from four subscales (high fats, sweets, starches, and fast-food fats) over the previous month on a five-point Likert scale from “never” (1) to “always/almost everyday” (5). White et al.
Knowledge and Consumption

(2002) report high internal consistency (Cronbach’s alpha of .93) and test-retest reliability of .86 for this test.

Three-Factor Eating Questionnaire (TFEQ): Restraint Subscale. This 21-item subscale of the TFEQ (see Appendix G), developed by Stunkard and Messick (1985), measured cognitive restraint of eating to control weight. The first 12 questions are in true/false format. The next eight questions are rated on a four-point Likert scale, and the last question is rated on a six-point Likert scale. Higher scores indicate greater dietary restraint. Stunkard and Messick (1985) noted high internal consistency (Cronbach’s alpha efficient of .90) for the restraint subscale.

Child Eating Behavior Questionnaire (CEBQ). Mothers completed this 31-item questionnaire (see Appendix H), which contains six subscales that assess shyness, emotionality, sociability, negative reactions to foods, activity, and food neophobia in children (Pliner & Hobden, 1992; Pliner & Loewen, 1997). Mothers responded on a five-point Likert scale from “completely disagree” (1) to “completely agree” (5). Only the neophobia subscale, which was adapted from Pliner and Hobden’s FNS (1992), was analyzed in this study.

Statistical Analyses

For each child, we determined the percentage of cards which contained foods that were correctly identified, and correctly categorized as healthy or unhealthy. For the healthy cards, we additionally determined the percentage of foods that were correctly categorized as fruits or vegetables. We also determined children’s consumption of the fruits and vegetables that were presented in the buffet on both Day 1 and Day 10 (hereafter referred to as familiar foods).
To determine changes in children’s knowledge and their consumption in the familiar buffet foods we conducted separate three-way repeated Analyses of Variance (ANOVAs) with information (brought books home [Book Group] vs. did not bring books home [No Book Group]) and food (brought food home [Food Group] vs. did not bring food home [No Food Group]) as the between-subjects variables and time (Day1 vs. Day 10) as the repeated measure for each dependent variable.

For the novel foods presented on Day 10, we determined the percentage of children within each group who tried at least one of these foods and analyzed them using chi-square analyses. We then calculated their mean consumption of the novel foods and conducted a 2 x 2 between-subjects ANOVA with type of information and food exposure they received as independent variables. Because children in the Food Group had been exposed to two of the novel foods once during the home analyses we compared their consumption of the novel foods to the novel home exposure buffet foods as a function of whether they brought home books with a two-way mixed ANOVA.

Finally, we conducted correlational analyses to determine whether children’s knowledge of and responses to food correlated with their mothers’ and their own eating habits and their reports of food neophobia. All summary statistics are reported as mean ± SEM.

Results

Participant Characteristics

As shown in Table 1, the four groups of children (N = 40) were similar in age, BMI, and food neophobia, as reported by their mothers. Likewise, their mothers (N = 32) did not differ in their age, BMI, years of schooling, food craving and eating restraint
scores, or general neophobia. However, mothers of children in the No Book Group had significantly higher neophobia scores than mothers of the remaining children \((F(1, 39) = 5.02, p = .03)\). Although approximately 35% of the mothers in the current sample reported smoking in their lifetime, none were smokers at the time of the study.

*Frequency of Food Consumption and Neophobia of Mother and Child*

Mother’s reports of their frequency of fruit and vegetable consumption over the past six months indicated that they ate an average of 3.35 fruits and 3.36 vegetables per day and their frequency of vegetable consumption negatively correlated with their reported food neophobia \((r(38) = -.33, p = .04)\). Mothers’ reports of their children’s intake of fruit, vegetables, and unhealthy foods suggested that the children’s fruit and vegetable intake was somewhat lower than their own, with an average of 1.43 fruits, and 1.17 vegetables per day. Mothers also reported that their children consumed an average of 2.60 unhealthy foods per day. Overall, mothers who reported higher levels of neophobia had children who were also high in this construct \((r(38) = .39, p = .02)\) and who consumed less food (fruits, vegetables, and unhealthy foods) overall \((r(38) = -.38, p = .02)\).

*Initial Response to Foods on Day 1*

*Fruits and vegetables.* When children were asked if they could identify the healthful foods on the cards and to classify them as either a fruit or a vegetable in Task 1, they were generally better at identifying and classifying more commonly eaten foods such as apples and carrots than less common foods such as Brussels sprouts or exotic foods such as starfruit as shown in Table 2. Overall, children were able to correctly
identify more than half of the fruits ($M = 58\% \pm 11.9$) and vegetables ($M = 50.03\% \pm 18.91$) on the cards.

Although they were only able to identify half of the vegetables, children were more successful at categorizing these foods as vegetables ($M = 80.50\% \pm 20.61$). They were most successful at categorizing asparagus and they had the most difficulty categorizing tomatoes (see Table 2) as vegetables. Children were able to successfully classify most fruits and vegetables as healthy ($M = 81.8\% \pm 23.31$). They were best at categorizing commonly eaten foods, like apples and carrots, and they had the most difficulty with unfamiliar foods, like passionfruit (Table 2).

*Unhealthy food.* Almost two-thirds of the children successfully identified the unhealthy foods ($M = 62.86\% \pm 18.24$). Children were best at identifying pizza, and they had the most difficulty identifying jam. On average, children were only able to correctly categorize about half ($M = 48.4\% \pm 23.38$) of these foods as unhealthy. The children were best at categorizing carrot cake, and they had the most difficulty categorizing the high-fat casserole (Table 2).

*Relationship between children’s food neophobia and their food knowledge and consumption.* As children’s neophobia scores increased, their ability to identify the fruits ($r(38) = -.47, p < .01$), vegetables ($r(38) = -.42, p < .01$), and unhealthy foods ($r(38) = -.34, p = .03$) decreased. There was also a marginal correlation between food neophobia and the ability to successfully categorize fruits and vegetables ($r(38) = -.27, p = .09$), such that children with lower food neophobia scores were better able to categorize fruits and vegetables than those with higher food neophobia.
Similarly, as the children’s neophobia increased, the variety of foods they ate in the buffet decreased. That is, those with greater neophobia consumed fewer fruits \((r(38) = -.48, p < .01)\) and fewer vegetables \((r(38) = -.50, p = .01)\).

*Effect of Home Exposure on Knowledge*

*Knowledge about fruits and vegetables.* As shown in Figure 1, children correctly identified a higher proportion of vegetables on Day 10 than on Day 1. This was supported by a repeated measures ANOVA, which revealed a main effect of time \((F(1, 36) = 4.40, p = .04)\). This effect was qualified by a marginal Book x Food x Time interaction \((F(1, 36) = 3.79, p = .06)\). Simple main effects analyses revealed that children who brought home books identified a higher proportion of vegetables on Day 10 regardless of whether or not they brought home food, as shown in Figure 2A \((F(1, 20) = 5.30, p < .04)\). However, for those children who did not bring home books, those who brought home food identified more vegetables on Day 10 \((F(1, 9) = 11.40, p < .01)\), whereas those who brought home nothing during the home exposure showed no improvement (see Figure 2B).

Separate analyses were conducted to determine whether the proportion of fruits the children correctly identified and the proportion they correctly categorized as healthy improved after the home exposure. These analyses revealed that the children’s ability to identify or classify fruits did not improve on Day 10 regardless of whether they took food or books home.

*Knowledge about the healthfulness of foods.* Although children who brought home food tended to improve in their ability to correctly categorize the pictures of the fruits and vegetables as healthful \((M = 87.57\% \pm 5.29)\) when compared to those who did not bring food home \((M = 73.99\% \pm 5.40; F(1, 36) = 3.23, p = .08)\), the book exposure
did not affect the children’s ability to categorize healthful foods on Day 10 ($F(1, 36) = 0.61, p = .44$). Likewise, home exposure did not increase the Food or Book Groups’ ability to correctly identify ($t(39) = -1.81, p = .08$) or categorize ($t(39) = -.48, p = .64$) the unhealthful foods on Day 10 relative to Day 1.

**Effect of Home Exposure on Buffet Consumption**

*Familiar fruit and vegetable consumption.* As shown in Figure 3, overall food consumption was significantly higher on Day 1 than on Day 10 ($t(39) = 2.25, p = .03$). For fruit and vegetables that were presented on both days, there was a marginal main effect of time, such that children ate less fruit ($t(39) = 1.91, p = .06$) and less vegetables on Day 10 ($t(39) = 1.92, p = .06$) than on Day 1. Children consumed significantly more fruits than vegetables on Day 1 ($t(39) = 7.25, p < .01$) and on Day 10 ($t(39) = 8.77, p < .01$).

The three-way Book x Food x Time ANOVA conducted on familiar fruit consumption failed to reveal significant main effects of Food or Book exposure, time, or significant interactions (all $p$s > .05). Similar analyses were conducted on vegetable consumption, which also failed to reveal significant main effects or interactions (all $p$s > .05).

*Novel fruit and vegetable consumption.* A chi-square analysis indicated that children who did not bring food home were significantly more likely to try the novel fruits (80%) than children who brought home food (35%; $\chi^2(1, N = 40) = 8.29, p = .01$). Moreover, a two-way Book x Food ANOVA indicated that children who did not bring home food had a higher mean consumption of novel fruits than children who brought home food regardless of whether or not they brought home books, as shown in Figure 4.
Knowledge and Consumption

\(F(1,36) = 11.03, p < .01\). There was no significant Book x Food interaction on the amount of fruits eaten.

A chi-square analysis indicated that children who took books home were significantly more likely to try the novel vegetables (68%) than children who did not bring books home (33%; \(\chi^2 (1, N = 40) = 4.83, p = .03\)). However, there were no significant main effects of food or book exposure or a significant Book x Food interaction on the amount of vegetables eaten.

**Consumption of novel food compared to home exposure food for the Food Group.** For the children who brought home food, the novel foods presented on Day 10 consisted of two foods that were completely novel and two foods that they had been exposed to once during the home exposure period. When we compared children’s consumption of these two groups of food to determine whether there was a difference in the amount they consumed of each, we found a trend \((t(19) = -1.73, p = .10)\) for children to eat more home exposure food than novel food, as shown in Figure 5.

**Effect of food neophobia on novel food consumption.** Children with greater food neophobia consumed less of the 10 foods presented during the buffet on Day 10 \((r(38) = -.37, p = .02)\). Children with greater food neophobia also consumed less novel fruits \((r(38) = -.44, p < .01)\), vegetables \((r(38) = -.50, p < .01)\), and foods overall \((r(38) = -.49, p < .01)\).

**Discussion**

In this study, we were interested in determining whether exposure to information about healthy eating and/or a variety of fruits and vegetables would affect children’s knowledge about and willingness to try these foods. Our results showed that exposure to
information increased children’s knowledge about healthy foods and increased their willingness to try novel vegetables. However, it did not affect their consumption of familiar foods. Contrary to our predictions, exposure to a variety of fruits and vegetables at home did not increase children’s consumption of the buffet foods. In fact, those who were exposed to a variety of fruits and vegetables were less willing to try novel foods in the buffet and consumed less novel foods than children who brought food home. A secondary goal of this study was to determine whether children’s food neophobia predicted their food consumption. As children’s neophobia scores increased, they were reported by their mothers to eat fewer healthy foods at home. Children’s neophobia scores were also negatively related to their knowledge about healthy food, their food consumption in the buffet, and their willingness to try novel foods.

Effect of Home Exposure on Knowledge

In the present study, exposure to information about healthful foods and healthy eating increased children’s knowledge about these foods. In the two card games, children were asked to identify foods, to categorize fruits and vegetables, and to categorize healthy and unhealthy foods. Children who brought home books identified significantly more of the vegetables after the home exposure, when compared to those who did not bring home books. Thus, as long as children received information about healthy eating, exposure to foods did not provide an advantage. These results are consistent with previous studies that indicate programs like 5-a-Day are generally successful at increasing children’s knowledge of healthy foods and healthy eating (Havas et al., 1995; Subar et al., 1992).
In the absence of information, the food exposure provided children with an opportunity to learn more about foods. Among children who did not bring home books, only those who brought home food identified a significantly greater proportion of vegetables on Day 10. Children who brought home food also tended to improve their ability to categorize fruits and vegetables as healthy. These results were unexpected because we did not explicitly instruct the mothers to talk to their children about the foods they took home. Although children were given carrots, broccoli and/or peppers to eat at home, which might have improved their ability to identify these cards on Day 10, we also saw improvement in children’s ability to identify other vegetable cards. Because many of the mothers reported eating more than the five recommended servings of fruits and vegetables per day, suggesting that they were relatively health-conscious, we hypothesize that they may have used the feeding opportunities to teach their children about healthful foods during the eight-day home exposure. This approach may be especially effective in the context of the family. For example, other research has shown that children whose parents talk to them about nutrition have greater nutritional knowledge (Anliker et al., 1990).

Previous research indicates that children can understand taxonomic (e.g., fruit vs. vegetable) and evaluative (e.g., healthy vs. unhealthy) categorizations by age three (Nguyen, 2007; Nguyen & Murphy, 2003), so it is not surprising that more than 80% of the children were successful at categorizing the fruits on Day 1. Due to this high initial performance, there was little room for them to improve on Day 10, which may explain why our home exposure manipulation failed to affect children’s ability to correctly categorize these foods. It is probable that the exotic fruits, starfruit and passionfruit, were
simply too unfamiliar to recognize the second time around. Therefore, because children were already at a ceiling for identifying and categorizing the more familiar fruits, no improvement in identifying or categorizing the fruits was observed in Day 1. Despite this lack of improvement for fruits, children were able to identify more of the vegetables on Day 10 possibly because they did not originally recognize certain vegetables, such as potatoes and tomatoes, in their whole, raw forms on Day 1, thereby leaving room for improvement.

It is interesting to note that the children were better able to categorize the fruits and vegetables (more than 80%) than to identify them (more than 50%). This difference in success indicates that the children had already formed cognitive schemata for recognizing these different food categories (i.e., fruits, vegetables, and healthy foods). While the makeup of these schemata are still unknown, we hypothesize based on the children’s verbal responses that they associated the characteristics of green and leafy with vegetables and the characteristics of colorful and juicy with fruit.

Although none of the groups increased in their ability to identify or categorize unhealthy foods, they were generally able to identify about 65% of the unhealthy foods. Their success rate is not surprising, given that mothers reported that they consumed approximately 2.60 unhealthy foods (such as sweet and salty snacks) each day at home. Because many children begin eating outside of the home once they start preschool, this number likely underestimates the amount of junk food these children actually consume (Fox et al., 2004). Additionally, the children could possibly have been confused about the healthfulness of the unhealthy foods, resulting in them categorizing only approximately 50% of these foods correctly. We deliberately chose unhealthy foods containing fruits
and vegetables, such as pizza topped with vegetables and apple pie. Hart, Bishop, and Truby found that many children are unable to provide justifications for why a food is considered “good” or “bad,” so unhealthy foods containing fruits and vegetables could have confused the children about their overall healthfulness (2002).

**Effect of Home Exposure on Familiar Buffet Food Consumption**

The type of home exposure did not differentially affect children’s consumption of the buffet foods that were presented on both Days 1 and 10 (i.e., the familiar foods). In accordance with our hypothesis, children who brought books home did not increase their consumption of these buffet foods. This is in line with previous research which has shown that children tend to be more concerned with how their foods taste rather than their healthfulness (Wellman & Johnson, 1982). Therefore, despite the information that they were given about the healthfulness of these foods, children were still unwilling to eat them, likely because they remembered how they tasted from Day 1. This may explain why many programs aimed at increasing knowledge have not resulted in increased liking or consumption of healthy foods (Domel et al., 1993).

By far, the most successful method to increase consumption of fruits and vegetables is to repeatedly expose children to novel foods, which has been shown to result both in increased liking and increased consumption of novel foods (Birch et al., 1987; Wardle et al., 2003a, 2003b). These studies show that children must try novel foods eight to 15 times before they learn to like them better (Birch et al., 1987, Forestell & Mennella, 2007; Wardle et al., 2005). Gerrish and Mennella extended these results with infants to show that, similar to mere exposure, variety serves to increase infants’ acceptance of a familiar food (2001). Contrary to these findings, children in the present
study, who had been exposed to a variety of foods at home, did not increase consumption of familiar foods.

This finding could be attributable to negative experiences during the eight-day home exposure. If children refused the novel food when their mothers initially offered it, mothers were instructed to offer their children the novel food again later in the day and to encourage their children simply to try it. It is during this second offer that mothers may have pressured their children to try the novel food. Previous research indicates that children must have positive experiences with novel foods in order to increase their acceptance of them. Parents’ use of authoritarian styles to pressure their children to consume healthy foods actually results in decreased intake and greater dislike for these foods (Birch, Marlin, & Rotter, 1984; Newman & Taylor, 1992). In fact, authoritarian feeding practices are also associated children’s reduced ability to self-regulate their intake of calories (Birch & Fisher, 2000) and subsequent weight problems (Rhee, Lumeng, Appugliese, Kacirot, & Bradley, 2006). More positive parenting techniques, such as offering encouragement to eat more fruits and vegetables and praise for healthy eating habits, are associated with greater fruit and vegetable consumption (Vereecken, Keukelier, & Maes, 2004). Nevertheless, if parents positively expose their children repeatedly to novel foods, their children will learn to like these foods (Wardle et al., 2003a).

**Effect of Home Exposure on Novel Buffet Food Consumption**

Children who brought home books did not consume significantly more of the novel foods on Day 10 when compared to those who did not bring home books. This finding is consistent with previous studies with elementary school children and
adolescents, which found that offering information about nutrition or providing children with the opportunity to look at novel foods does not increase consumption of novel foods (Pelchat & Pliner, 1995). It is interesting to note however, that while the children in the Book group were not willing to consume more of the foods, they were significantly more likely to try novel fruits and vegetables than children in the No Book Group. This difference may have important implications over the long-term, because the more children try a vegetable, the greater the chance they will learn to like it. Another important long-term implication of this manipulation was that, anecdotally, many of the mothers in this study commented that they became encouraged to provide their children with more fruits and vegetables after reading the books about healthy eating. Therefore, in the short-term, the book manipulation might have had more of an impact on the mothers than on their children, but over the long-term, mothers’ enthusiasm about healthy eating may serve to improve their children’s eating habits. Research indicates that children who have greater availability to fruits and vegetables are more willing to try novel foods (Pelchat & Pliner, 1986).

Children who brought home a variety of food similar to the foods which were presented on Days 1 and 10 were significantly less likely to try and to consume more novel fruits and vegetables than children who did not bring home food. As explained above, this finding could be attributable to possible negative experiences during the eight-day home exposure. Also, it remains unknown whether children would have consumed more novel foods if they were not presented alongside familiar foods. After possible negative experiences with novel foods during the home exposure period, children could have been more unwilling to try novel foods in a situation where they
were not pressured to consume them and instead directed their attention toward more familiar foods. Although children will typically avoid novel foods when they are presented with more familiar alternatives, it may be possible to overcome this if children are exposed to peer models consuming the children’s non-preferred (novel) food (Birch, 1980).

Interestingly, while children who brought food home were significantly less likely to try novel foods, they actually consumed more of the home exposure buffet foods than the completely novel buffet foods after only a single previous experience. Possibly, these single exposures, combined with exposure to a variety of other fruits and vegetables, were enough to increase consumption of the home exposure foods in comparison to completely novel foods. Since children’s consumption of the home exposure foods was not measured before the home exposure, it remains unknown whether children’s post-exposure consumption of these foods would have been significantly greater than their pre-exposure consumption.

*Food Neophobia*

In accordance with previous research, children’s level of food neophobia correlated with that of their mothers, such that children with high neophobia had mothers who were also high in neophobia. These results are consistent with Skinner et al. (2002) who also found that children and mothers’ neophobia scores were correlated. This genetic link has additionally been demonstrated in a twin study, with genetic factors accounting for 78% of the variation in food neophobia scores, while non-shared environmental variables accounted for 22% of the variance (Cooke, Haworth, & Wardle, 2007).
The children’s food neophobia also negatively correlated with their knowledge and food consumption. Children with low food neophobia were better at identifying fruits, vegetables, and unhealthy foods and at categorizing the healthy foods. They also consumed less fruits, vegetables, and novel foods at home, as reported by their mothers, and consumed fewer of the 10 foods presented in the Day 10 buffet. High levels of neophobia have been shown in previous research to be associated with lower frequency of fruit and vegetable consumption, as well as a smaller variety of foods served in children’s diets (Cooke, Wardle, & Gibson, 2003; Koivisto & Sjoden, 1996).

Finally, children with high neophobia consumed less novel fruits, vegetables, and overall foods, as well as less of the two home exposure vegetables presented on Day 10. Neophobia, which shows a rapid increase around age two, is a major barrier to healthy eating throughout early childhood (Addessi, Galloway, Visalberghi, & Birch, 2005). Koivisto and Sjoden (1996) found that high levels of neophobia were associated with fewer foods tried. Furthermore, Wardle et al. found that while neophobia may be overcome by repeated exposures to novel food, some parents believe this method takes too long and is too demanding (2003a).

Nevertheless, the present food neophobia results must be interpreted cautiously. Neophobia and food frequency scores from the previous six months were self-reported by the mother, which were subject to errors of memory and bias, especially in over- or underestimating frequency of food consumption, and demand characteristics, which affect the level of honesty of their reports.

In summary, children were better at categorizing fruits and vegetables than identifying them, indicating that they possibly have well developed cognitive schemata
for these different categories. Exposure to information in the form of children’s books further increased children’s knowledge about healthful foods. Similarly, if books were not provided, exposure to food may have also increased children’s knowledge, possibly because mothers used the opportunity to teach their children about healthy eating. The type of home exposure did not differentially affect consumption of familiar buffet foods; however, children who did not bring food home were more likely to try and consume more novel foods, indicating that type of exposure only affects novel foods and not familiar ones. Additionally, children who brought food home consumed significantly more of the novel foods that were sent home than the completely novel buffet foods, indicating that one previous exposure, in conjunction with exposure to a variety of other foods, can increase consumption of novel foods. Lastly, children’s level of food neophobia predicted their knowledge of healthy eating, food consumption, and willingness to try novel foods.

Conclusions

The findings of the present study are very important in light of our obesigenic environment. Children currently have diets low in fruits and vegetables and high in sugary and fatty snack foods (Fox et al., 2004), resulting in increasingly greater numbers of overweight and obese children and adolescents (Jahns et al., 2001; Ogden et al., 2002). While many programs like 5-a-Day, which focus on increasing knowledge of healthful foods and healthy eating, have succeeded in increasing knowledge (Domel et al., 1993), they have not succeeded in increasing liking or consumption of fruits and vegetables. This is a difficult task, first, because children’s diets are limited by their neophobia and, second, because children’s consumption of fruits and vegetables is guided primarily by
their liking of the taste of these foods rather than their healthfulness (Birch et al., 1987; Rescinow et al., 1998). The latter is supported by the finding that while children understand the link between nutrition and health by the sixth grade, they are not concerned about their own health (Wellman & Johnson, 1982). Because obese children tend to become obese adults (Kelder et al., 1994; Singer et al., 1995) with greater risk of adult morbidity and mortality (Guo & Chumlea, 1999; Must et al., 1992), it is of primary importance to develop effective strategies to prevent the development of unhealthy eating styles. In order to reach this goal, future research should focus on understanding the long-term implications of various interventions in order to provide evidence-based strategies for developing healthy eating habits in our children, a generation which will struggle with the effects of obesity.
References


Appendix A

Food Cards

*Healthy Foods:*

**Fruit**
- Apple
- Banana
- Orange
- Passionfruit
- Raspberry
- Starfruit

**Vegetables**
- Asparagus
- Broccoli
- Brussel sprouts
- Carrots
- Eggplant
- Pepper
- Potato
- Tomato
- Squash

*Unhealthy Foods:*

- Apple pie
- Casserole
- Carrot cake
- French fries
- Jam
- Onion rings
- Pizza
Appendix B

Mother Food Frequency Questionnaire Foods

1. Potatoes
2. Sweet potatoes
3. Carrots
4. Cabbage
5. Corn
6. Peas
7. Squash
8. Green beans
9. Spinach
10. Tomatoes
11. Broccoli
12. Collard greens/kale
13. Brussel sprouts
14. Asparagus
15. Bell peppers (all colors)
16. Eggplant
17. Water chestnuts
18. Celery
19. Cauliflower
20. Bananas
21. Oranges
22. Pineapples
23. Melons (all kinds)
24. Papaya
25. Apples
26. Pears
27. Peaches
28. Berries (all kinds)
29. Guava
30. Raisins
31. Starfruit
32. Passionfruit
33. Kiwi
34. Quince
Appendix C

Child Food Frequency Questionnaire Foods

1. Apples
2. Apple pie
3. Asparagus
4. Baby corn
5. Bananas
6. Blueberries
7. Broccoli
8. Brussel sprouts
9. Carrot cake
10. Carrots
11. Cauliflower
12. Celery
13. Corn
14. Eggplant
15. French fries
16. Jam
17. Kiwi
18. Onion rings
19. Oranges
20. Papaya
21. Passionfruit
22. Bell peppers
23. Pineapples
24. Pizza
25. Potatoes
26. Raspberries
27. Sugar snap peas
28. Starfruit
29. Tomatoes
30. Water chestnuts
31. Yellow squash
## Appendix D

### Food Neophobia Questionnaire

Please read the following statements carefully and circle the appropriate responses using the scale below:

<table>
<thead>
<tr>
<th>Statement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am constantly sampling new and different foods................................</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>I don’t trust new foods...........................................................................</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>If I don’t know what is in a food, I won’t eat it...................................</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>I like foods from different countries..................................................</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Ethnic food looks too weird to eat..........................................................</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>At dinner parties I will try a new food...............................................</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>I am afraid to eat things I have never had before....................................</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>I am very particular about the foods I will eat.......................................</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>I will eat almost anything........................................................................</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>I like to try new ethnic restaurants......................................................</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>
Appendix E

General Neophobia Questionnaire

Please read the following statements carefully and circle the appropriate responses using the scale below:

1 - EXTREMELY DISAGREE   5 - SLIGHTLY AGREE
2 - VERY MUCH DISAGREE     6 - VERY MUCH AGREE
3 - SLIGHTLY DISAGREE       7 - EXTREMELY AGREE
4 - NEITHER AGREE NOR DISAGREE

I feel uncomfortable when I find myself

in novel situations........................................1 2 3 4 5 6 7

Whenever I’m away, I want to get home to

my familiar surroundings..............................1 2 3 4 5 6 7

I’m afraid of the unknown................................1 2 3 4 5 6 7

I am very uncomfortable in new situations...........1 2 3 4 5 6 7

Whenever I am on vacation, I can’t wait to get home...1 2 3 4 5 6 7

I avoid speaking to people I do not know when

I go to a party..........................................1 2 3 4 5 6 7

I feel uneasy in unfamiliar surroundings..............1 2 3 4 5 6 7

I don’t like sitting next to someone I don’t know........1 2 3 4 5 6 7
Appendix F

Food Craving Inventory

Directions: For each of the foods listed below (items 1-37), please circle the appropriate number using the following scale.

Over the past month, how often have you experienced a craving for the food?

1 = never
2 = rarely (once or twice)
3 = sometimes
4 = often
5 = always / almost everyday

<table>
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<th>Food</th>
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Appendix G

Three-Factor Eating Questionnaire: Restraint Subscale

Please answer the following questions by circling the response that applies most to you.

When I have eaten my quota of calories, I am usually good about not eating anymore.  
True  False

I deliberately take small helpings as a means of controlling my weight.  
True  False

Life is too short to worry about dieting.  
True  False

I have a pretty good idea about the number of calories in common food.  
True  False

While on a diet, if I eat food that is not allowed, I consciously eat less for a period of time to make up for it.  
True  False

I enjoy eating too much to spoil it by counting calories or watching my weight.  
True  False

I often stop eating when I am not really full as a conscious means of limiting the amount that I eat.  
True  False

I consciously hold back at meals in order to not gain weight.  
True  False

I eat anything I want, any time I want.  
True  False

I count calories as a conscious means of controlling my weight.  
True  False

I do not eat some foods because they make me fat.  
True  False

I pay a great deal of attention to changes in my figure.  
True  False

How often are you dieting in a conscious effort to control your weight?  
Rarely  Sometimes  Usually  Always

Would a weight fluctuation of 5 lbs. affect the way you live your life?  
Rarely  Sometimes  Usually  Always

Do your feelings of guilt about overeating help you to control your food intake?  
Never  Rarely  Often  Always
How conscious are you of what you are eating?

<table>
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<tr>
<th>Not at all</th>
<th>Slightly</th>
<th>Moderately</th>
<th>Extremely</th>
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How frequently do you avoid “stocking up” on tempting foods?

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<th>Almost never</th>
<th>Seldom</th>
<th>Usually</th>
<th>Almost always</th>
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</table>

How likely are you to shop for low calorie foods?

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<th>Unlikely</th>
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<th>Moderately likely</th>
<th>Very likely</th>
</tr>
</thead>
</table>

How likely are you to consciously eat slowly in order to cut down on how much you eat?

<table>
<thead>
<tr>
<th>Unlikely</th>
<th>Slightly unlikely</th>
<th>Moderately likely</th>
<th>Very likely</th>
</tr>
</thead>
</table>

How likely are you to consciously eat less than you want?

<table>
<thead>
<tr>
<th>Unlikely</th>
<th>Slightly unlikely</th>
<th>Moderately likely</th>
<th>Very likely</th>
</tr>
</thead>
</table>

On a scale of 0 to 5, where 0 means no restraint in eating (eating whatever you want, whenever you want it) and 5 means total restraint (constantly limiting food intake and never “giving in”), what number would you give yourself? Please circle the choice that applies to you.

0 = Eat whatever you want, whenever you want it

1 = Usually eat whatever you want, whenever you want it

2 = Often eat whatever you want, whenever you want it

3 = Often limit food intake, but often “give in”

4 = Usually limit food intake, rarely “give in”

5 = Constantly limit food intake, never “give in”
Appendix H

Child Eating Behavior Questionnaire

The food neophobia subscale includes items 6, 15, 17, 21, 24, and 29.

Directions: Please rate, on a scale of 1-5 whether the following statements are true for your child that participates in this study. Circle the appropriate number:

1 = Completely disagree
2 = Slightly disagree
3 = Neither agree nor disagree
4 = Slightly agree
5 = Completely agree

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<tr>
<td>1</td>
<td>Once my child decides s/he doesn’t like something, there is no way of getting him/her to like it</td>
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<td>My child makes friends easily</td>
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<td>3</td>
<td>My child likes to be with people</td>
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<td>My child has strong likes and dislikes in food</td>
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<td>My child tends to be shy</td>
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<td>7</td>
<td>My child often fusses and cries</td>
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<td>My child makes faces at new foods</td>
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<td>My child is off and running as soon as s/he wakes up in the morning</td>
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<td>My child prefers quiet, inactive games to more active games</td>
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Table 1

Participant Characteristics

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<td>58.3</td>
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<td>Sex, percent female</td>
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<td>9</td>
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<td>Mothers, n</td>
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<td>32.4 ± 4.6</td>
<td>31.0 ± 1.9</td>
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<td>Age, mean ± SEM, y</td>
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<td>26.2 ± 2.5</td>
<td>24.1 ± 1.8</td>
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<td>Years of schooling, mean ± SEM</td>
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<td>27.0 ± 2.8</td>
<td>20.3 ± 3.1</td>
<td>25.5 ± 1.5</td>
</tr>
<tr>
<td>Food craving score (range: 4-20)</td>
<td>9.8 ± 0.8</td>
<td>8.8 ± 0.6</td>
<td>7.6 ± 1.1</td>
<td>8.4 ± 1.2</td>
<td>8.6 ± 0.5</td>
</tr>
<tr>
<td>Eating restraint score (range: 0-21)</td>
<td>11.1 ± 1.5</td>
<td>8.4 ± 1.5</td>
<td>8.2 ± 1.2</td>
<td>9.0 ± 2.1</td>
<td>9.1 ± 0.8</td>
</tr>
</tbody>
</table>

^aMean ± SEM (all such values).
^bTotal number of mothers is less than that of children because there were 6 sibling dyads and 1 sibling triad.
^cBecause the children of one sibling dyad participated in different groups, the total number of mothers listed (N = 32) does not correspond to the total mothers in each of the groups (N = 33).
^dSignificant main effect of Book Group such that value for the No Book Group was higher than for the Book Group.
Table 2

*Initial Response to Foods*

<table>
<thead>
<tr>
<th>Food</th>
<th>Mean monthly consumption</th>
<th>Identification</th>
<th>Fruit/vegetable categorization</th>
<th>Healthy/unhealthy categorization</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fruits</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apple</td>
<td>12.5 ± 1.4</td>
<td>100.0</td>
<td>92.5</td>
<td>97.5</td>
</tr>
<tr>
<td>Banana</td>
<td>12.0 ± 1.4</td>
<td>100.0</td>
<td>77.5</td>
<td>95.0</td>
</tr>
<tr>
<td>Orange</td>
<td>8.8 ± 2.2</td>
<td>97.5</td>
<td>95.0</td>
<td>95.0</td>
</tr>
<tr>
<td>Passionfruit</td>
<td>0.1 ± 0.0</td>
<td>0.0</td>
<td>42.5</td>
<td>62.5</td>
</tr>
<tr>
<td>Raspberry</td>
<td>0.6 ± 0.2</td>
<td>30.0</td>
<td>80.0</td>
<td>87.5</td>
</tr>
<tr>
<td>Starfruit</td>
<td>0.0 ± 0.0</td>
<td>5.0</td>
<td>27.5</td>
<td>75.0</td>
</tr>
<tr>
<td><strong>Vegetables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asparagus</td>
<td>0.3 ± 0.1</td>
<td>20.0</td>
<td>95.0</td>
<td>85.0</td>
</tr>
<tr>
<td>Broccoli</td>
<td>3.5 ± 0.6</td>
<td>35.0</td>
<td>100.0</td>
<td>80.0</td>
</tr>
<tr>
<td>Brussels sprouts</td>
<td>0.2 ± 0.1</td>
<td>2.5</td>
<td>80.0</td>
<td>77.5</td>
</tr>
<tr>
<td>Carrots</td>
<td>7.4 ± 0.9</td>
<td>100.0</td>
<td>92.5</td>
<td>97.5</td>
</tr>
<tr>
<td>Eggplant</td>
<td>0.1 ± 0.0</td>
<td>10.0</td>
<td>75.0</td>
<td>75.0</td>
</tr>
<tr>
<td>Pepper</td>
<td>2.0 ± 0.8</td>
<td>52.5</td>
<td>82.5</td>
<td>70.0</td>
</tr>
<tr>
<td>Potato</td>
<td>4.7 ± 0.7</td>
<td>80.0</td>
<td>95.0</td>
<td>90.0</td>
</tr>
<tr>
<td>Tomato</td>
<td>4.4 ± 1.0</td>
<td>70.0</td>
<td>70.0</td>
<td>90.0</td>
</tr>
<tr>
<td>Squash</td>
<td>0.8 ± 0.3</td>
<td>30.0</td>
<td>70.0</td>
<td>82.5</td>
</tr>
<tr>
<td><strong>Unhealthy Foods</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apple Pie</td>
<td>0.6 ± 0.2</td>
<td>60.0</td>
<td>--</td>
<td>57.5</td>
</tr>
<tr>
<td>Casserole</td>
<td>--</td>
<td>35.0</td>
<td>--</td>
<td>12.5</td>
</tr>
<tr>
<td>Carrot Cake</td>
<td>0.3 ± 0.2</td>
<td>85.0</td>
<td>--</td>
<td>85.0</td>
</tr>
<tr>
<td>French Fries</td>
<td>5.1 ± 0.7</td>
<td>97.5</td>
<td>--</td>
<td>50.0</td>
</tr>
<tr>
<td>Jam</td>
<td>8.4 ± 1.3</td>
<td>17.5</td>
<td>--</td>
<td>45.0</td>
</tr>
<tr>
<td>Onion Rings</td>
<td>0.3 ± 0.1</td>
<td>50.0</td>
<td>--</td>
<td>42.5</td>
</tr>
<tr>
<td>Pizza</td>
<td>4.4 ± 0.5</td>
<td>100.0</td>
<td>--</td>
<td>40.0</td>
</tr>
</tbody>
</table>
Figure Caption

Figure 1. The percentage of vegetable cards that children correctly identified on Day 1 (grey bars) and Day 10 (dark bars). *Indicates significant difference at $p < .05$. 
Figure 1

Percent identified correctly (%)
Figure 2. Mean percent of vegetable cards correctly identified on Day 1 (grey bars) and Day 10 (dark bars) for the Book Group (Panel A) and for the No Book Group (Panel B).

*Indicates significant difference at $p < .05$. 

Figure Caption
A. Book Group

![Graph showing the percentage of correctly identified subjects for Book Group, with day 1 and day 10 comparisons for both food and no food conditions.]

B. No Book Group

![Graph showing the percentage of correctly identified subjects for No Book Group, with day 1 and day 10 comparisons for both food and no food conditions.]

Figure 2
Figure Caption

Figure 3. Children’s mean consumption of familiar buffet foods during test sessions on Day 1 (grey bars) and Day 10 (dark bars). *Indicates significant difference at $p < .001$. 
Figure 3

The graph shows the mean consumption of fruits, vegetables, and total buffet foods on Day 1 and Day 10. The bars indicate the average consumption with error bars representing the standard error. The asterisk (*) denotes a statistically significant difference between Day 1 and Day 10.
Figure Caption

Figure 4. Mean consumption of novel fruits as a function of whether the children received Food (light grey bars) or No Food (dark grey bars). *Indicates significant difference at $p < .01$. 
Figure 4

Mean consumption (g)

Food
No Food

Group

Book
No Book
Figure Caption

Figure 5. Mean consumption of novel food versus novel home exposure food during the buffet for the Food Group on Day 10.
Figure 5