MODERATORS OF CHILDREN’S FOOD LIKING AND INTAKE

A Thesis in

Food Science

by

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DEDICATION

This one is for you, Dad.
ABSTRACT

Children’s food choices have long been assumed to be almost entirely driven by hedonics. Children are biologically driven to like tastes associated with high-energy foods but dislike bitter tastes often associated with nutrient dense foods. Better understanding of the relationship between food liking and intake and identifying parental influences on food liking and intake may help efforts to improve children’s diet quality.

To clarify the relationship between food liking and intake we determined correlations between children’s food liking and intake in a cross-sectional, laboratory-based study of the strength of the relationship between liking and intake. In this study, 58 young children (mean: 5.44 +/- 0.8 years) attended two sessions in which they tasted and rated their liking of 7 foods and 2 beverages before eating self-selected, ad libitum test-meals.

We found that the relationship between children’s food liking and intake is more complex than previous work and common assumptions indicate. Liking and intake of some foods were correlated, but overall, children’s liking ratings did not significantly predict test meal intake. Mean liking and mean intake of low energy density foods (grapes, tomatoes, and broccoli) were moderately correlated (rho=0.28 p=0.03), but no significant relationship was found between mean liking and mean intake of high energy density foods (p=0.72). Contrary to our expectations, no relationship was found between combined liking scores for all test meal items and total meal intake (p=0.72).

Moderation analysis showed that the relationship between food liking and intake is influenced by sex (p=0.004), parental work status (p=0.041), and child weight status (p=0.007), with significant high energy density food liking/intake relationships among girls (r=0.46, p=0.02) but not boys (p=0.14) as well as among children with stay-at-home parents(r=-0.46, p=0.02) but not children of working parents (p=0.60). Liking predicted low energy density food intake among overweight/obese children (r= 0.76, p= 0.01), but not among lower weight children (p=0.99). These data suggest that food liking may not positively predict intake in all situations, but that in certain situations, food liking is a strong predictor of intake.

Results of exploratory analyses indicate that children’s independent food choices might be associated with their parents’ food-related behaviors. Our findings suggest a negative relationship between time spent on food preparation and test meal food energy density using both correlation analysis (r= -0.35, p= 0.01) and group-wise comparison using one-way ANOVA (F (2,55) = 4.557, p = 0.015).

Our findings suggest that children’s eating behavior is more complex than previous work and common assumptions indicate, and further research is needed to clarify influences on children’s eating behavior including the relationship between food liking and intake.
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I could probably write an acknowledgements section as long as (if not longer than) my actual thesis, but I’ll try to keep it short. The past two years have been far rockier than I could have imagined, but I am incredibly fortunate to be surrounded by incredible people who have helped me more than they could ever know.

Thank you.
Chapter 1

Literature Review

Children’s Diet Quality

In the early 20th century and before, medical professionals and nutrition researchers often aimed to find ways to make children to eat more food [1-4] to avoid consequences of nutrient deficiencies that rarely appear in developed countries in the 21st century (e.g. rickets and goiters) [1-4]. Today’s consumers, surrounded by processed* foods rich in fat, sugar, and salt that are convenient, readily available, and often more affordable than healthier options [5-10], face different nutritional concerns. While many children within developed countries are malnourished, these problems usually stem from the types of food eaten rather than the amounts of food eaten.

The current state of children’s diet quality

In general, children’s diets do not align with current dietary recommendations [11-13]). Over the past few decades, intake of energy-dense, nutrient-poor foods and

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* It could be argued that nearly all foods are processed to some extent—processing can be as simple as washing, cutting, or boiling a vegetable, but for the purposes of this thesis, the term ‘processed foods’ refers to products that are classified as ultra-processed, which can be defined as industrially produced, ready-to-eat or ready-to-heat products that are designed to be “durable, accessible, convenient, and palatable” replacements for foods/drinks that would normally be prepared at home. Examples of ultra-processed items include foods such as chicken nuggets, cereal bars, ice cream, sugar-added cereals, and pre-prepared packaged meals such as canned ravioli and TV dinners.
sugary beverages have increased while intake of nutrient-rich, lower-energy foods such as fruit, vegetables, and whole grains has decreased. [13-16].

Research indicates that 80% of children eat dessert or sugar-sweetened beverages on a daily basis, while up to a quarter of children eat no fruit and nearly a third of children do not consume even a serving of vegetables per day. In fact, the most common “vegetable” of choice was the French fry. [17-19].

Energy intake has increased among both adults and children [20] Excess energy intake can be attributed to increases in size of the overall food supply as well as the size of common food portions. Serving sizes have increased considerably within the past few decades[20-22]: Both adults and children have been shown to eat more food when offered large portions[23]. Increases in energy intake can also be partially attributed to shifts in cultural norms surrounding food [24, 25]. Today’s families eat homemade meals less often than in the past, consuming more ultra-processed foods and meals away from the home, including fast food [8, 21, 22, 24, 26, 27]. These foods tend to be higher in calories but lower in nutritional quality than from-scratch foods [21, 28, 29]. Accordingly, consumption of fast food and ultra-processed foods is associated with a variety of chronic diseases and deleterious health conditions [30-32].

Obesity and other chronic health conditions related to diet quality

As diet quality and levels of physical activity have declined, prevalence of obesity among both adults and children has increased to epidemic levels worldwide. Since the
1970s, prevalence rates of childhood overweight and obesity have nearly tripled in the United States [33-36]. Children with a body mass index (BMI) above the 85th percentile for their age and sex are considered overweight and children at or above the 95th percentile are considered obese [37].

Recent epidemiologic data suggest that childhood obesity incidence rates may be reaching a plateau[38], and that prevalence of childhood obesity may have declined in select populations, including preschoolers [33] Others debate the validity of these findings, publishing research showing that childhood obesity is continuing to grow [39]. Regardless, obesity is an alarmingly common condition affecting nearly 1 in every 5 children aged 6-19 years old [33],

Obesity is an associated and sometimes causal factor for many chronic conditions that affect the entire body, including hypertension, joint pain and arthritis, Type 2 diabetes, several varieties of cancer, cardiovascular disease (CVD), kidney disease, and fatty liver disease [30-32, 40]. Diet-associated diseases such as Type 2 diabetes and cardiovascular disease have traditionally been found in older populations, but in recent years, the prevalence of these diseases in pediatric populations has increased to alarming levels [41]. Preschoolers who are obese as children are more likely than their peers to be obese later in life [42] and because many chronic conditions associated with obesity are progressive, obese children are at risk of developing serious and sometimes lethal complications[30]. Largely due to increasing prevalence diseases associated with obesity, children born today are projected to have a shorter lifespan than their parents [43 , 44]
Development of Food Preferences

**Innate and Biological Influences**

Early nutrition researchers believed that food preferences resulted from the body physiologically “knowing” what foods it needs to maintain homeostasis[45]. Proponents of this theory believed that innate, unlearned “special appetites” for macro- and micronutrients are responsible for food choices [45-51]. Clara Davis’s classic work on self-selection and development in infants and children is commonly given as support of the “wisdom of the body” hypothesis. Davis tracked the dietary habits and development of children who were allowed to self-select their diets from the time they were weaned to early childhood; she found that children developed properly without any adult dietary interference or instruction [3]. A surface-level interpretation of her work supports this theory, but there was an important nuance in this work; the children were given access to only healthful, whole foods that were unseasoned. Davis herself cast doubt on “wisdom of the body,” stating that “self-selection can have no value if the diet must be selected from inferior foods.” Contemporary research suggests that food preferences are not innate although there may be some innate influences on the formation of these preferences.

While humans do not have innate preferences for specific foods, there is some evidence of innate reactions to certain tastes. Humans have evolved to like and seek out the sweetness and fatty textures associated with highly energy dense foods, which provide ample energy for development and reproduction [24]. On the other hand, toxic substances are often bitter and regarded as unpleasant, and are usually rejected. [52, 53]
Innate taste preferences are highly conserved among different species and similar facial reactions to pleasant and aversive tastes can be seen in humans, apes, and even mice [54, 55]. When given sucrose solutions, newborn human children, show classic signs of acceptance, including lip smacking, smiling, and sticking their tongues out in an upward fashion [56] Conversely, newborns show clear disliking of bitter solutions, by crying, grimacing, or wrinkling their noses [57-59].

Food preferences begin to form long before a child puts anything in his or her mouth and may potentially start developing in utero. During fetal and infant development, humans are hypothesized to undergo a process known as flavor programming, which familiarizes them with flavors of foods that are safe, nutritious, and available within their environment [58-61]. Flavor compounds ingested by a pregnant woman are carried into amniotic fluid, exposing the fetus to flavors and odors in utero [60]. Mennella and colleagues [58] found that babies whose mothers consumed carrot juice during pregnancy were more accepting of novel carrot-flavored cereals than babies whose mothers did not consume carrot juice, suggesting that exposure to flavors compounds in the womb may influences preferences later in life via programming.

Additionally, flavor compounds can be transmitted through breast milk, allowing infants to be exposed to the foods that their mother eats [57, 58, 62]. Because multiple exposures to stimuli lead to higher levels of liking and repeated exposure to flavor compounds through the prenatal environment or through breastfeeding provides a way for children to be exposed to novel flavors repeatedly [63, 64]. Programming may potentially influence children’s food preferences later in life by increasing acceptance of
flavors associated with foods mothers ate during pregnancy and breastfeeding.[58, 59, 61, 65].

After being weaned off the bottle or breast, infants tend to accept new foods readily, which is notable in terms of food preference development; infancy is seen as a critical window for food preference development and is arguably the last chance that parents have to expose their child to new foods without significant resistance [55, 66-68]. However, babies’ openness to trying new things can lead to trouble—they have difficulty discriminating between what is food and what is not food and can accidentally ingest harmful substances [52, 69]. Fortunately, around age two, coinciding with most children’s ability to move around independently [52, 70], children develop a sense of food neophobia, or the fear of trying (or rejection to try) novel foods [71].

This trait presumably developed as a cautionary measure to survive in a world where the unknown could be deadly. By eliciting feelings of fear, disgust or general disliking, neophobic traits allowed humans to avoid harmful substances such as toxins, spoiled food, or foods contaminated with feces [52, 72]. In terms of evolutionary fitness, food neophobia is generally advantageous, but it can be a frustrating phenomenon for parents trying to expose their children to different types of foods [70, 73, 74] Neophobia persists until one learns that a particular food is harmful. Thus, food preferences can be formed through the mechanism of “learned safety” that depends on repeated exposure [72]. Young children have neophobic tendencies and prefer familiar foods, but can develop preferences for novel foods after multiple exposures [75]. As children grow older, social and environmental influences become increasingly more important in the development of food preferences and food-related decision-making [5, 16, 57, 69, 76-83].
Social Influences on Food Preferences

Parents

Parents and other caregivers have a substantial influence on children’s diets. From the time of conception to the time of weaning, caregivers entirely control their children’s food intake, and throughout childhood, parents act as models for behavior and gatekeepers who determine what foods are readily available to their children[84]. Maternal diet during pregnancy has been associated with children’s weight statuses and may potentially affect food preferences later in life [85]. Even after children begin to eat solid foods, parents still have a substantial role in children’s food intake and preference development. Efforts to control children’s diets such as limiting access to some foods and pressuring children to eat other types of foods often backfire, leading to increased preference for forbidden foods and decreased preferences for foods that they are pressured to eat [84, 86-91]. Additionally, children tend to model adult behavior, and may mimic their parents’ eating behaviors and preferences, and are more likely to try a novel food[92] if they see an adult eating it. Parents also largely determine their child’s home food environment, determining what foods are available, how and when foods are prepared, and how often and under which circumstances foods are served [93].

Peer Influence

Children’s food preferences are prone to social influence from their peers [94-96]. Children are more readily influenced by their peers than by adults and are particularly
vulnerable to social pressure from their more popular peers as well as slightly older children [68]. Some studies have shown that trained peer models can affect other children’s food preferences and intake patterns [94-96]. For example, Birch and colleagues showed that children’s preference and intake of initially disliked vegetables increased after children observed their peers eating them[96]. However, later work from Hendy and colleagues suggests the positive effects of trained peer model interventions may not be long-lasting and that these interventions may lead to the trained peer models disliking the target foods over time[97]. As children age, peer influence may have a negative effect on the quality of food choices, leading to increased consumption of energy-dense, nutrient poor choices [12, 98-100]. Food is deeply linked with social interaction from childhood through adulthood, and eating behavior is influenced by a wide variety of social influences throughout the lifetime [5, 98]}. 

**Environmental Influences on Food Intake**

**Socioeconomic Status**

Energy-dense foods are often cheaper and more easily available in areas associated with lower socioeconomic status without reliable access to grocery stores [5, 9, 101, 102]. Stress and instability during childhood could also have direct physical effects on children’s hormone levels and sleep patterns, leading to increased risk for obesity, as mentioned above [103-105]. Additionally, because people of lower socioeconomic status often have less time to spend on food, they may use prepared
convenience food or purchase their food from fast food restaurants. While it seems counterintuitive that many children who face economic hardship are overweight or obese, they often face major barriers to healthy diet and exercise [106-113]. Another socioeconomic factor associated with diet quality is education [110]; some studies that children with highly educated parents eat healthier diets than peers with less educated parents, potentially due to income-related differences. Finally, children of working parents who may not be able to afford childcare may need to plan and prepare their food, but may lack requisite knowledge or skills to prepare nutritious meals for themselves [28, 109, 112-116]

*Home food preparation*

Nearly half of all food expenditures go to meals and snacks prepared away from home (including processed convenience foods), and children’s intake of these foods has increased dramatically since the 1970’s [10]. The main source of children’s energy intake from foods prepared away from home is fast food, even after accounting for intake of foods prepared at school [13, 117]. Foods prepared and consumed away from home are generally higher in energy content and lower in nutritional content than foods cooked at home [21, 26, 27, 118-121] and intake of foods prepared away from home these foods is associated with negative health consequences, including obesity and cardiovascular disease [13, 26, 27, 118, 122, 123]. Home food preparation has been linked to increased dietary quality in both adults and adolescents, with some researchers suggesting that eating home cooked meals with family may mitigate the effects from consumption of
energy-dense, nutrient poor foods prepared away from home and lead to family-wide dietary improvements [10, 124-127].

Food-Related Knowledge and Nutrition Label Reading

Nutrition knowledge has been shown to have a marked effect on diet quality even after controlling for individual differences in a variety of both personal and sociodemographic factors and has been found to be the factor most changeable by policy—nutrition knowledge can be increased using public service announcement campaigns, for example [88, 128]. Mathematical models designed by economists suggest that maternal nutrition knowledge likely has an impact on child diet quality [129] and Australian researchers found that nutrition knowledge may affect the relationship between the relationship of socioeconomic status and diet quality in first-time pregnant mothers in urban environments.[130].

The use of nutrition labels has also been linked to diet quality. Label users’ diets are lower in total energy, total fat, saturated fat, cholesterol, sodium and sugars and higher in fiber than non-users’ diets [131, 132]. Additionally, the use of nutrition labels is linked to healthy purchasing behaviors, including increased purchases of produce and decreased purchases of snack foods [133]. Unfortunately, many consumers have difficulties interpreting and applying information from nutrition labels to their food choices. [134]
Food Liking and Intake

**Food liking and intake in adults**

Much of the research focused on the effects of liking on food intake was conducted by the US Army and aimed to optimize food rations to increase soldiers’ intake to ensure physical and mental health. Army researchers repeatedly showed that the foods soldiers chose in cafeteria settings were (to an extent) reflective of their acceptance ratings [135-137]. However, this research as well as subsequent research in civilian populations indicates that food choice is extremely complex and is influenced by a variety of factors, including monotony, presentation, novelty, familiarity, expectations of how filling foods may be, cultural expectations, emotion, and a wide variety of other biological, behavioral, cultural, economic influences [5, 108, 138].

**Food Liking and Intake in Children**

Children are thought to have simpler motivations than adults when it comes to food; previous, widely-cited research found that that the correlation between food liking/preference and intake was stronger in children than in adults, and it was presumed that children’s food choices are primarily driven by liking and are minimally affected by external concerns such as social desirability or health-related concerns [77].

Much of the research in children’s nutrition prior to the 1970s [1-3, 139, 140] depended on adults’ (and often mothers’) interpretations of children’s food-related
attitudes and behaviors. This data can be easily and readily obtained, but can be unreliable, inaccurate or biased and may not necessarily reflect the child’s actual feelings. Consequently, in 1979, Leann Birch developed a novel method to capture children’s food preferences [141, 142].

Her method, which required an adult interviewer as well as actual food samples presents a number of potential logistical issues but allows the researcher to get information about children’s actual food preferences by asking the child directly, as opposed to relying on observation or parental reports [141, 142]. This process involves a tasting session followed by the creation of a rank preference order. Children taste samples of various foods, classify them as “yummy, yucky, or just okay”, and are then asked to pick the “yummy” food they liked best, which is considered the top of the child’s rank order. The liked food is removed from the group and the process is repeated until there are no more “yummy” foods. This process is then carried out with the foods that are considered “just okay” until no more remain, and finally with the “yucky” foods resulting in rank orders for each taste. Birch found a strong relationship (|r| = - 0.8) between preference rank order and intake and argued that this correlation was much stronger than had been previously observed in adults [141, 142].

The results of this study are often held as evidence that the link between food liking and intake is stronger in children than in adults. Birch compared her results to previous studies on “food preferences” and intake in adults and reported that the correlation she found (0.80) was stronger than correlations reported in adults (0.25 - 0.50) in various US Army studies [135, 137, 143, 144] However, the Army’s studies used 9-point hedonic scales, using the word preference interchangeably with liking (How good is
A?) [145]. Birch’s uses a connotation of preference that implies a comparison between two or more stimuli (Is A better than B?) and accordingly used rank order measurements[145]. Because of this semantic confusion, it is largely assumed that children eat solely based on the pleasure derived from foods and will not eat foods they dislike, unlike adults, whose food choices are complicated by numerous external factors (125). More recent studies have shown positive associations between children’s liking and intake of various foods [93, 146-149] including fruit [16, 99, 104, 150, 151] vegetable [53, 80, 152-154], and snacks [155], but none of these studies have shown correlations as strong as Birch’s original study of liking and intake. It should be noted that these studies did not entirely replicate Birch’s study; methodological difference may explain why the strength of Birch’s results were not replicated. Some studies used her rank order preference assessment task, but used different foods and intake protocols, potentially explaining why similar correlation coefficients were not found. Other studies did not use actual tasting or food intake measures, relying on reports of liking and intake using preference and food frequency questionnaires, which may not accurately predict actual liking or intake [156-158].
Study Aims and Objectives

Children are predisposed to preferring sweet, energy dense foods to more nutrient-dense but less palatable foods [59]. Because children’s food preferences are thought to be strongly associated with intake, it is important to understand the extent to which liking affects intake when children are allowed to self-select from an assortment of common foods that vary in energy- and nutrient density.

The research presented in this thesis focuses on the relationship between children’s food liking and intake, comparing children’s hedonic ratings of a variety of common foods with intake in a self-selected ad libitum test meal. Our primary objectives were to determine the relationship of liking and intake in a test meal setting including a variety of common foods, and to identify potential parental characteristics that influence the relationship between liking and intake. Secondary aims were to identify child characteristics that influence the relationship between food liking and intake and to determine if children’s laboratory food intake is related to home food preparation behaviors. Specific aims and hypotheses are shown in table 1-1.
### Table 1 - 1: Study Aims and Hypotheses

<table>
<thead>
<tr>
<th>Primary Aim 1: Determine the nature and strength of the association between food liking and intake in an ad libitum test meal</th>
<th>Hypothesis</th>
<th>Children’s intake of a variety of foods in an ad libitum test meal setting will be positively correlated with children’s pre-meal hedonic ratings of these foods.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothesis</td>
<td>The strength of the relationship between liking and intake is dependent on the type of food being evaluated.</td>
<td></td>
</tr>
<tr>
<td><strong>Primary Aim 2: Determine if socioeconomic status affects the relationship between food liking and intake</strong></td>
<td>Hypothesis</td>
<td>The relationship between food liking and intake is weakened by increases in family income.</td>
</tr>
<tr>
<td>Hypothesis</td>
<td>The relationship between food liking and intake is weakened by increases in parental education</td>
<td></td>
</tr>
<tr>
<td>Hypothesis</td>
<td>The relationship between food liking and intake differs by parental work status.</td>
<td></td>
</tr>
<tr>
<td><strong>Primary Aim 3: Determine if parental food related knowledge and behaviors affect the relationship between food liking and intake</strong></td>
<td>Hypothesis</td>
<td>Increases in nutrition knowledge reduce the effect of liking on intake</td>
</tr>
<tr>
<td>Hypothesis</td>
<td>Increases in time spent on food preparation reduce the effect of liking on intake</td>
<td></td>
</tr>
<tr>
<td>Hypothesis</td>
<td>Liking is a stronger predictor of intake among children whose parents do not regularly read nutrition labels.</td>
<td></td>
</tr>
<tr>
<td><strong>Secondary Aim 1: Determine if child specific traits affect the relationship between food liking and intake</strong></td>
<td>Hypothesis</td>
<td>The relationship between food liking and intake differs between boys and girls</td>
</tr>
<tr>
<td>Hypothesis</td>
<td>Liking predicts intake to a lesser extent as children age.</td>
<td></td>
</tr>
<tr>
<td>Hypothesis</td>
<td>Liking is a stronger predictor of intake among overweight/obese children than their peers.</td>
<td></td>
</tr>
<tr>
<td><strong>Secondary Aim 2: Determine if home food preparation is related to children’s laboratory eating behavior</strong></td>
<td>Hypothesis</td>
<td>Children whose parents spend more time on food-related activities will self-select lower energy density laboratory test meals,</td>
</tr>
<tr>
<td>Hypothesis</td>
<td>The hypothesized relationship between food-related time and energy density is dependent on differences in socioeconomic status.</td>
<td></td>
</tr>
<tr>
<td>Hypothesis</td>
<td>Children who more eat more foods prepared away from home will self-select higher energy density laboratory test meals than their peers.</td>
<td></td>
</tr>
</tbody>
</table>
Chapter 2

Materials and Methods

This chapter summarizes the study in terms of design, food stimuli, testing conditions, data collection instruments and protocols, and data analysis. In order to investigate parental influences on children’s food liking and intake, we carried out a laboratory-based study with 4-6 year old children and their parents. This age range was chosen to allow for a group of participants who have developed sufficient cognitive abilities to perform tasks associated with food preference assessment but young enough to still have their food environment largely determined by their parents.

All food preparation and testing took place at the Metabolic Kitchen and Children’s Eating Behavior Lab at Pennsylvania State University, a facility specially designed for food preparation and pediatric eating behavior research. The facility includes a full sized professional kitchen as well as two 90 square foot observation rooms and a control room with two computers. During the visits, children participated in one-on-one sessions with a research assistant in a 90 sq. ft. observation room separate from their parent, but viewable through a one-way mirror.

This research was carried out using a cross-sectional study design assessing parent and child reports as well as laboratory measures of food liking and intake. Food liking data were obtained using multiple methods, including a tasting protocol, a
structured interview with children, and parental report. Intake data were collected by assessing the average mass of various foods and beverages consumed during two *ad libitum* test meals. Family factors including parental nutrition knowledge and label reading skills, socioeconomic status, and child feeding attitudes and practices were measured using parental self-report via computerized questionnaires. This research was conducted across two visits completed within two weeks of one another to allow for average test meal consumption to be determined, as meal-to-meal variation in children can be high [159].

All data were collected from participants who gave their informed consent and were compensated for their time. This study was approved by Pennsylvania State University’s Institutional Review Board.

**Participants**

Sixty-one (61) healthy children from Central Pennsylvania participated in this study, including 34 boys and 27 girls aged 4-6 years old (mean age: 5.44 ± 0.8 years). Of these children, 58 completed both visits. Detailed information about children and their parents can be found in chapters 3, 4, and 5. Additionally, each child was accompanied by the parent who reported being primarily in charge of food preparation at home. Participants were recruited from the greater Centre County, PA area with flyers and online ads advertising a “Food Choice Study”. Flyers were distributed to area preschools, churches, community centers, shops, laundromats, gyms, restaurants, and establishments with community bulletin boards. Additionally, flyers were distributed to
area human service agencies. Online ads were posted on Craigslist.com as well as on the Pennsylvania State University’s research volunteer recruiting page.

Interested parents called the Metabolic Kitchen and Children’s Eating Behavior Laboratory and were screened over the phone by a research assistant. Inclusion criteria for children included being healthy and between ages 4 and 6 years at the time of the first study session. Exclusion criteria for children included being outside the target age range, having food allergies, having any medical conditions or taking any medications known to affect sense of taste, appetite, or body weight. Participants were asked to reschedule sessions if their child felt ill on the day of their scheduled visit.

**Minimizing Potential for Social Bias**

In order to collect high quality data, multiple strategies were used to control study conditions with the aim of reducing potential bias. All research data are vulnerable to various forms of bias [78, 160, 161] but the potential for bias is heightened in behavioral investigations[160, 161]; human behaviors[162] are affected by countless social influences.

This is particularly true in research that involves self-reports[161] of sensitive topics such as body size, socioeconomic status, or health habits. In order to minimize potential social desirability biases in parental reports of their attitudes, behaviors, and their children’s eating habits, parents were assured that all data would be de-identified and stored securely. Children’s eating behaviors are susceptible to social influence from parents and peers [57, 69, 92, 163], so efforts were made to minimize bias by having only
a trained member of the research staff and the child in the observation room. Parents were asked to stay within the adjacent room throughout the visit, where they could not be seen or heard by the child, to minimize prompting, commentary, or any other input that could influence their child’s eating behavior. Parents were also instructed to avoid making comments to the child about the study or meal between visits. Research staff were also instructed to refrain from discussing children’s food preferences and intake after the first laboratory visit.

Research staff involved with the project were trained to use specific language and scripts during data collection to maintain consistency. Staff were also instructed not to give their input on the child’s preferences or eating behaviors. Research participants often try to give responses that they think would please the investigator [164] and young children are particularly prone to answering in the affirmative regardless of their actual opinions[165, 166]. Children were urged to accurately and honestly answer questions and assured that the investigator would not be hurt or upset if the child indicated that they did not like a particular food or drink.

Any visitors other than the child enrolled in the study and the parent primarily in charge of food preparation for the child were asked to stay in the laboratory waiting room, where toys and books were provided for entertainment. If additional children, such as siblings or cousins, were present for the sessions, a trained staff member stayed with them in the waiting room to ensure that they would remain entertained and safe, minimizing the chances for interruption and extraneous influences on children’s participation in the study.
Materials

Food Stimuli

Children were offered a variety of common and familiar foods varying in flavor and energy density (table 2-1), including chicken nuggets (Tyson Foods, Springvale AR), ketchup (Heinz, Pittsburgh PA), steamed broccoli (Birds Eye, Pinnacle Foods, Parsippany NJ), red seedless grapes (Wegman’s, Rochester NY), grape tomatoes (Wegman’s, Rochester NY) potato chips (Frito-Lay, Plano TX), chocolate chip cookies (Chips Ahoy, Mondelez International, Deerfield IL), fruit punch (Hawaiian Punch, Dr. Pepper Snapple Group, Plano TX) and nonfat milk (Galliker Dairy Company, Johnstown PA). Serving sizes were estimated using the Continuing Survey of Food Intake for Individuals and were similar to serving sizes in previous children’s eating behavior research [167, 168]. All foods were purchased from local grocery stores on a weekly basis and were prepared before shortly before each participant visit.

<table>
<thead>
<tr>
<th>Item</th>
<th>Brand/Type</th>
<th>Serving Size (g)</th>
<th>Energy (Kcal)</th>
<th>Energy Density (Kcal/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomatoes</td>
<td>Fresh Grape</td>
<td>75 ± 3</td>
<td>15</td>
<td>0.20</td>
</tr>
<tr>
<td>Fruit Punch</td>
<td>Hawaiian Punch</td>
<td>200g ± 5</td>
<td>62</td>
<td>0.31</td>
</tr>
<tr>
<td>Broccoli</td>
<td>Birdseye</td>
<td>75 ± 5</td>
<td>26</td>
<td>0.34</td>
</tr>
<tr>
<td>Milk</td>
<td>Non- Fat</td>
<td>200g ± 5</td>
<td>74</td>
<td>0.37</td>
</tr>
<tr>
<td>Grapes</td>
<td>Red Seedless</td>
<td>75 ± 3</td>
<td>93</td>
<td>0.75</td>
</tr>
<tr>
<td>Ketchup</td>
<td>Heinz Original</td>
<td>55 ± 5</td>
<td>65</td>
<td>1.18</td>
</tr>
<tr>
<td>Chicken Nuggets</td>
<td>Tyson 100% Natural</td>
<td>90 ± 5</td>
<td>270</td>
<td>3.00</td>
</tr>
<tr>
<td>Cookies</td>
<td>Chips Ahoy Original</td>
<td>34 ± 3</td>
<td>160</td>
<td>4.71</td>
</tr>
<tr>
<td>Potato Chips</td>
<td>Lay's Original</td>
<td>50 ± 5</td>
<td>290</td>
<td>5.71</td>
</tr>
</tbody>
</table>
**Food Preparation**

Hot foods (chicken nuggets and broccoli) and beverage servings were prepared on the day of the study, within 30 minutes of each visit and other foods were repackaged into individual bags on a weekly basis and kept in dry storage. Chicken nuggets were baked in a toaster oven (Oster, Wickliffe OH) according to manufacturer instructions (400°F for 12 minutes). Broccoli was prepared by steaming frozen broccoli with tap water in a covered bowl (Pyrex, Corning NY) in a microwave oven (General Electric, Fairfield CT). Grapes and tomatoes were rinsed with water and dried before storage. Milk, fruit punch, tomatoes, grapes, and ketchup were held and served at a chilled temperature. Cookies and chips were served at room temperature. Two to three servings of each item were prepared for each visit to ensure their availability during the ad libitum test meal, with additional food readily available if the child wanted more than three servings of a given food.

**Presentation**

Prior to serving, test meal foods and beverages were weighed to the nearest 0.01g using a digital balance and a small label indicating their initial weight was attached to each container in an inconspicuous location. For the test meal, foods were presented as follows: chicken nuggets were arranged on a six-inch plastic plate and broccoli was served in a six-inch plastic bowl. Beverages were served in clear 8oz. plastic cups with lids and straws. Ketchup was served in a clear 2oz soufflé cup that was placed on the center of the chicken nugget plate. Grapes, tomatoes, potato chips, and cookies were served in clear plastic zip-top bags. All items were arranged on a tray, as seen fig 2-1.
Fig.2-1: Test Meal Presentation

Each child was presented with a tray with tomatoes, potato chips, chocolate chip cookies, grapes, nonfat milk, fruit punch, broccoli, chicken nuggets, and ketchup. Children were offered additional servings of foods they approached finishing, and were reminded that they could eat as much or as little food as they wanted. Trays were arranged identically for each visit.
Methods

Participants attended two 60-90 minute laboratory visits, conducted within two weeks of each other. Parents were instructed to have their child fast for three hours prior to their appointment. At the beginning of each visit, children were accompanied by their parent reported to be primarily in charge of feeding them; parents and children were then led to individual rooms. Children then tasted foods and ate an *ad libitum* test meal while their parents filled out various questionnaires.

Participant Visits

Visit One

At the first visit, the parents gave written consent for their child’s participation in the study after receiving a written and verbal explanation of the study procedure and risks/benefits of participation. Children gave their verbal assent after receiving a simplified verbal explanation of the procedures from the researcher. Both parents and children were informed that they could stop/withdraw from the study at will and were given an opportunity to ask questions before giving consent/assent.

After collecting participant consent/assent, children’s anthropometric data were collected in light clothing without shoes or coats. Height was measured to the nearest quarter-inch using a portable stadiometer (SECA, Chino CA) and weight was measured to the tenth of a pound using a digital scale (Tanita, Arlington Heights IL).
Following measurement of body weight, children were trained to rate food liking using a developmentally appropriate hedonic scale (Fig. 2-2) and to express their feelings of fullness using a 150mm analog line scaling device, described in Appendix F.

![Peryam & Kroll Five Point Smiley Face Scale](image)

Fig 2-2: Peryam & Kroll Five Point Smiley Face Scale

Children then tasted and rated small samples of chicken nuggets, ketchup, broccoli, grapes, tomatoes, potato chips, cookies, milk, and fruit punch. They were then given *ad libitum* access to the items they previously tasted. Foods were weighed before and after the test meal to assess intake. Children’s perceived fullness was also assessed before and after the test meal.

While the children were going through the above procedure, parents filled out various questionnaires using a computerized survey program (Qualtrics, Provo, UT). Parents provided information about their child’s food preferences and intake, the home food environment, parental feeding practices, knowledge and beliefs about food and nutrition, and socioeconomic status.
Visit Two

Participants returned one to two weeks later for their second visit, which was conducted in a similar manner to the first. Children were reintroduced to the smiley face scale and the fullness scale to ensure they remembered how to use them. If the child forgot how to use either scale, the training script for the respective measure was repeated. The tasting and rating procedure for the test-meal foods from the first visit was then repeated. Children then rated their liking of a variety of foods and activities using the Child Reported Liking Survey, a measure designed for this study that involved children using a five-point smiley face scale to rate their liking of 53 images of foods and activities that are familiar to most children, described in Appendix F. Children were then given 30 minutes ad libitum access to a test meal identical to the test meal from their first session. Perceived fullness was assessed using the Freddy Fullness Scale before and after the meal. At the conclusion of the visit, participants were thanked for their time and effort and received compensation for their time; parents received $40 in cash and children received a toy valued between $3-5.

Child Measures

Laboratory measures of children’s liking and intake used in the analyses described in this study are described below. Measures not used in the analyses presented this thesis are described in Appendix F.
**Food Liking**

Children tasted and rated their liking of each item in the test meal using a developmentally appropriate 5-point hedonic smiley face scale, shown in fig 3-2 [169]. Children were asked to name their favorite and least favorite foods before being instructed on how to use the scale using a script shown in Appendix D. Children’s understanding of the scale was confirmed by having them rate their liking of their favorite and least favorite foods using the tool. If the child gave a nonsensical rating (e.g. rating their favorite food as “super bad”), the researcher repeated the explanation of the scale and asked the child to indicate which face they would point at for a “very yummy food that you like a lot” and a “yucky food you really don’t like.” All participants demonstrated understanding before going on to rate foods.

Samples of each item were served in clear, unmarked 2oz soufflé cups. Potato chip samples weighed approximately 1g and all other samples weighed approximately 5g. These samples were used to obtain direct liking ratings during test sessions and were placed on a small tray in the testing room. Samples were presented individually and children were asked to rinse with spring water before and after each sample (Culligan, Rosemont, IL). If children were reluctant to try any of the samples, they were reminded that they were allowed to expectorate the sample and rinse their mouth with water (“You can spit it back into the cup if you think it’s really yucky!”).

Each response was converted to a 1-5 scale, where 1 represented “Super Bad” and 5 represented “Super Good,” in accordance with established terminology for sensory testing with children [170]. Participant means were calculated for each item by
averaging ratings for each food at the first and second visits. Summed liking scores were also created for high energy density foods (chicken nuggets, cookies, and potato chips) and low energy density foods (grapes, tomatoes, and broccoli).

**Food Intake**

At both test sessions, the child ate an *ad libitum* test-meal composed of the foods described in table 2-1. The researcher informed children that they had 30 minutes to eat as much or as little food as they wanted and could ask for more food at any time but that they could not take food home. While the child was eating, the researcher read to them from various children’s books that were vetted prior to the visits to make sure they were not related to food, eating, or sensitive topics (e.g. religion). The researcher covertly monitored the child’s eating while reading to them, and if the child finished a serving of food or stopped eating, the researcher would remind them that they could have as much or as little food as they want.

Each child’s mean intake of each item over both visits was calculated to account for potential variability in intake (Birch 1991). To determine intake by mass, post-meal food mass was subtracted from pre-meal food mass. Energy intake was calculated by multiplying the mass consumed of each item by its respective energy density (Table 2-1). Intake was also measured in terms of number of servings, calculated by dividing mass intake by mass served for each time. Intake data used in this section included mass of individual test meal items as well as aggregate intake of high ED items (chicken nuggets, cookies, and potato chips), low ED items (broccoli, grapes, and
tomatoes) and overall intake. Meal energy density was calculated by dividing total mass intake by total energy intake of all items. Food energy density was calculated by dividing mass intake of food items by energy consumption of food items.

**Parent Measures**

Questionnaires used to collect information about parental and family factors that may influence children's eating behavior are described below. Copies of all questionnaires used for the analyses presented in this these can be found in Appendix C. For clarity, measures not used for the immediate work presented this thesis are described in Appendix F.

**Food Related Time Use and Label Usage**

Usage of nutrition labels has been associated[171] with positive food habits and increased dietary quality. However, many people either do not read labels or find them overly complicated and confusing [119, 132-134, 172-176]. Because nutrition label reading skills and usage is associated with child weight status and may affect food intake, it was tested as a potential moderator of the relationship between children’s food liking and intake [177].

The questionnaire used in this study was adapted from a tool used to assess young adults’ food and nutrition-related attitudes, behaviors, and skills [178]. The first
part of the inventory assessed beliefs and behaviors related to food as well as time and money expenditures related to food. The second part assessed ability to locate, manipulate, and interpret quantitative information found on nutrition labels. The third part of the inventory assessed ability to make comparisons between different products using nutrition labels. Information used in the analyses in this thesis, including food-related time use [(hours/week spent on a) meal planning b) grocery shopping, and c) food preparation)], food-related spending [($/week spent on a) groceries and b) restaurants/takeout)], and frequency of label reading (Never \(\rightarrow\) Always), and label reading skills (% of quantitative questions answered correctly).

**Nutrition Knowledge**

The parent’s basic nutrition knowledge was measured using an adapted version of Parmenter and Wardle’s General Nutrition Knowledge Questionnaire, originally designed for adults in the United Kingdom. The original measure included 50 items covering Dietary Recommendations, Sources of Nutrients, Choosing Everyday Foods, and Diet-Disease Relationships [179].

For the purposes of this study, the language and some of the food items in the survey were adapted to suit an American population. Language adaptations included changing some words from their British spelling (e.g. fibre) to their American English spelling (e.g. fiber) as well as some lexical changes, like changing the phrase “muesli bar” to “cereal snack bar” and using the phrase “skim milk” rather than “skimmed milk”. Some items in Parmenter and Wardle’s instrument are not commonly eaten in the United
States, so they were replaced with similar foods that are more commonly eaten by Americans; for example, kippers and digestive biscuits were replaced by sardines and graham crackers, respectively.

Additionally, the Diet-Disease Relationship section was replaced with a section that examines common misconceptions about food and nutrition. Nutrition concerns and trends have changed considerably since the original tool was validated, and so a series of items involving contemporary food trends and concerns, such as gluten intolerance, organic foods, microwave cooking, and trans fats [180-183]. These items were developed using reports from academic and market research as well as popular media. One such item reads, “Everyone should eliminate gluten from their diet,” based on growing interest in gluten free diets among consumers [180] Parents were also asked questions focused on nutrition recommendations for children. The items for this measure were developed using recommendations from the FDA’s MyPlate, the World Health Organization, the American Academy of Pediatrics, and the Centers for Disease Control [17, 184-188]. Questions were reviewed by Registered Dieticians and childhood nutrition experts. Each parents’ nutrition knowledge was expressed as the percentage of questions he or she answered correctly.

**Socioeconomic Status and Family Structure**

Socioeconomic status is a complex construct involving social class, education, occupation, income, wealth, and various other factors that have been implicated in health outcomes because it can affect access to healthy foods, safe physical activity, and
healthcare [8, 9, 101, 108, 189-192]. In order to gather information about participants’ socioeconomic status, we developed questionnaire with the guidance of sociologists and demographers.

The questionnaire included items that were specifically written for this study as well as items that were adapted from measures from the PhenX toolkit (RTI International, Research Triangle Park, NC). Constructs of interest in this measure included parental and child race and ethnicity, household size, family income, parental employment status, parental educational status, and use of income-dependent public assistance programs such as Supplemental Nutrition Assistance Program (SNAP), Women, Infants, and Children (WIC), and Medicaid. Additionally, the questionnaire included items concerning markers of poverty such as ownership of a functional automobile and use of soup kitchens and food pantries [193]. The data from this questionnaire were used to stratify participants in multiple terms of socioeconomic status (income, education, work status, and use of public assistance programs). To account for differences in family size, an estimate of per capita income was calculated by dividing the median of each income level by the number of people living in a household (see table 2-3).

<table>
<thead>
<tr>
<th>Reported Income</th>
<th>Estimated Gross Income</th>
<th>Per Capita Income (Family of 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than $20,000</td>
<td>$10,000</td>
<td>$2500</td>
</tr>
<tr>
<td>$20,000 - $35,000</td>
<td>$27,500</td>
<td>$6875</td>
</tr>
<tr>
<td>$36,000 - $50,000</td>
<td>$44,000</td>
<td>$11,000</td>
</tr>
<tr>
<td>$51,000 - $75,000</td>
<td>$63,000</td>
<td>$15,750</td>
</tr>
<tr>
<td>$76,000 - $100,000</td>
<td>$88,000</td>
<td>$22,000</td>
</tr>
<tr>
<td>More than $100,000</td>
<td>$120,000</td>
<td>$30,000</td>
</tr>
</tbody>
</table>
Data Analysis

Analytical methods used for primary and secondary aims are described below. SPSS20 (SPSS Inc., Chicago, IL) was used for all data analysis.

*Primary Aim 1 (Chapter 3): How strong is the relationship between children’s liking and intake of a variety of foods?*

The strength of the relationship between food liking and intake was determined using Spearman rank order correlations between children’s liking ratings and multiple measures of children’s test meal intake. For each food/category, three correlations were calculated – liking vs. number of servings consumed, liking vs. mass consumed, and liking vs. energy intake. To test the overall relationship between food liking and intake, mean liking scores for all test meal items were compared to children’s mean total test meal intake. To test the relationship between liking and intake of high energy density foods (chicken nuggets, cookies, and potato chips), mean liking ratings for these foods were compared to mean intake of these foods using Spearman’s rho. To test the relationship between liking and intake of low energy density foods, Spearman’s rho was calculated between mean liking and intake of tomatoes, grapes, and broccoli.
Primary Aim 2 (Chapter 4): Does family socioeconomic status affect the relationship between children’s food liking and intake?

The effects of socioeconomic status on the relationship between food liking and intake were determined using moderation analyses [194]. Factors tested as potential moderators included parental education, family income, use of government assistance programs (e.g. WIC, SNAP, and Medicaid, among others), and parental work status (whether or not parents reported being full-time stay-at-home parents). Continuous variables (education, income) were normalized and dichotomous factors (WIC eligibility, use of government assistance programs, and work status) were coded as 1 (yes) or 0 (no).

To test for moderation, family/parent/child factors that are associated with food intake were added to linear regression models as predictors of the outcome variable (food intake) along with normalized liking (the main predictor). A multiplicative interaction term (predictor \times potential moderator) was included in the regression model in addition to liking and the potential moderator itself (3 predictors in total for each model). A significant interaction effect was taken as evidence of moderation. Significant interactions were interpreted using graphical interaction plots. For continuous variables, high and low categories were created by grouping children whose value for a given variable was 1 standard deviation above (high) or below (low) the group mean value of that variable. For dichotomous variables, categories were determined through coding (0 or 1).
Primary Aim 3 (Chapter 4): Does parental involvement/knowledge in/of food and nutrition affect the relationship between food liking and intake?

The effects of parental nutrition knowledge, food-related time use, and nutrition label reading on the relationship between food liking and intake were determined using moderation analyses [194]. Nutrition knowledge test scores and reports of weekly time spent on food preparation were normalized and label reading was coded as 1 (regular label reader) or 0 (not a regular label reader). Moderation analysis (described above, under Primary Aim 2) and interaction plots were used to determine and interpret parental effects on the relationship between food liking and intake.

Secondary Aim 1 (Chapter 4): Do child-specific characteristics affect the relationship between food liking and intake?

The effects of child sex, age, and weight status on the relationship between food liking and intake were determined using moderation analyses [194]. Continuous factors (age and child BMI percentile) were normalized and sex was coded as 1 (male) or 0 (female). Moderation analysis (described above, under Primary Aim 2) and interaction plots were used to determine and interpret parental effects on the relationship between food liking and intake.
Secondary Aim 2 (Chapter 5): Does the amount of time parents spend on food at home affect children’s food choices in a laboratory environment?

To investigate the relationship between parents’ food-related time use and children’s food intake at laboratory test-meals, Pearson correlations were calculated between test meal intake data and parents’ reported time spent on grocery shopping, meal planning, and food preparation. A partial correlation that controlled for family income, use of social assistance programs, family size, race/ethnicity, education, parental work status, and marital status was used to test for effects due to socioeconomic status. Additionally, one-way ANOVA was used to compare children’s test-meal intake between three groups of participants depending on levels of parent-reported time spent on food preparation classified as low (5 or fewer hours per week), medium (between 5 and 10 hours per week) and high (10 or more hours per week). When significant ANOVA results were found, post-hoc Fisher’s LSD analyses were used to identify group differences in mean test meal intake.
Chapter 3  
Correlations between Food Liking and Intake

Introduction

This relationship between food liking and intake is assumed especially strong among children, to the extent that it has been stated, “children eat what they like and leave the rest” [195]. Birch’s seminal work on food preference and intake is often cited as evidence that children’s eating behavior is driven by how much they like foods and that the link between food liking and intake is stronger in children than in adults. Birch compared her results to previous studies on “food preferences” and intake in adults and reported that the correlation she found (0.80) was stronger than correlations reported in adults (0.25 - 0.50) in various US Army studies [135, 137, 143, 144]. However, the Army ‘preference’ studies used 9-point scales that measure hedonic liking[145]. Birch’s study measured food preference (Do you like A more than B? – measured as a rank order) rather than liking (How much do you like A? – measured as an acceptance rating)[145]. Because of this semantic confusion, it is largely assumed that children eat solely based on the pleasure derived from foods and will not eat foods they dislike, unlike adults, whose food choices are complicated by other concerns. [196]

While this seminal paper is highly esteemed and frequently referenced, the study was conducted before research revealed a variety of influences on children’s eating behavior. Birch’s design included foods that are not commonly eaten by preschoolers
(such as caviar/cream cheese and mint jelly/margarine sandwiches) which may show effects due to novelty and used a group meal setting, allowing peer influences to potentially impact children’s food intake. Since this study was carried out, understanding of children’s eating behaviors has grown considerably, largely due to subsequent contributions from Birch and colleagues [75, 96, 197-203]. Additionally, since this study was published, hedonic liking scales that are appropriate for young children have been developed and validated, allowing for better comparisons between adults and children’s food ratings [169, 170, 204-206].

To gain a better understanding of the relationship between children’s food liking and intake, we asked children to taste and rate their liking of seven foods and two beverages and eat *ad libitum* test meals composed of the rated items. Relationships between food liking and intake were determined using Spearman rank order correlations between children’s self-reported liking ratings and their food intake at two identical, self-selected, *ad libitum* test-meals. Mean food intake values were used to account for variability often seen in children’s eating behavior [199]. We expected that, in general, children’s food intake would be positively correlated with their hedonic ratings. However, we also hypothesized that the strength of the effect of liking on intake would differ among individual foods. Finally, we hypothesized that the relationship between food liking and intake would be stronger in disliked foods than in universally liked foods.
Results

Participants

Fifty-eight (58) children (26 girls and 32 boys) between ages 4 and 6 years (mean: 5.44 +/- 0.8 years) attended both study visits—three other children participated in the first visit, but did not return for their second visit (retention – 95%). Results reported in this thesis are analyses of data from children who completed both visits. For information about overall participant characteristics, including the children who did not complete both visits, see appendix A.

Participants were recruited using advertisements throughout Central Pennsylvania. The majority of children in this study were white (86%), but the racial distribution was similar to US Census reports about Centre County, Pennsylvania, where this research took place [207].

As shown in fig 3-1, Children’s age and sex adjusted body mass indices ranged from the 4th (underweight) to the 99th (obese), but most children in the study were neither underweight (< 5th percentile) nor overweight/obese (overweight: >85th percentile; obese: >95th percentile) [37]. This sample is not representative of the United States population BMI distribution; recent epidemiological data indicate that a quarter of preschoolers are overweight or obese [33].
Table 3-1: Children’s age, race, sex, and weight status (n=58)

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5.44</td>
<td>0.80</td>
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</tbody>
</table>

<table>
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<th>BMI Percentile</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>51.6</td>
<td>27.7</td>
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<table>
<thead>
<tr>
<th>Child’s Race</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asian</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Black</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Multiracial</td>
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<td>9</td>
</tr>
<tr>
<td>White</td>
<td>50</td>
<td>86</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Child’s Sex</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>32</td>
<td>55</td>
</tr>
<tr>
<td>Female</td>
<td>26</td>
<td>45</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Child’s Weight Status</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
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<td>2</td>
</tr>
<tr>
<td>Normal Weight</td>
<td>47</td>
<td>81</td>
</tr>
<tr>
<td>Overweight</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Obese</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

Fig 3-1: Distribution of children’s age/gender adjusted BMI percentiles

Participants ranged from underweight to obese, but only 10 children (17.2% of the sample) were considered overweight or obese.
**Food Liking**

Liking ratings are shown in table 3-2. Among individual foods, cookies were most liked (mean rating: 4.69 +/- 0.92) and tomatoes were least liked (mean rating: 2.81 +/- 1.48). Overall, high energy density foods (chicken nuggets, cookies, and potato chips [mean rating: 4.64 +/- 0.33]) were liked more (t= 10.4, p< .001) than low energy density foods (broccoli, grapes, and tomatoes [mean rating: 3.68 +/- 0.69]). Consistent with previous sensory studies in adults [136, 208] and children [170, 205, 206], ratings were skewed toward liking, particularly in the case of high energy density foods like cookies, which only received ratings of “good” and “super good” from our participants, and chicken nuggets, which were not rated as “bad” or “super bad” by any participant.

<table>
<thead>
<tr>
<th></th>
<th>Mean Score</th>
<th>Super Bad (1)</th>
<th>Bad (2)</th>
<th>Maybe Good or Maybe Bad (3)</th>
<th>Good (4)</th>
<th>Super Good (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broccoli</td>
<td>3.53 ± 1.29</td>
<td>6</td>
<td>4</td>
<td>14</td>
<td>23</td>
<td>11</td>
</tr>
<tr>
<td>Chicken Nuggets</td>
<td>4.36 ± 0.90</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>27</td>
<td>26</td>
</tr>
<tr>
<td>Cookies</td>
<td>4.69 ± 0.92</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12</td>
<td>46</td>
</tr>
<tr>
<td>Fruit Punch</td>
<td>4.22 ± 1.04</td>
<td>0</td>
<td>2</td>
<td>13</td>
<td>18</td>
<td>25</td>
</tr>
<tr>
<td>Grapes</td>
<td>4.32 ± 1.00</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>27</td>
<td>25</td>
</tr>
<tr>
<td>Ketchup</td>
<td>3.91 ± 1.13</td>
<td>2</td>
<td>3</td>
<td>12</td>
<td>24</td>
<td>17</td>
</tr>
<tr>
<td>Milk</td>
<td>3.68 ± 1.19</td>
<td>3</td>
<td>5</td>
<td>15</td>
<td>22</td>
<td>13</td>
</tr>
<tr>
<td>Potato Chips</td>
<td>4.45 ± 0.93</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>29</td>
<td>28</td>
</tr>
<tr>
<td>Tomato</td>
<td>2.81 ± 1.48</td>
<td>19</td>
<td>8</td>
<td>8</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>High Energy</td>
<td>4.64 ± 0.33</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>68</td>
<td>100</td>
</tr>
<tr>
<td>Low Energy</td>
<td>3.68 ± 0.69</td>
<td>25</td>
<td>13</td>
<td>27</td>
<td>65</td>
<td>44</td>
</tr>
<tr>
<td>All Items</td>
<td>4.13 ± 1.04</td>
<td>30</td>
<td>23</td>
<td>73</td>
<td>197</td>
<td>199</td>
</tr>
</tbody>
</table>

Table 3-2: Mean Liking Ratings and Rating Distributions
Food Intake

Group intake means are shown in table 3-3. Overall intake varied considerably between individuals, with some children eating as few as 110 kcal and others eating over 1100 kcal (mean intake: 615 +/- 203 kcal) when given ad libitum access to a variety of familiar foods and beverages. By number of servings (fig 3-1), chicken nuggets were most consumed and tomatoes/milk were least consumed. In terms of mass, fruit punch was most consumed and ketchup was least consumed. In terms of energy intake, chicken nuggets were most consumed and tomatoes were least consumed. On average, children consumed more (t=7.94, p<0.001) high energy density food (mean intake: 142.62 +/- 52.90 g) than low energy density food (mean intake: 49.16+/49.20 g).

<table>
<thead>
<tr>
<th>Item</th>
<th>Mass (g)</th>
<th>Energy (kcal)</th>
<th>Servings (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broccoli</td>
<td>21.07 ± 2.77</td>
<td>5 ± 7</td>
<td>0.2 ± 0.3</td>
</tr>
<tr>
<td>Chicken Nuggets</td>
<td>47.48 ± 6.23</td>
<td>282 ± 142</td>
<td>2.8 ± 1.4</td>
</tr>
<tr>
<td>Cookies</td>
<td>22.77 ± 2.99</td>
<td>171 ± 107</td>
<td>1.1 ± 0.7</td>
</tr>
<tr>
<td>Grapes</td>
<td>24.16 ± 31.60</td>
<td>18 ± 24</td>
<td>0.3 ± 0.4</td>
</tr>
<tr>
<td>Ketchup</td>
<td>12.64 ± 1.66</td>
<td>24 ± 15</td>
<td>0.4 ± 0.2</td>
</tr>
<tr>
<td>Milk</td>
<td>36.39 ± 4.78</td>
<td>9 ± 13</td>
<td>0.1 ± 0.3</td>
</tr>
<tr>
<td>Potato Chips</td>
<td>14.19 ± 1.86</td>
<td>71 ± 81</td>
<td>0.2 ± 0.3</td>
</tr>
<tr>
<td>Punch</td>
<td>84.02 ± 11.03</td>
<td>31 ± 26</td>
<td>0.5 ± 0.4</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>18.12 ± 2.38</td>
<td>2 ± 4</td>
<td>0.1 ± 0.2</td>
</tr>
<tr>
<td><strong>High ED Foods</strong></td>
<td><strong>142.62 ± 52.90</strong></td>
<td><strong>524 ± 186</strong></td>
<td><strong>4.1 ± 1.5</strong></td>
</tr>
<tr>
<td><strong>Low ED Foods</strong></td>
<td><strong>49.16 ± 49.20</strong></td>
<td><strong>25 ± 27</strong></td>
<td><strong>0.6 ± 0.6</strong></td>
</tr>
<tr>
<td><strong>Entire Meal</strong></td>
<td><strong>328.07 ± 124.69</strong></td>
<td><strong>614 ± 204</strong></td>
<td><strong>5.7 ± 1.9</strong></td>
</tr>
</tbody>
</table>
Correlations between food liking and intake:

As shown in Fig 3-2, positive liking/intake correlations were found for milk (rho=0.30, p=0.03), grapes (rho=0.34, p=0.01), potato chips (rho=0.35, p=0.01), fruit punch (rho=0.41, p=0.001), and tomatoes (rho=0.60, p<0.001). No significant relationships between liking and intake were found for chicken nuggets (p=0.75), ketchup (p=0.84), cookies (p=0.30), or broccoli (p=0.22). No significant negative correlations were found between liking and intake for any test meal item.

Mean liking and mean intake of low energy density foods (grapes, tomatoes, and broccoli) were moderately correlated (rho=0.28 p=0.03), but no significant relationship was found between mean liking and mean intake of high energy density foods (p=0.72). No relationship was found between mean liking scores for all test meal items and total meal intake (p=0.72) nor between mean liking and combined intake of food items (p=0.19).
Discussion

Children’s food liking and intake may be related in some cases, but the relationship is not as strong or straightforward as previously assumed. We found significant positive relationships between liking and intake of some individual foods (tomatoes, potato chips, grapes, milk, and fruit punch) as well as for low energy density foods as a group, but overall, children’s mean liking ratings for all meal items did not correlate with how much they ate. Overall, these data only partially support the widely held assumption of a strong relationship between children’s food liking and intake.

While liking and intake of some foods showed moderate to strong correlations, they are not as strong as what was reported in Birch’s original food preference and intake paper. One potential reason for the difference between our results and the 1979 results could be the types of foods offered in the test meal; as previously mentioned, Birch’s original study used foods that are unfamiliar to most preschoolers and would therefore most likely have lower and more varied liking ratings than the familiar foods chosen for this study[75].

Differences in measurement methods could also explain some of the disparity between our results and the 1979 study results. The correlation coefficients from the present work are closer to those found in adults by Pilgrim, Peryam, and colleagues in the 1950s and 1960s [135, 136, 143, 144, 209], which is not surprising, because the Smiley Face Scale used in this experiment is a children’s adaptation of the Quartermaster 9-Point Hedonic Scale, which was used in these early studies [169, 170, 204]. Preference may have been a better predictor of intake – two items may be equally
liked (or disliked) but one item may be preferred over the other [145, 208]. There was limited variance in liking scores for some foods – for example, every child rated cookies as “good” or “super good,” which may explain why relationships between liking and intake were not found. Had preference rank orders been used rather than hedonic ratings, correlations may have been food, because the rank order method forces participants to give different ratings for each food, possibly introducing more variance.

Overall, these data suggest that the relationship between food liking and intake is more complex than has often been stated in the literature [138, 195, 210], and that further investigation of the role of liking in determining children’s food intake is needed.
Chapter 4

Moderation of Children’s Food Liking and Intake

Introduction

Liking is considered the best predictor of food intake, particularly among children [93, 211-215]. Children’s food liking and preferences are affected by energy density, the amount of energy per unit of food (often in kcal/g); children are prone to liking foods high in energy density and disliking less energy dense foods [9, 155, 216, 217]. Unfortunately, this contributes to many children disliking lower energy density foods such as vegetables and liking sweet, fatty foods. Because a diet high in discretionary calories and low in fruit and vegetable intake is associated with the development of many serious health conditions [9, 17, 23, 32, 59, 100, 218-220], it is important to clarify the relationship between children’s food acceptance patterns and intake.

However, liking is not the only factor that influences eating behavior. (If that were the case, many people would eat much more birthday cake!) Multiple non-sensory factors have been shown to influence food liking and intake in adults and children, such as food availability, social norms, health concerns, time scarcity, and cost [81, 125, 196, 221]. Understanding what factors can affect the relationship between food liking and intake may lead to the development of more effective, tailored nutrition interventions [16]. Parent-centered nutrition interventions have been shown to be the most effective for improving children’s diet quality [68, 88], and understanding the effects of parent traits
and behaviors could potentially lead to better parent-based programs to help improve children’s diets.

Because parents largely determine young children’s diets [222, 223], we predicted that the relationship between children’s food liking and intake might be moderated by parental characteristics. We hypothesized that family factors would moderate the relationship between food liking and intake, ultimately weakening the relationship between children’s hedonic liking and food intake. Characteristics of interest were chosen because of their associations with diet quality and included socioeconomic status (income[9, 103, 106, 113, 221, 224], education, use of financial assistance programs[225-227], and parental work status[228, 229], nutrition knowledge[130, 133, 174, 178, 179, 226, 230-235], and food-related behaviors (food preparation[109, 115, 125, 163, 178, 231, 236, 237] and nutrition label reading[124, 131, 132, 171-173, 175, 238, 239]). Additionally, we tested child-specific traits including age, gender, and BMI to better characterize the relationship between children’s food liking and intake. We expected to see differences in the strength of the liking/intake relationship between boys and girls as well as between overweight and non-overweight children.

To determine what factors impact the relationship between food liking and intake, we used moderation analysis, developed by Baron and Kenny [194]. For more information about the statistical methodology used for these analyses as well as the study in which these data used in these analyses were collected, see chapter 2. For more information about the children participating in the study as well as their liking and intake ratings, see chapter 3.
Results

Socioeconomic Status (fig 4-1)

The majority (86%) of the children in this sample had at least one parent with a Bachelor’s degree. While the parents in this study were well educated, household incomes were more diverse and ranged from less than $20,000 to over $100,000 per year. Nearly half of the participants in this study were income-eligible to participate in the WIC food assistance program and over a third of the participants in this study received some form of government assistance such as WIC, SNAP, or Medicaid.

Table 4-1: Family Socioeconomic Status Markers

<table>
<thead>
<tr>
<th>Income</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than $20,000</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>$20,000-$35,000</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>$36,000-$50,000</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>$51,000-$75,000</td>
<td>16</td>
<td>28</td>
</tr>
<tr>
<td>$76,000-$100,000</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>More than $100,000</td>
<td>10</td>
<td>17</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Highest Parental Education*</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than High School</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>High School Diploma/GED</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>Bachelor’s Degree</td>
<td>24</td>
<td>41</td>
</tr>
<tr>
<td>Graduate/Professional Degree</td>
<td>26</td>
<td>45</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assistance Program Participant</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>22</td>
<td>38</td>
</tr>
<tr>
<td>No</td>
<td>36</td>
<td>62</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Homemaker</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>27</td>
<td>47</td>
</tr>
<tr>
<td>No</td>
<td>31</td>
<td>53</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WIC Income Eligibility</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>28</td>
<td>48</td>
</tr>
<tr>
<td>No</td>
<td>30</td>
<td>52</td>
</tr>
</tbody>
</table>

Food-related Knowledge and Behaviors (fig 4-2)

While most parents (71%) reported reading nutrition labels “Always” or “Most of the time,” nutrition knowledge levels (57 – 99 % correct) and reported food preparation time (1.0 – 16.0 hours/week) differed considerably.
Moderation Analysis

As shown in Table 4-3, some evidence of moderation of liking and intake was observed. A variable of interest was considered a moderator if an interaction term with liking significantly predicted intake (p<0.05) in a linear model. Regression results and interaction plots for significant moderators are shown in subsections below. Data describing factors that did not meet moderator status but trended toward significance can be found in Appendix E.

Table 4-2: Parental Food Related Knowledge and Behaviors

<table>
<thead>
<tr>
<th>Potential Moderator</th>
<th>Range</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Preparation (hr./week)</td>
<td>1.0 – 16.0</td>
<td>7.7</td>
<td>4.0</td>
</tr>
<tr>
<td>Knowledge Score</td>
<td>57 – 99</td>
<td>81</td>
<td>9</td>
</tr>
<tr>
<td><strong>Response</strong></td>
<td>N</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Label Reading</td>
<td>Regularly reads labels</td>
<td>41</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>Does not read labels</td>
<td>17</td>
<td>29</td>
</tr>
</tbody>
</table>

*Moderation Analysis*

As shown in Table 4-3, some evidence of moderation of liking and intake was observed.

A variable of interest was considered a moderator if an interaction term with liking significantly predicted intake (p<0.05) in a linear model. Regression results and interaction plots for significant moderators are shown in subsections below. Data describing factors that did not meet moderator status but trended toward significance can be found in Appendix E.

Table 4-3: Potential Moderators of Food Liking/Intake

<table>
<thead>
<tr>
<th>Potential Moderator</th>
<th>Overall Meal</th>
<th>High ED Foods</th>
<th>Low ED Foods</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Nutrition Knowledge</em></td>
<td>-</td>
<td>-</td>
<td>/</td>
</tr>
<tr>
<td><em>Nutrition Label Use</em></td>
<td>-</td>
<td>-</td>
<td>/</td>
</tr>
<tr>
<td><em>Food Preparation Time</em></td>
<td>-</td>
<td>-</td>
<td>/</td>
</tr>
<tr>
<td><em>Parental Education</em></td>
<td>/</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>Family Income</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>Parental Work Status</em></td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td><em>Gender</em></td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td><em>Age</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>Child BMI Percentile</em></td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>

+ indicates significant moderation of liking/intake relationship (p < 0.05)
- indicates no significant evidence of moderation
/ indicates a potential trend (0.05 < p < 0.10)
Work status as a moderator of high Energy Density Food Liking and Intake

Neither a model using high energy density food liking (F (1, 56) =1.625, p=0.208) nor a two-predictor model with high energy density food liking and work status (F (2, 55) =1.693, p=.193) significantly predicted high-energy food intake. The addition of a liking/work status interaction term (Table 4-4) was a significant predictor of intake and significantly increased model fit (p=0.041). This model trended (F (3,54) = 2.659, p=0.06) toward prediction of high energy density food intake, explaining 12.9% of variance in intake in comparison to the 4.4% of variance explained by predicting high energy density food intake by liking alone and 5.8% of variance explained by liking and parent work status, without an interaction term.

As shown in fig 4-1, high energy density food liking and intake were negatively related (r=-.46, p=0.02) among children with parents who reported themselves to be homemakers, but high energy density food intake was not significantly related to liking (r= -0.09 p=0.60) among children whose parents reported working outside the home.

Table 4 - 4: Regression Analysis- Parent Work Status/ High Energy Density Foods

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B</th>
<th>p</th>
<th>r</th>
<th>(r^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>138.375</td>
<td>.000</td>
<td>0.359</td>
<td>0.129</td>
</tr>
<tr>
<td>Liking</td>
<td>-2.862</td>
<td>.764</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work Status</td>
<td>-15.508</td>
<td>.333</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interaction</td>
<td>-36.816</td>
<td>.041</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As shown in fig 4-1, high energy density food liking and intake were negatively related (r=-.46, p=0.02) among children with parents who reported themselves to be homemakers, but high energy density food intake was not significantly related to liking (r= -0.09 p=0.60) among children whose parents reported working outside the home.
Parental work status significantly interacts with high energy density food liking (p=0.041), showing a negative relationship ($r=-0.46$, $p=0.02$) between liking and intake among children with parents who report being homemakers (dashed line). No relationship was found between high energy food liking and intake ($p=0.60$) among children with working parents (solid line).
Sex as a moderator of high energy density food liking and intake

Initially, the relationship between high energy density food liking and energy intake from these foods was not significant (p=.208). A model predicting intake as a function of liking and sex was significant (F (2, 55) =6.10, p=0.004). Adding an interaction term as an additional predictor significantly increased the model fit (F (3, 54) = p=0.004), explaining 27.1% of variance in intake in comparison to the 18.2% of variance explained by a model without an added interaction term or the 2.8% explained by high energy density food liking alone.

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B</th>
<th>p</th>
<th>R</th>
<th>r²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>444.669</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liking</td>
<td>91.602</td>
<td>.003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>144.804</td>
<td>.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interaction</td>
<td>-127.841</td>
<td>.004</td>
<td>0.521</td>
<td>0.271</td>
</tr>
</tbody>
</table>

As shown in figure 4-2, girls’ intake of high energy density foods is positively affected by liking (r=0.46, p=0.02), while liking did not predict high energy density food intake in boys.
Fig 4-2: Effect of gender on high energy density food liking/intake

Liking and intake of high energy density foods were positively related ($r=0.46$, $p=0.02$) among girls ($n=27$; solid line), but among boys ($n=31$; dashed line), the relationship between liking and intake not significant ($p=.14$).
BMI Percentile as a moderator of low energy density food liking/intake

Children’s liking of low energy density foods predicted intake of low energy density foods ($r=0.348$, $p=0.007$), Adding children’s BMI percentile to the model did not affect the model fit ($p=0.24$) but the addition of a multiplicative interaction term between liking and BMI percentile significantly improved the fit of model ($p=0.049$). The final model explained 21.1% of variance in low energy density food intake in comparison to 12.9% of variance explained without BMI percentile in the model.

Table 4-6: Regression Analysis - BMI / Low ED Foods

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B</th>
<th>p</th>
<th>r</th>
<th>r²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>49.893</td>
<td>.000</td>
<td>0.46</td>
<td>0.211</td>
</tr>
<tr>
<td>Liking</td>
<td>15.501</td>
<td>.013</td>
<td></td>
<td></td>
</tr>
<tr>
<td>zBMI</td>
<td>5.041</td>
<td>.413</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interaction</td>
<td>12.107</td>
<td>.049</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Children whose BMI percentile was one or more standard deviation below the sample mean (51.6 +/- 27.7) were classified as low weight (n=10; mean BMI percentile: 11.5 +/- 4.7) and children whose BMI percentile was one or more standard deviation above the sample mean were classified as high weight (n=10, mean BMI percentile = 91.9 +/- 4.7). In the low weight group, one child was considered underweight and the other nine were considered normal weight; in the high weight group, three children were considered obese and seven children were considered overweight, according to the 2000 CDC Growth Charts [37]. As shown in fig 4-3, the relationship between low energy density food liking/intake was stronger among children with higher BMI percentiles ($r=0.76$, $p=0.01$) than among children with lower BMI percentiles ($p=0.99$).
Weight status moderated the relationship between low energy density food liking and intake. Among children whose BMI percentile was one standard deviation above the group mean (n=10; dashed line), liking was strongly positively related ($r = 0.76$, $p = 0.01$) to intake of low energy density food. No significant relationship ($r < 0.01$, $p = 0.99$) was found between low energy density food liking and intake among lower weight (-1 SD) children (n=10; solid line).
Discussion

We identified some variables that significantly moderated the relationship between children’s food liking and intake. Specifically, the relationship between children’s liking and intake of high energy density foods was influenced by sex as well as reported parental work status. In contrast, the relationship between low energy density food liking and intake was moderated by children’s BMI percentile. These data suggest that food liking may not positively predict intake in all situations, but that in certain situations, food liking is a strong predictor of intake — particularly in the case of overweight/obese children and low energy density foods.

Moderation analyses gave an unexpected result when it came to the effect of parental work status on liking and intake of highly energy dense foods: among children of stay-at-home parents, liking was a negative predictor of intake. Follow-up comparisons of parental responses to the Child Feeding Questionnaire (Appendix F) indicated some differences between the two groups: stay-at-home parents reported perceived lower weight statuses than working parents (t= -2.18, p = 0.03) and reported monitoring their child’s food intake more than working parents (t= 2.05, p=0.05). Additionally, a non-significant trend toward stay-at-home parents spending more time on food preparation was observed (t=1.81, p=0.09). Future investigations of food liking and intake could investigate these and other differences between stay-at-home and employed parents (and their children) that may explain the relationship we found.

None of the other markers of socioeconomic status we tested as potential moderators affected the relationship food liking and intake — however, these data were
collected in a non-representative environment. Participants in this study were more educated than the general population—nearly 90% of the parents in this study had bachelor’s degrees, while fewer than a third of Americans over age 24 have completed the a bachelor’s degree [207]. Minimal variance in parental education levels may explain why this variable was not found to have moderated the relationship between liking and intake in the present study. Income levels varied considerably, but because this study was conducted in a university-centered town, many participants had WIC-eligible income levels despite having postgraduate degrees. Previous studies examining the relationship between socioeconomic status, time use, and diet quality have primarily been in populations with simultaneously low income and education levels [9, 106, 126, 221, 240-243]. Repeating this study with participants who are more representative of the general population may produce different results.

Additionally, the sample size used in this study was probably too small to see many moderation effects—because eating behaviors are complex, finding a single source of variance can be challenging, particularly when limited statistical power is available for analyses. However, some significant moderation effects were found despite this study’s relatively small sample size—given a larger sample size, we may be able to find other moderators of food liking and intake.

Future research is needed to clarify how and why the identified moderators may affect the relationship between food liking and intake in the laboratory as well as whether or not the observed effects would remain significant under free living conditions (e.g., in homes or schools). Future research with a larger sample size could lead to the discovery of other moderators of food liking and intake that were not found in the present study.
These data show that children’s eating behavior, specifically the relationship between liking and intake, is more complex than previous studies have shown [141, 142]; food liking positively predicts intake in some cases, but just as in adults [23, 196, 212-214], other factors can impact whether or not children eat foods they like and like foods they eat.
Chapter 5

Home food preparation and children’s food choices away from home

Introduction

Nearly half of all food expenditures go to ultra-processed meals and snacks prepared away from home, and children’s intake of these foods has increased dramatically since the 1970’s [10]. The main source of children’s energy intake from foods prepared away from home is fast food, even when intake of foods prepared at school is considered [21, 22]. Foods prepared and consumed away from home are generally higher in energy content and lower in nutritional content than foods cooked at home [21, 26, 27, 118-121]. Intake of foods prepared away from home is associated with poor health [13, 26, 27, 118, 122, 123]. Home food preparation has been linked to increased dietary quality in both adults and adolescents, with some researchers suggesting that eating home cooked meals with family may mitigate the effects from consumption of energy-dense, nutrient poor foods prepared away from home and lead to family-wide dietary improvements [10, 124-127].

To investigate the relationship between parents’ food-related time use and children’s independent food choices away from home, we conducted exploratory secondary analyses on data collected from a study primarily focused on the relationship between children’s food liking and intake. At each of two study visits, parents filled out various questionnaires on a wide range of topics including their children’s food preferences and eating habits, their knowledge of nutrition, their family’s socioeconomic
status, and their personal food-related attitudes, beliefs, and behaviors while their children individually tasted and rated their liking of multiple foods and beverages before eating an ad libitum test meal. Variables of interest for the reported analyses include parental reports of food-related time use in terms of hours per week spent on grocery shopping, meal planning, and food preparation and children’s test meal intake. For further information about study methodology, see Chapter 2.

Because parents make most decisions related to children’s diets, [223], we hypothesized that parental food-related behaviors would affect children's food selection in a laboratory setting. Because consumption of energy-dense foods prepared away from home is often driven by perceptions of time scarcity (feeling like there is not enough time to engage in both necessary and leisure activities) and home food preparation is associated with better diet quality, we predicted that children whose parents reported more time spent on food preparation would select foods lower in energy density in an ad libitum test meal containing a variety of foods. Additionally, because socioeconomic status is associated with diet quality [108] as well as perceived and actual time scarcity[109, 221, 228, 229, 244, 245] (e.g. working multiple jobs or having an unpredictable work schedule), we predicted the time/intake relationship would be partly explained by differences in socioeconomic status.

The research described in the this chapter was presented as a talk titled “Parents' reported food preparation time is inversely associated with energy density of children's ad libitum laboratory meals” at SSIB 2014, the 22nd Annual Meeting of the Society for the Study of Ingestive Behavior, on August 2, 2014 in Seattle, Washington.
Results

Table 5-1 shows mean values and ranges of parental reports of time usually spent on food-related activities (grocery shopping, meal planning, and food preparation) in terms of hours per week, to the nearest 0.1 hour. Time used for food-related activities was highly variable, with coefficients of variation for grocery shopping, meal planning, and food preparation time ranging from 52-100%.

Table 5-1: Parental reports of time spent on food related activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Mean (SD)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grocery Shopping (hours/week)</td>
<td>2.7 (1.9)</td>
<td>0.00 – 12.4</td>
</tr>
<tr>
<td>Meal Planning Time (hours/week)</td>
<td>1.9 (1.9)</td>
<td>0.3 – 12.7</td>
</tr>
<tr>
<td>Meal Preparation (hours/week)</td>
<td>7.7 (4.0)</td>
<td>1.0 – 16.0</td>
</tr>
</tbody>
</table>

Some significant correlations (table 5-2) were observed between food-related time use and children’s test meal intake. Reported time spent on grocery shopping was positively correlated with children’s laboratory intake of grapes (r=0.29, p =0.03) and non-significant negative associations were observed between parent reported grocery shopping time and children’s meal energy density (r=-.25, p= .06), overall energy intake (r= -.23, p=.08), high energy density food intake (chicken nuggets, chips, and cookies) (r= -.22, p=.09), and fruit punch intake (r=-.23, p= .09) . An significant negative correlation was observed between meal planning and high energy density food intake (r= -.29, p= .03) and a non-significant negative relationship was observed between meal planning time and children’s test meal energy intake (r=-.23, p= .09). Significant negative correlations were found between time spent on food preparation and child-selected food energy density (r= -.35, p= .01) but not food intake in terms of mass (r= -.10, p= .35).
A simultaneous partial correlation analysis indicated that the association between food preparation time (1) and test meal energy (2) density remained significant after controlling for socioeconomic status and home structure in terms of family income (3), use of social assistance programs, family size, race/ethnicity, education, parental work status, and marital status ($r_{12} = .39$, $p = .01$). These data do not support the hypothesis that the relationship between food preparation time and energy density is explained by family socioeconomic status or related variables.

To further clarify the relationship between reported food preparation time and test meal intake, participants were grouped by their reported weekly food preparation time: the low group (n=20) spent 5 or fewer hours, the mid group (n=22) spent between 5 and 10 hours, and the high group (n=16) spent 10 or more hours on food preparation on a weekly basis. Intake data for low, mid, and high prep time groups are shown in table 5-3. A comparison using one-way ANOVA showed a significant (F(2,55) = 4.557, $p = .015$) difference in the energy density of foods eaten during the test meal (table 5-3) by children in the low (2.89 ± .63 kCal/g), mid (3.01 ± .55 kCal/g), and high (2.39 ± 63 kCal/g) food preparation time groups and follow-up analyses using Fisher’s LSD revealed significant differences in test meal food energy density between the low and high food preparation time groups ($p = .024$) as well as the mid and high groups ($p = .005$), but not between the low and mid food preparation time groups.

<table>
<thead>
<tr>
<th></th>
<th>Grocery Shopping</th>
<th>Meal Planning</th>
<th>Food Preparation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meal ED (kcal/g)</td>
<td>-.05</td>
<td>-.16</td>
<td>-.23*</td>
</tr>
<tr>
<td>Food ED (kcal/g)</td>
<td>-.25*</td>
<td>-.18</td>
<td>-.35**</td>
</tr>
<tr>
<td>Energy (kCal)</td>
<td>-.23*</td>
<td>-.23*</td>
<td>-.19</td>
</tr>
<tr>
<td>Mass (g)</td>
<td>-.18</td>
<td>-.11</td>
<td>-.10</td>
</tr>
<tr>
<td>Low ED Intake (g)</td>
<td>.18</td>
<td>.13</td>
<td>.18</td>
</tr>
<tr>
<td>High ED Intake (g)</td>
<td>-.27*</td>
<td>-.29*</td>
<td>-.28*</td>
</tr>
</tbody>
</table>

*p<.1  *p<.05  **p<.01
Table 5-3: Effects of reported food preparation time on children’s *ad libitum* test meal intake

<table>
<thead>
<tr>
<th></th>
<th>Less than 5hr/week (n=20)</th>
<th>5-10 hr/week (n=22)</th>
<th>More than 10hr/week (n=16)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Food Energy Density (kcal/g)</strong></td>
<td>2.89 ± 0.63&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.01 ± 0.55&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.39 ± 0.63&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Total Meal Intake (kcal)</strong></td>
<td>633.43 ± 230.97</td>
<td>652.61 ± 145.04</td>
<td>533.59 ± 225.32</td>
</tr>
<tr>
<td><strong>Total Meal Intake (g)</strong></td>
<td>350.94 ± 158.31</td>
<td>337.96 ± 103.31</td>
<td>316.50 ± 114.01</td>
</tr>
<tr>
<td><strong>Chicken Nuggets (g)</strong></td>
<td>96.74 ± 51.42</td>
<td>93.73 ± 44.66</td>
<td>90.63 ± 49.01</td>
</tr>
<tr>
<td><strong>Ketchup (g)</strong></td>
<td>17.57 ± 10.25</td>
<td>19.02 ± 15.09</td>
<td>24.00 ± 11.35</td>
</tr>
<tr>
<td><strong>Tomato (g)</strong></td>
<td>8.35 ± 18.28</td>
<td>5.13 ± 14.16</td>
<td>11.84 ± 22.70</td>
</tr>
<tr>
<td><strong>Broccoli (g)</strong></td>
<td>11.49 ± 17.60</td>
<td>18.23 ± 26.92</td>
<td>17.36 ± 15.62</td>
</tr>
<tr>
<td><strong>Grapes (g)</strong></td>
<td>22.59 (35.65)</td>
<td>19.36 (23.82)</td>
<td>32.70 (32.70)</td>
</tr>
<tr>
<td><strong>Cookies (g)</strong></td>
<td>39.86 ± 23.44&lt;sup&gt;a&lt;/sup&gt;</td>
<td>42.15 ± 24.17&lt;sup&gt;a&lt;/sup&gt;</td>
<td>23.64 ± 14.79&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Milk (g)</strong></td>
<td>23.56 ± 41.11</td>
<td>19.11 ± 9.19</td>
<td>31.17 ± 38.60</td>
</tr>
<tr>
<td><strong>Fruit Punch (g)</strong></td>
<td>118.17 ± 110.80</td>
<td>104.28 ± 56.77</td>
<td>75.39 ± 75.21</td>
</tr>
</tbody>
</table>

Participants were divided into groups by their reported food preparation time: the low group (n=20) spent 5 or fewer hours on food preparation, the mid group (n=22) spent between 5 and 10 hours on food preparation, and the high group (n=16) spent 10 or more hours on food preparation. Significant differences (p<0.05) are marked with a superscript in the first column.
Discussion

The time parents reported spending on food preparation was associated with children’s independent food choices in a laboratory test meal setting. Significant negative associations and trends were observed between food-related time use in terms of grocery shopping, meal planning, and food preparation, and energy intake / food energy density in a child-selected *ad-libitum* meal, suggesting that children whose parents spend more time on food at home may choose healthier foods on their own.

These data do not support the hypothesis that the relationship between food-related time expenditures and children’s food choices is explained by socioeconomic status, but it should be noted that these data were collected in a non-representative environment. The participants in this study were highly educated (>90% earned a Bachelor’s degree) and some may have been more interested in nutrition than the general population. Income levels varied considerably, but because this study was conducted in a university-centered town, many participants had low income levels but high education levels. Previous studies examining the relationship between socioeconomic status, time use, and diet quality have primarily been in populations with low income *and* education levels [9, 106, 126, 221, 240-243]. Repeating this study in a setting more representative of the general population may produce different results.

While the results we found are encouraging in that increasing parents’ reported involvement with food preparation may be associated with an improve in children’s food choices, this work was a secondary analysis of data collected in a study primarily
investigating the relationship between children’s food liking and intake. It is possible that the relationship we found is the result of an unknown third variable that we did not measure—it could be that increased food preparation time and the quality of foods children choose on their own result from something not directly related to food, such as family stability [103, 246]. There is also the possibility that parents in this study did not accurately report the time they spend on food, potentially due to a lack of clarification of what counted as food preparation (we did not provide a definition) or perhaps due to a social desirability bias. Parents are socially expected to cook healthy meals for their families [25, 228, 229, 247, 248] and often report feeling stressed about managing meals. Additionally, self-reports of food preparation time may not accurately represent parents’ involvement with food and cooking or the types of foods they cook at home—many highly nutritious foods can be prepared quickly, and time-intensive recipes are not necessarily healthy.

Future research is needed to clarify what types of food-related time use affect children’s food choices and eating behaviors as well as whether or not the observed effects would remain significant in free living environments (e.g., home, school) and whether encouraging parents to spend more time cooking could lead to better food choices by children in a randomized control trial setting. Future studies might investigate parental food knowledge, skills, and attitudes toward cooking and food preparation with the goal of designing parent-centered interventions to improve children’s diet quality.

These interventions should be carefully planned to make cooking an enjoyable and feasible option for parents without making them feel guilty or overwhelmed—simply telling parents to cook more may not lead to substantial benefits for children. A recent
critique of “foodie-elitism” by Bowen and colleagues entitled “The Joy of Cooking?” concluded that “While some wax nostalgic about a time when people grew their own food and sat around the dinner table eating it, they fail to see the invisible labor that goes into family meals … Cooking is at times joyful, but it is also filled with time pressures, tradeoffs designed to save money, and the burden of pleasing others” [247]. Multiple participants in our study reported that their efforts to ensure a healthy diet for their children were affected by high perceived costs of healthy food, high time requirements for cooking, lack of cooking skills/knowledge, and taste preferences. One potential strategy to help overcome these barriers to home food preparation would be to teach parents how to cook a variety of palatable foods using recipes that could be prepared cheaply and easily and could be prepared ahead of time to allow for healthy meals on busy days.

These preliminary data suggest a connection between parental food-related behaviors and their children’s independent food choices, but further research is needed to clarify this relationship and its applicability to future interventions.
Chapter 6

Overall Discussion and Conclusions

We found that children’s food choices are not necessarily dependent on liking, contrary to what was shown in early work and commonly assumed. Our findings suggest that liking and intake of select foods are positively correlated, but overall, liking does not always predict food intake. Using moderator analysis, we showed that in certain situations and populations, food liking may be a strong predictor of intake, but in other situations and populations, food intake is independent of liking. Finally, we found some evidence to suggest that the amount of time parents spend on food preparation may be related to children’s independent food choices.

Contrary to our expectations, children’s overall mean test meal liking and intake were not correlated. Liking and intake of some individual foods as well as low energy density foods as a group were positively related, but no relationship was found between liking and intake of other individual foods nor between liking and intake of high energy density foods. Scatterplots showing participants’ liking and intake are shown in figure 6-1. We found moderate to strong correlations between in some cases, but the correlations we found were weaker than those found in previous work.

Children’s liking and intake of low energy density foods were significantly related, but liking and intake of the overall test meal as well as high energy density foods were not related. There was limited variance in overall and high energy density food acceptance ratings for which may explain why liking and intake were not always related.
Fig 6-1: Liking and intake of overall test meal and high/low energy density foods
Differences in measurement methods may explain some of the disparity between our findings and prior work in children. The correlation coefficients from our work are closer to those found in adults in the 1950s and 1960s [135, 136, 143, 144, 209] than to the strong correlation reported in Birch’s 1979 study. This is unsurprising, because the Smiley Face Scale used in this experiment is a children’s adaption of the Quartermaster 9-Point Hedonic Scale used in Pilgrim et al.’s studies [169, 170, 204]. Had we used preference rankings, we may have found a stronger correlation—two items may be equally liked (or disliked) but one item may be preferred over the other [145, 208]. However, using acceptance ratings allowed us to analyze liking and intake for individual foods/categories of foods.

Children’s food acceptance ratings may not accurately predict consumption of meals or individual items, which has been previously observed in adults [23, 249]. In a similar vein, many of the correlation coefficients we found (average of individual correlation coefficients: 0.26) for liking and intake were similar to liking/intake correlations found in adults (averages ranged from 0.25 – 0.50 across studies) [214]. Overall, these data suggest that the relationship between food liking and intake is more complex than has often been stated in the literature and that children’s food intake is affected by more than hedonics. [138, 195, 210].

To further investigate the relationship between food liking and intake, we used moderation analysis to test variables previously shown to be associated with diet quality. We did find some evidence of moderation of food liking/intake—the relationship between liking and intake of high energy density foods differed between boys and girls—girls’ intake of high energy density foods was positively associated with liking but no
significant relationship was found between boys’ food liking and intake. The relationship between liking and intake of low energy density foods differed between higher weight children and lower weight children, where liking was a stronger predictor of intake among children who were overweight or obese than among lower weight children, who ate similar amounts of low energy density foods regardless of whether these children actually liked them.

We also found that parental work status moderated the relationship between food liking and intake; unexpectedly, we found a negative relationship between liking and intake of high energy density foods among children with full time stay-at home while no relationship was observed among children with parents who work outside the home. This result was unexpected, as previous research shows significant positive relationships between children’s food liking and intake; while we foresaw that we might not observe relationships between food liking and intake, we did not expect to see a significant negative relationship between liking and intake. One potential explanation of this unexpected finding might be that stay-at-home parents have more opportunity to discuss food choices with their children [228, 248], potentially encouraging children to avoid overindulging in foods they enjoy [250-252]. However, we did not collect in-depth data related to parent/child food-related interactions, so we are not able to explain how parental work status may influence eating behavior with any certainty. Follow-up studies to clarify these findings are warranted.

While we did find some evidence of moderation of liking and intake, predictors we hypothesized would affect the relationship between liking and intake including parental nutrition knowledge, family income, enrollment in financial assistance programs,
and label reading were not found to be significant moderators in our analysis. It could be that these factors genuinely do not affect the relationship between food liking and intake, but it is also likely that we did not have a large enough sample to provide the statistical power needed for proper moderation analysis—many behavioral studies using this method use more than double the sample size of our study [253]. Future research may clarify our findings and uncover other influences on the relationship between food liking and intake.

While we found few predictors of the strength of the relationship between food liking and intake, we did find that some variables predicted food liking and intake independently of one another. In particular, an exploratory secondary analysis revealed relationships between the time parents reported spending on food preparation and the energy density of the foods children ate in ad libitum laboratory test meals. Specifically, we showed evidence of a negative relationship between time spent on food preparation and test meal food energy density using both correlation analysis and group-wise comparison using one-way ANOVA. These data suggest that the time parents spend on food may affect children’s independent food choices. However, the primary aim of this study was to investigate the relationship between food liking and intake and not to investigate how home cooking affects away-from-home food choices. Follow-up studies focused on the effects of parents’ food-related behaviors are necessary to clarify and validate the relationship we found.
Limitations and Strengths

This section contains a discussion of several limitations encountered in this study, including explanations of strategies we took to work around limitations we predicted ahead of time as well as a discussion of some potential consequences of study limitations. Finally, some suggestions for future studies are included throughout this discussion—further discussion of future work can be found in the next section, titled “Future Work”.

Potential for Self-Report Biases

Humans are susceptible to a number of self-report biases related to social desirability [254]. To try to minimize this potential issue, we thoroughly explained questionnaires to parents, ensuring that their answers were confidential. This was of particular concern because we asked questions related to income, markers of poverty, dieting, health issues, and other sensitive topics.

Collecting self-reports from children presents a number of challenges, as well: preschool-aged children are likely to answer in the affirmative regardless of their actual thoughts or feelings in an effort to please the experimenter [165, 166, 255] and are often taught that it is rude or inappropriate to criticize food prepared by others [256, 257]. To try accurate ratings from the children in this study, we told them that it was important that they told the truth, and that we would not be offended if they did not like any of the foods. Nonetheless, there is a possibility that the data we collected using self-reports may not depict reality. It should be noted that high energy density foods were more liked than low energy density foods, as we expected, but no foods in this study were rated less than “just okay” on average. In future research, we could potentially find ways to measure
liking that do not involve collecting responses directly from participants [257] or use foods that are less familiar and universally well-liked, such as the cream cheese/caviar combination that Birch used in her 1979 study [142].

**Generalizability of Laboratory Intake Data**

Because this study took place in a limited amount of time, children only visited our laboratory two times. While the participant retention rate was extremely high (95%), taking the average of two eating occasions may not accurately portray children’s eating behaviors, as they are highly variable [3, 199, 258]. However, adding additional visits to the study may have led to greater participant burden and less study compliance.

Test meals can approximate usual eating occasions, but may not generalize to less controlled environments away from the laboratory. For example, children eating away from home would likely have a greater variety of foods to choose from than what was presented to them in our study. Additionally, because meals are often social occasions in comfortable locations, a meal eaten in front of a stranger who isn’t eating and a one-way mirror may be awkward for some participants[259]. To lessen the potential awkwardness of the situation, we read to children during their meals, but as many parents casually reported, many of the children in this study had never been read to during a meal, which could have potentially acted as a distraction[260] or could have engaged children in their eating experience. In either case, reading to the children in this study may have influenced their eating behavior; however, all children were read the same set of stories in the same order, so we can at least be sure that each child had a similar test meal experience.
Potential Parental Influences

Children were not told that their parents could view their visits, but some participants indicated awareness that their parents could see them. Previous research has shown that parental presence and/or knowledge of parental monitoring affect children’s food choices and intake in laboratory settings [261]. In future studies, parents may complete additional tasks that would divert their attention away from their child’s visit, potentially helping children feel less like they are under parental supervision.

While each child’s test meal eating experience was highly controlled, we cannot control what happened outside the laboratory between children’s visits. Although parents were instructed to not discuss their children’s food choices during the study nor talk about food/nutrition any more than they usually would, we cannot guarantee parental compliance. At least two parents scolded children about their food choices after the first visit, potentially leading children giving different responses and eating different foods during the test meal in hopes of pleasing their parent by making “healthy” choices [78, 112, 202, 223, 262-264].

Because children were given ad libitum access to a variety of foods, we expected that some children would overeat during test meals, however at least one child overate to the point of physical discomfort in our study. One parent reported that her child became ill the day of their first visit after eating much more food than is usually offered to him at home; this child then significantly less food at his second visit. The mother also mentioned telling her son to “take it easy” on his second visit, coaching him to eat less. The child’s changes in intake at the second meal could also potentially be the result of a
learned food aversions, since people tend to reject foods they associate with feeling sick [47-49].

**Participant Demographics**

Conducting human research in a university-centered town presents a number of limitations regarding the diversity of our participant pool and the generalizability of the results we found. Central Pennsylvania is not representative of the country (or world), and because Pennsylvania State University is located in a “college town” environment, our study participants may not be representative of the population at large. Participants in this study were primarily white and non-Hispanic, reflecting the demographic characteristics of Central PA, but not the United States at large. Participant education levels did not reflect the general population: 86% of children in this study had at least one parent with a Bachelor’s degree, while less than a third of American adults have earned a Bachelor’s degree [207]. While the vast majority of parents participating in this study attained Bachelor’s degrees, nearly half of the families had incomes low enough to qualify for participation in the WIC program [265].

Additionally, because these data were collected in a university environment, the majority of our participants were affiliated with Pennsylvania State University in some way, with a non-trivial number of academic families. These families may have different values, food-related attitudes, and behaviors from the general population. Notably, many of the children in the study were exposed to a number of foods not generally associated with the standard American child’s diet[12], including
kale, sushi, and hummus, and many parents mentioned that they were “foodies” who placed much importance on cooking, eating, and exploring unfamiliar cuisines. These children may have been less neophobic than average, and therefore they could have been more willing to try certain foods than children who are less encouraged to try new foods.

**Study Strengths**

This study provided robust preliminary results that further understanding of children’s eating behavior, with a larger sample size and more updated measurement tools than previous studies of children’s food preference and intake. Methodological strengths of this study include having participants actually taste foods before rating them rather than having them indicate their preferences using a checklist, a convenient but not necessarily accurate tool used by many previous eating behavior studies in adults and children.

A related strength is that our food intake data were collected from actual consumption during multiple eating occasions rather than a dietary recall record or food frequency questionnaire; while there is error involved with any type of consumption measurement, we can be fairly sure of the accuracy of laboratory test meal intake data. Another strength of this work is its interdisciplinary nature—our study was conducted cross-departmentally, bringing together sensory science and nutritional science to further the understanding of children’s eating behavior.

Our work contributes to understanding of eating behavior in a number of ways: first, it challenges widely held assumptions about the role of liking in children’s food
choices, indicating that children’s food liking and intake are more complex than previously thought. The relationship between food liking and intake depends on the foods used in the study as well as individual characteristics. This work is also the first to study moderation of food liking and intake in children, and is the first study to investigate moderation of food liking and intake in a laboratory test meal setting. Finally, our exploratory analysis of the effects of food preparation on children’s food choices in a laboratory test meal setting indicates that food preparation may positively affect diet quality in children, as has been recently shown in adults [231] and adolescents [125]. To our knowledge, this is the first investigation of the influences of food-related time use at home on food choice in a controlled laboratory setting.
Future Work

This section presents five suggested areas for future research exploring the relationship between food liking and intake in children:

1) Collecting data at other research sites;
2) Analyzing non-verbal reactions to food
3) Investigating parent and child beliefs and attitudes about food and eating
4) Investigating home food preparation practices
5) Developing and testing nutrition interventions targeting food preparation practices

Increasing Sample Size and Broadening Participant Demographics

A logical next step would be to repeat and expand the study with a larger and more diverse sample size. Collaborating with research groups in different locations could address several limitations of our study. Clearly, studying multiple cohorts in different locations would increase the number of study participants, and if we were to collaborate with groups in other areas of the country, participant diversity in terms of race, ethnicity, and socioeconomic status could be greatly increased. Additionally, repeating this study outside a college-town environment could potentially give results that are more generalizable—our participants are not representative of the US population. In addition to increasing diversity in study population, a cross-site study may offer additional benefits for carrying out the study. Conducting test meal studies can be time-, money- and labor-intensive and collaborating with other groups would add more personnel to conduct participant visits, potentially leading to more efficient data collection.

Additionally, adding senior investigators as well as adding collaborators may increase the
chances of receiving research funding [266]. On the other hand, cross-site studies present challenges of their own, in terms of planning, logistics, and general intergroup cooperation. Involving additional investigators and research personnel can surely increase manpower, but it also increases the potential for study-related frustration, due to differences in investigators’ research aims, facilities, and personalities. In addition, while conducting this study in multiple locations with increased numbers of both study participants and research personnel could increase analytical power and the generalizability of the results, it would also increase the potential for error—including more groups in data collection could lead to differences in data collection methodology between sites. To offset the potential for error due to conducting research with different groups, careful attention should be given to initial planning phases: we could work proactively to ensure that the effects we may find are due to differences between the participants and not due to idiosyncrasies between labs.

**Assessing Non-Verbal Reactions**

Consistent with other consumer studies in adults and children, the acceptance ratings reported by our study participants were skewed toward liking; while we intentionally avoided using highly objectionable foods, our study participants may not have been entirely truthful about their feelings. Many children are taught that it is inappropriate to criticize foods prepared by others, and thus, they could have given a high rating to a food they did not actually like. Discrepancies between participants’ true feelings and reports pose problems in a variety of fields, including sensory and
psychology research and consumer product testing. Video recording could be used to track participants’ non-verbal reactions to seeing and tasting foods, potentially circumventing the issues presented by collecting self-reports of acceptability. Some research suggests that measuring micro-expressions (immediate subconscious facial reactions) may present a truer indicator of human reactions than self-reports.[257] By examining participants subconscious reactions to foods, we may be able to determine if participants truly enjoy the foods they rate highly or if their ratings are not actually representative of their true feelings [256, 267]. Using this technology would allow researchers to collect more detailed information about children’s liking that they may not be cognitively developed enough to verbally express, potentially allowing for greater resolution of acceptance data than can currently be obtained from preoperational children[206]. Additionally, we could use this technology to code children’s eating behaviors during the test meal, looking at how they eat, rather than just how much they eat. Lab-based coding of eating behaviors may then translate to easier investigations into eating behavior in less controlled environments outside the laboratory, as long as video recording equipment is available.

Exploring Family Attitudes toward Food and Eating

Future research could use interviews with parents or children (or both) to explore attitudes toward and behavioral motivations regarding food and eating behaviors. Specifically, we could interview children post-meal to understand their thought process
during the test meal, potentially clarifying the reasons for their food choices.
Additionally, conducting interviews with both parents and children may provide information about parent-child dynamics and food-related negotiations (e.g. who decides when, what, where, and how much food is eaten?), which could then be tested as moderators of the relationship between food liking and intake.

*Exploring Family Food Preparation Practices*

Our results indicated a potential relationship between parental time use on food preparation and children’s independent food choices, and future studies could explore this topic in further depth, looking not only at parental reports time use on food preparation, but also at the types of foods parents buy and prepare at home, their declarative and procedural knowledge of food (one bit of declarative knowledge might be whether or not parents can identify cruciferous vegetables—related procedural knowledge might be whether or not parents know how to reduce the bitterness of cruciferous vegetables through preparation methods), their motivations for spending time (or not spending time) on food preparation, and their perceptions of barriers to spending time on food. We could also interview parents about their food-related attitudes and behaviors, getting more in depth information about perceived barriers to healthy eating, which may help in the design of more user-friendly and feasible intervention strategies targeted at parents.
Food Preparation-Centered Interventions

With the information gathered from the present study as well as related follow-up work, we could then design interventions to improve children’s diet quality by encouraging home food preparation. We could incorporate information from the hypothetical follow-up studies described above to determine different intervention strategies. All parents who participated in our study were asked to indicate their thoughts about barriers to healthy eating (Table 6-1). Multiple participants responded that their efforts to ensure a healthy diet for their children were affected by high perceived costs of healthy food, high time requirements for cooking, lack of cooking skills/knowledge, and taste. One potential strategy to help overcome these barriers to home food preparation would be to teach parents how to cook a variety of palatable foods using recipes that could be prepared cheaply and easily and could be prepared ahead of time to allow for healthy meals on busy days. Another strategy would be to involve children in recipe development and preparation sessions, which would help ensure that the recipes are “kid-friendly” and would allow children to be actively involved and interested in food.
### Table 6-1: Perceived Barriers to Improving Children’s Diet Quality

<table>
<thead>
<tr>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Healthy food choices are normally pricey, the cheapest options are normally the ones that are processed food and full of trans fats and artificial flavors. Prices and family budgets are the biggest obstacle.”</td>
</tr>
<tr>
<td>“Not having the time or money to do it.”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cooking Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;my knowledge on preparing different types of meals that are healthy instead of preparing the same old veggies night after night&quot;</td>
</tr>
<tr>
<td>&quot;Sugar added to many foods that are easy to prepare.&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>“At school he gets to eat food that he does not get to eat with me such as; poptarts, white bread, nuggets, etc. I wish I had more time to pack all his lunches so he would not have to eat that mess.”</td>
</tr>
<tr>
<td>“Once I get home I am so exhausted that I go to quick and fast recipes or frozen healthy items (hot dogs, pizza, chicken nuggets). I intend to make better choices but than fall back into this rut.”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Taste</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Lots of good tasting, unhealthy options available”</td>
</tr>
<tr>
<td>“They often don't like the healthy foods I prepare.”</td>
</tr>
<tr>
<td>“The fact that other people (ie daycare, other family) have conditioned her to think to taste good, things should be fatty or sweet”</td>
</tr>
</tbody>
</table>

Parents of study participants were asked for open-ended responses to the following prompt: “What is the biggest obstacle to getting your child to eat a healthy diet?” Selected verbatim responses not edited for spelling or grammar are shown above.
Potential Impact

Ultimately, the information learned from the present work as well as related follow-up work could be used in a variety of ways to affect children’s eating behavior. Our results in combination with future research could help efforts by both the public health field and the food industry to affect children’s eating behaviors.

Many public health nutrition interventions designed to improve children’s diet quality are based around the assumption that food liking predicts intake—our research suggests that changing children’s food liking may not always affect intake, and that in some cases, other strategies, such as targeting parent behaviors, may be more effective ways to improve children’s diet quality.

Understanding the impact of liking relative to other factors may also inform product development and marketing strategies within the food industry—for product categories where liking does not predict intake, more resources could be directed into market research and advertising, while in categories where liking does predict intake, more resources could be directed to optimizing the sensory experience to be as pleasant as it can be.
Conclusions

We found that the relationship between children’s food liking and intake is more complex than previous work and common assumptions indicate: liking is positively related to intake of some foods, but we did not find a relationship between overall test meal liking and intake. Furthermore, the relationship between food liking and intake can be affected by participant characteristics; in certain cases, liking is a strong predictor of intake, but in other situations and populations, food intake is independent of liking. Food liking may not always be the best predictor of children’s food intake, and our findings from exploratory data analyses suggest an alternate predictor of children’s food choices—the amount of time their parents spend on food preparation. Our findings are encouraging in they may eventually lead to new strategies for improving children’s diet quality, but much more research must be done before we can apply this work to a real-world setting.
Appendix A: Descriptive data for all participants (n=61)

<table>
<thead>
<tr>
<th>Children’s age, race, sex, and weight status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>BMI Percentile</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Child’s Race</td>
</tr>
<tr>
<td>Asian</td>
</tr>
<tr>
<td>Black</td>
</tr>
<tr>
<td>Multiracial</td>
</tr>
<tr>
<td>White</td>
</tr>
<tr>
<td>Child’s Sex</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Child’s Weight Status</td>
</tr>
<tr>
<td>Underweight</td>
</tr>
<tr>
<td>Normal Weight</td>
</tr>
<tr>
<td>Overweight</td>
</tr>
<tr>
<td>Obese</td>
</tr>
</tbody>
</table>
Appendix B: Liking and Intake Data from Visits 1 and 2

Table B1: Rating Distribution for Visit 1

<table>
<thead>
<tr>
<th>Item</th>
<th>Super Bad</th>
<th>Bad</th>
<th>Maybe Good</th>
<th>Good</th>
<th>Super Good</th>
<th>Group Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broccoli</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>4.52 (0.65)</td>
</tr>
<tr>
<td>Chicken Nuggets</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>19</td>
<td>37</td>
<td>4.90 (0.30)</td>
</tr>
<tr>
<td>Cookies</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>55</td>
<td>4.31 (0.90)</td>
</tr>
<tr>
<td>Fruit Punch</td>
<td>1</td>
<td>1</td>
<td>9</td>
<td>17</td>
<td>33</td>
<td>4.44 (0.83)</td>
</tr>
<tr>
<td>Grapes</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>22</td>
<td>35</td>
<td>4.03 (1.05)</td>
</tr>
<tr>
<td>Ketchup</td>
<td>3</td>
<td>2</td>
<td>8</td>
<td>25</td>
<td>17</td>
<td>3.78 (1.20)</td>
</tr>
<tr>
<td>Milk</td>
<td>4</td>
<td>4</td>
<td>14</td>
<td>17</td>
<td>22</td>
<td>4.64 (0.58)</td>
</tr>
<tr>
<td>Potato Chips</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>16</td>
<td>42</td>
<td>2.90 (1.57)</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>17</td>
<td>11</td>
<td>9</td>
<td>9</td>
<td>15</td>
<td>4.69 (0.37)</td>
</tr>
<tr>
<td>High Energy Foods</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>41</td>
<td>134</td>
<td>3.61 (0.84)</td>
</tr>
<tr>
<td>Low Energy Foods</td>
<td>25</td>
<td>20</td>
<td>22</td>
<td>50</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>All Items</td>
<td>33</td>
<td>27</td>
<td>65</td>
<td>149</td>
<td>272</td>
<td>4.11 (0.42)</td>
</tr>
</tbody>
</table>

Test Meal Intake

<table>
<thead>
<tr>
<th>Item</th>
<th>Mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broccoli</td>
<td>21.07 (2.77)</td>
</tr>
<tr>
<td>Chicken Nuggets</td>
<td>47.48 (6.23)</td>
</tr>
<tr>
<td>Cookies</td>
<td>22.77 (2.99)</td>
</tr>
<tr>
<td>Grapes</td>
<td>24.16 (31.60)</td>
</tr>
<tr>
<td>Ketchup</td>
<td>12.64 (1.66)</td>
</tr>
<tr>
<td>Milk</td>
<td>36.39 (4.78)</td>
</tr>
<tr>
<td>Potato Chips</td>
<td>14.19 (1.86)</td>
</tr>
<tr>
<td>Punch</td>
<td>84.02 (11.03)</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>18.12 (2.38)</td>
</tr>
<tr>
<td>High ED Foods</td>
<td>142.62 (52.90)</td>
</tr>
<tr>
<td>Low ED Foods</td>
<td>49.16 (49.20)</td>
</tr>
<tr>
<td>Entire Meal</td>
<td>328.07 (124.69)</td>
</tr>
</tbody>
</table>
### Acceptance Ratings

<table>
<thead>
<tr>
<th>Item</th>
<th>Super Bad 1</th>
<th>Bad 2</th>
<th>Maybe Good 3</th>
<th>Good 4</th>
<th>Super Good 5</th>
<th>Group Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broccoli</td>
<td>6</td>
<td>3</td>
<td>10</td>
<td>16</td>
<td>22</td>
<td>3.79 (1.31)</td>
</tr>
<tr>
<td>Chicken Nuggets</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>23</td>
<td>30</td>
<td>4.46 (0.63)</td>
</tr>
<tr>
<td>Cookies</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>7</td>
<td>48</td>
<td>4.81 (0.48)</td>
</tr>
<tr>
<td>Fruit Punch</td>
<td>1</td>
<td>1</td>
<td>9</td>
<td>13</td>
<td>33</td>
<td>4.33 (0.93)</td>
</tr>
<tr>
<td>Ketchup</td>
<td>1</td>
<td>2</td>
<td>10</td>
<td>22</td>
<td>22</td>
<td>4.09 (0.93)</td>
</tr>
<tr>
<td>Milk</td>
<td>2</td>
<td>6</td>
<td>13</td>
<td>16</td>
<td>20</td>
<td>3.81 (1.14)</td>
</tr>
<tr>
<td>Potato Chips</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>20</td>
<td>34</td>
<td>4.54 (0.60)</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>17</td>
<td>8</td>
<td>9</td>
<td>13</td>
<td>10</td>
<td>2.84 (1.51)</td>
</tr>
<tr>
<td>High Energy Foods</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>50</td>
<td>112</td>
<td>4.60 (0.43)</td>
</tr>
<tr>
<td>Low Energy Foods</td>
<td>23</td>
<td>11</td>
<td>24</td>
<td>51</td>
<td>62</td>
<td>3.69 (.72)</td>
</tr>
<tr>
<td>All Items</td>
<td>27</td>
<td>20</td>
<td>65</td>
<td>152</td>
<td>249</td>
<td>4.12(0.41)</td>
</tr>
</tbody>
</table>

### Test Meal Intake

<table>
<thead>
<tr>
<th>Item</th>
<th>Mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broccoli</td>
<td>14.70(21.10)</td>
</tr>
<tr>
<td>Chicken Nuggets</td>
<td>90.90(59.00)</td>
</tr>
<tr>
<td>Cookies</td>
<td>36.48(23.57)</td>
</tr>
<tr>
<td>Grapes</td>
<td>26.51(40.30)</td>
</tr>
<tr>
<td>Ketchup</td>
<td>19.31(14.72)</td>
</tr>
<tr>
<td>Milk</td>
<td>21.89(37.39)</td>
</tr>
<tr>
<td>Potato Chips</td>
<td>12.38(14.84)</td>
</tr>
<tr>
<td>Punch</td>
<td>106.95(100.41)</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>6.03(17.41)</td>
</tr>
<tr>
<td>High ED Foods</td>
<td>139.77(64.36)</td>
</tr>
<tr>
<td>Low ED Foods</td>
<td>47.24(53.56)</td>
</tr>
<tr>
<td>Entire Meal</td>
<td>333.95(150.81)</td>
</tr>
</tbody>
</table>
Appendix C: Questionnaires Completed by Parents

Nutrition Knowledge Survey 1

Thank you for participating in our study! Your answers to this survey will not be connected to your name. Please answer them to your best ability.

Please enter your participant ID:

How many servings of fruits and vegetables should people eat each day?

Which fat do experts say is most important for people to cut down on?
- Monounsaturated Fat
- Polyunsaturated Fat
- Saturated Fat
- Not sure

Some foods contain a lot of fat but no cholesterol.
- Agree
- Disagree

Some foods contain a lot of cholesterol but no fat.
- Agree
- Disagree

A glass of unsweetened fruit juice counts as a serving of fruit.
- Agree
- Disagree

Brown sugar is a healthy alternative to white sugar.
- Agree
- Disagree

Whole grain bread is usually higher in fiber than white bread.
- Agree
- Disagree
There is more protein in a glass of whole milk than a glass of skim milk.
- Agree
- Disagree

Which do you think is higher in calories: butter or margarine?
- Butter
- Margarine
- Both the Same

A type of oil which contains mostly monounsaturated fat is:
- Coconut Oil
- Sunflower Oil
- Olive Oil
- Palm Oil

If a food is high in sodium, it tastes salty.
- Agree
- Disagree

There is more calcium in a glass of whole milk than a glass of skim milk.
- Agree
- Disagree

Which one of the following has the most calories for the same weight?
- Carbohydrates
- Alcohol
- Protein
- Fiber
- Fat
Read the following statements and mark whether you think they are true or false.

<table>
<thead>
<tr>
<th>Statement</th>
<th>True</th>
<th>False</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trans fat has more calories than saturated fat.</td>
<td>☐</td>
<td>☑</td>
</tr>
<tr>
<td>Honey has a lot of cholesterol.</td>
<td>☑</td>
<td>☐</td>
</tr>
<tr>
<td>1/2 cup of raisins has less fiber than 1/2 cup of grapes.</td>
<td>☐</td>
<td>☑</td>
</tr>
<tr>
<td>100% apple juice has less fiber than a fresh apple.</td>
<td>☑</td>
<td>☐</td>
</tr>
<tr>
<td>MSG is a source of sodium.</td>
<td>☑</td>
<td>☐</td>
</tr>
<tr>
<td>Potassium intake should be limited to 1400mg/day.</td>
<td>☑</td>
<td>☐</td>
</tr>
<tr>
<td>Protein only comes from animal sources.</td>
<td>☑</td>
<td>☐</td>
</tr>
<tr>
<td>Cholesterol only comes from animal sources.</td>
<td>☑</td>
<td>☐</td>
</tr>
<tr>
<td>Saturated fat only comes from animal sources.</td>
<td>☑</td>
<td>☐</td>
</tr>
<tr>
<td>Using a microwave to heat food is unhealthy.</td>
<td>☑</td>
<td>☐</td>
</tr>
<tr>
<td>Citrus fruits are a good source of Vitamin C.</td>
<td>☐</td>
<td>☑</td>
</tr>
<tr>
<td>Milk is a rich source of iron.</td>
<td>☑</td>
<td>☐</td>
</tr>
<tr>
<td>Organic foods have less calories than conventional foods.</td>
<td>☑</td>
<td>☐</td>
</tr>
<tr>
<td>It's impossible to eat too much calcium.</td>
<td>☑</td>
<td>☐</td>
</tr>
<tr>
<td>Children need more calories than adults.</td>
<td>☑</td>
<td>☐</td>
</tr>
<tr>
<td>Milk is a rich source of calcium.</td>
<td>☑</td>
<td>☐</td>
</tr>
<tr>
<td>Gluten is high in sugar.</td>
<td>☑</td>
<td>☐</td>
</tr>
<tr>
<td>Gluten is high in fat.</td>
<td>☑</td>
<td>☐</td>
</tr>
<tr>
<td>Everyone should eliminate gluten from their diet.</td>
<td>☑</td>
<td>☐</td>
</tr>
</tbody>
</table>
**Experts classify foods into groups. We are interested whether people are aware of what foods are in these groups.**

Do you think these foods are high or low in added sugar?

<table>
<thead>
<tr>
<th>Food</th>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bananas</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Plain Yogurt</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Ice cream</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Lemonade</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Ketchup</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Strawberry Yogurt</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Fruit Snacks</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Do you think that these foods are considered to be in the grains group?

<table>
<thead>
<tr>
<th>Food</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheese</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Pasta</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Butter</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Nuts</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Rice</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Cereal</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
Do you think these foods are high or low in sodium?

<table>
<thead>
<tr>
<th>Item</th>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot dogs</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Pasta</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Sardines</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Red Meat</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Spaghetti Sauce</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Frozen Vegetables</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Fresh Vegetables</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Canned Vegetables</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Cheese</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Bread</td>
<td>☐</td>
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</tr>
</tbody>
</table>

Do you think these foods are high or low in fiber?

<table>
<thead>
<tr>
<th>Item</th>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oatmeal</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Bananas</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Eggs</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Red Meat</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Broccoli</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Nuts</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Baked potatoes with skins</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Chicken</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Baked beans</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Dried Fruit</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
The next few items are about choosing foods. Please answer what is being asked and not whether you like or dislike these foods!

Which would be the best choice for a low fat, high fiber snack?
- Light Strawberry Yogurt
- Raisins
- Granola Bar
- Whole wheat crackers and cheddar cheese

If a person wanted to reduce the amount of fat in their diet, which would be the best choice?
- Steak, grilled
- Sausage, grilled
- Turkey, grilled
- Pork chop, grilled

If a person felt like something sweet, but was trying to cut down on sugar, which would be the best choice?
- Honey on toast
- A cereal snack bar
- Graham crackers
- Banana with plain yogurt

If a person wanted to reduce the amount of sodium in their diet, which would be the best choice?
- Lasagna
- Chicken Noodle Soup
- Fruit and Yogurt Parfait
- Frozen Broccoli in Cheese Sauce
What is the USDA's current nutrition guidance system called?
- The Food Pyramid
- The Four Food Groups
- MyPlate
- The Food Plate

What sources do you use to find out what you should feed your family?
- Magazines
- Books
- Internet Forums
- Blogs
- Commercials
- WIC educators
- Doctor/Nurse
- Registered Dietician
- Friends
- My parents or in-laws
- Other members of my family
- I learned it in school.
- My instincts
- TV shows
- Food Packages (not labels)
- Twitter
- Facebook
- Other online social networks
- Other ______________________________

What is the biggest obstacle to getting your child to eat a healthy diet?
**Nutrition Knowledge**

How many servings of fruit should an average 4-5 year old child eat in a day?
- Less than 2
- 2-3
- 4-5
- 5-6
- More than 6

How much fruit is in a serving?
- One piece
- 1/2 cup
- 1 cups
- 1 1/2 cups

How many ounces of protein should a 4-6 year old child eat in a day?
- 2
- 4
- 8
- 16

How many cups of dairy foods should a 4-6 year old child have in a day?
- 0-1
- 2-3
- 4-5
- More than

Which of these counts as one serving of vegetables?
- 1/2 cup raw spinach
- 1 cup cooked spinach
- 1 cup raw spinach
- 2 cups cooked spinach

How much juice should a 4-5 year old child drink per day?
- Less than 1 cup
- 1 cup
- Between 1 and 2 cups
- 2 cups
- More than 2 cups
Which of these pictures shows 1 serving of grapes?
- A
- B
- C

Which of these cups has 1 cup of juice in it?
- A
- B
- C
- D

Children need to eat foods specially made for children.
- True
- False

If a child takes a multivitamin each day, they will get all the nutrients they need.
- True
- False

Fruit juice is a lower-calorie alternative to soda.
- True
- False

There should be as little fat as possible in a child's diet.
- True
- False
A serving of which of these foods counts as a serving of fruit?
- A
- B
- C
- D
- None of these foods.

How many calories are in a serving of each of these foods?
- A - Fruit Snacks
- B - Sweetened, Flavored Applesauce
- C - Fruit on the Bottom Yogurt
- D - Raisins

Which of these foods is

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>lowest in sugar?</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>highest in sugar?</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>highest in fat?</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>highest in fiber?</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
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</table>

How healthy is each of these foods?

<table>
<thead>
<tr>
<th></th>
<th>Very Unhealthy</th>
<th>Somewhat Unlikely</th>
<th>Neither Healthy Nor Unhealthy</th>
<th>Somewhat Healthy</th>
<th>Very Healthy</th>
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</thead>
<tbody>
<tr>
<td>Fruit Snacks</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>Flavored Applesauce</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>Fruit on the Bottom Yogurt</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>Raisins</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
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</table>

How likely are you to give these foods to your child?

<table>
<thead>
<tr>
<th></th>
<th>Very Unlikely</th>
<th>Somewhat Unlikely</th>
<th>Undecided</th>
<th>Somewhat Likely</th>
<th>Very Likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit Snacks</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>Flavored Applesauce</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>Fruit on the Bottom Yogurt</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
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<td>☒</td>
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<tr>
<td>Raisins</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
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</table>
Which of these foods is

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
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<td>〇</td>
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<td>〇</td>
</tr>
<tr>
<td>lowest in sodium?</td>
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<td>〇</td>
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</table>

How healthy are these foods?

<table>
<thead>
<tr>
<th></th>
<th>Very Unhealthy</th>
<th>Somewhat Unhealthy</th>
<th>Neither Healthy Nor Unhealthy</th>
<th>Somewhat Healthy</th>
<th>Very Healthy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macaroni and Cheese</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td>Peanut Butter &amp; Jelly Sandwich</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td>Chicken Nuggets</td>
<td>〇</td>
<td>〇</td>
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</tr>
<tr>
<td>Cheeseburger</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
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<td>〇</td>
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How likely are you to give these foods to your child?

<table>
<thead>
<tr>
<th></th>
<th>Very Unlikely</th>
<th>Somewhat Unlikely</th>
<th>Undecided</th>
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<th>Very Likely</th>
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<tbody>
<tr>
<td>Macaroni and Cheese</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td>Peanut Butter &amp; Jelly Sandwich</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td>Chicken Nuggets</td>
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<td>〇</td>
<td>〇</td>
<td>〇</td>
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</tr>
<tr>
<td>Cheeseburger</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
</tbody>
</table>
Which of these foods has the most fat per serving? Which of these foods has the most sodium per serving?

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheesy Puffs</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
</tr>
<tr>
<td>Pretzels</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
</tr>
<tr>
<td>Doritos Corn Chips</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
</tr>
<tr>
<td>Trail Mix</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
</tr>
</tbody>
</table>

How healthy are these foods?

<table>
<thead>
<tr>
<th>Food</th>
<th>Very Unhealthy</th>
<th>Somewhat Unhealthy</th>
<th>Neither Healthy Nor Unhealthy</th>
<th>Somewhat Healthy</th>
<th>Very Healthy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheetos (Cheesy Puffs)</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
</tr>
<tr>
<td>Pretzels</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
</tr>
<tr>
<td>Doritos (Corn Chips)</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
</tr>
<tr>
<td>Trail Mix</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
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</tbody>
</table>

How likely are you to give this food to your child?

<table>
<thead>
<tr>
<th>Food</th>
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<th>Somewhat Unlikely</th>
<th>Undecided</th>
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<th>Very Likely</th>
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</tr>
<tr>
<td>Pretzels</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
</tr>
<tr>
<td>Doritos (Corn Chips)</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
</tr>
<tr>
<td>Trail Mix</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
<td>Ø</td>
</tr>
</tbody>
</table>
Food and Nutrition Related Attitudes Behaviors, and Skills

Thank you for participating in our study! Your answers to this survey will not be connected to your name. Please answer them to your best ability.

Please enter your participant ID:

About how many HOURS do you spend doing each of the following things on a WEEKLY basis:

- Grocery Shopping
- Planning Meals
- Preparing Meals

About how much money do you spend on groceries each week? (Just type the number, you do not need to type a dollar sign.)

About how much money do you spend on restaurants or take-out each week? (Just type the number, you do not need to type a dollar sign.)

How would you rate the overall nutritional quality of your diet?
Do you read nutrition labels regularly when you purchase a food for the first time?
☑ Yes
☑ No

How long have you been regularly reading nutrition labels?
☑ More than 6 months
☑ Less than 6 months

Do you intend to regularly read nutrition labels in the future?
☑ Yes
☑ No

When do you intend to begin reading nutrition labels regularly?
☑ In the next 30 days
☑ In the next 6 months

How often does the information on a nutrition label affect your decision to buy a food?
☑ Always
☑ Most of the Time
☑ Sometimes
☑ Rarely
☑ Never

How often does the information on a nutrition label affect your decision to eat a food?
☑ Always
☑ Most of the Time
☑ Sometimes
☑ Rarely
☑ Never

How often does the information on a nutrition label affect your decision to give a food to your child?
☑ Always
☑ Most of the Time
☑ Sometimes
☑ Rarely
☑ Never
<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neither Agree Nor Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
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<tbody>
<tr>
<td>Knowing that a food is good for me has little influence on what I choose to eat</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<tr>
<td>Knowing that a food is good for my child has little influence on what I choose to feed my child</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Eating nutritiously can help prevent certain diseases.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I do not care about the foods I eat</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I do not care about the foods my child eats</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>The foods I eat now will keep me healthy</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>The foods my child eats now will keep them healthy</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I eat what I want regardless of what is good for me</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I feed my children what they want, regardless of what is good for them</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<td>○</td>
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<tr>
<td>I think nutrition is important to my health</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I think nutrition is important to my child's health</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I know what foods my child should eat</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
If you ate the whole package of food, how many grams of sugar would you get?

If you ate two servings of this food, how many calories would you get?

How many servings of this food would you need to get all the calcium you need in a day?

If you ate enough servings of this product to get all the Vitamin A you need for the day, how many grams of protein would you get?

If you ate half of the PACKAGE of this food, how many mg of sodium would you get?

---

**Nutrition Facts**

<table>
<thead>
<tr>
<th>Amount Per Serving</th>
<th>% Daily Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories 250</td>
<td>Calories from Fat 130</td>
</tr>
<tr>
<td>Total Fat 14g</td>
<td>22%</td>
</tr>
<tr>
<td>Saturated Fat 9g</td>
<td>45%</td>
</tr>
<tr>
<td>Cholesterol 55mg</td>
<td>18%</td>
</tr>
<tr>
<td>Sodium 75mg</td>
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</tr>
<tr>
<td>Total Carbohydrate 26g</td>
<td>9%</td>
</tr>
<tr>
<td>Dietary Fiber 0g</td>
<td>0%</td>
</tr>
<tr>
<td>Sugars 26g</td>
<td></td>
</tr>
<tr>
<td>Protein 4g</td>
<td></td>
</tr>
</tbody>
</table>

Vitamin A 10%
Vitamin C 0%
Calcium 10%
Iron 0%

*Percent Daily Values are based on a 2,000 calorie diet.
If you ate the entire package of this food, how many grams of fiber would you get?

If you ate 4 nuggets, how many mg of potassium would you get?

- 250
- 55
- 500
- 18
- 14%
- 0.25

If you ate the entire package, how much potassium would you get?

How many mg of cholesterol are in a serving of this product?

How many servings of this food would you need to get 100% of the daily value of iron?

How many calories are in each nugget?
These are nutrition labels from two popular snack foods. Please use these labels to answer the next few questions.

**Which product has more calories per serving?**
- A
- B

**Which product has more sodium per serving?**
- A
- B

**Which product has more vitamin C per serving?**
- A
- B

**Which product is the healthier choice?**
- A
- B

**Which snack is the healthier choice?**
- Potato Chips
- Pretzels
Demographic/Socioeconomic Status Survey

Thank you for participating in our study! Your answers to this survey will not be connected to your name. Please answer them to your best ability.

Please enter your participant ID:

How many people live in your household, including you?

How many children live in your household?

How many adults live in your household?

What is your marital status?
- Married
- Single (never married)
- Divorced
- Widowed
- Separated
- Remarried
- Living together (but not married)

Q4 Are you Hispanic or Latino?
- Yes
- No

Is your child Hispanic or Latino?
- Yes
- No

What is your race? (Select all those that apply)
- American Indian or Alaskan Native
- Asian
- Black or African American
- Native Hawaiian or Pacific Islander
- White

What is your child's race? (Select all those that apply)
- American Indian or Alaskan Native
- Asian
- Black or African American
- Native Hawaiian or Pacific Islander
- White

What is the highest level of education you have completed?
- 8th grade or below
Some high school
Completed high school
Some college
Completed College
Some graduate or professional school
Completed graduate or professional school

If applicable, what is the highest level of education your spouse or live-in partner has completed?
8th grade or below
Some high school
Completed high school
Some college
Completed College
Some graduate or professional school
Completed graduate or professional school
Not applicable

Q16 What is your current employment status?
Working now
Unemployed- Looking for Work
Unemployed - Not looking for work
Retired
On disability
Sick/Maternity Leave
Homemaker
Student
Other (please specify) ____________________

If working, what is your occupation?
I work as a ____________________
I am not currently working.

If working, how many hours per week?
I work ___ hours per week ____________________
I am not currently working.
What is your spouse or live-in partner's current employment status?
- Working now
- Unemployed- Looking for Work
- Unemployed - Not looking for work
- Retired
- On disability
- Sick/Maternity Leave
- Homemaker
- Student
- Other (please specify) ____________________

If working, what is their occupation?
- I work as a ____________________
- They do not currently work outside the home

If working, how many hours per week?
- They work ___ hours per week ____________________
- They do not currently outside the home.

What was your total or combined family income, before taxes, in 2012?
- Less than $20,000
- $20,000-$35,000
- $36,000-$50,000
- $51,000-$75,000
- $76,000-$100,000
- More than $100,000

Does your family own a functional automobile?
- Yes (How many?) ____________________
- No

Have you or anyone in your household used any of the following programs in the past 12 months? (Check all that apply.)
- SNAP (Formerly known as food stamps)
- WIC
- TANF (cash assistance)
- Medicaid (Medical Assistance)
- Home Energy Assistance (LIHEAP)
- Free/Reduced School Meal Program
- Other Programs ____________________

Have you ever gotten food from a food pantry or soup kitchen?
- Yes (How many times in the past 12 months? ____________________
- No
Introduction: “Let’s play a fun food game, okay? When you finish, you can pick out a sticker for doing such a good job.”

Part 1: Explanation of Five-point Scale
I am going to give you some fun foods to taste and I want you to taste each one and use these smiley faces to tell me how they taste, okay?

(Present Smiley face scale to the child) I have this card with five little faces that we can use today. (Point to the face that says “super good”) Do you see this face? This guy is smiling a lot because he just tasted something that is “super good.” If you taste something that is “super good” point to this face.

(Point to the face that says “good”) Do you see this face? This guy is smiling, but not as much as this one (the “super good” face). He is smiling because he just tasted something that is “good.” If you taste something that is “good” point to this face.

(Point to the face that says “bad”) Do you see this face? This guy is frowning because he just tasted something that is “bad.” If you taste something that is “bad” point to this face.

(Point to the face that says “super bad”) Do you see this face? This guy is really frowning. He just tasted something that is “super bad.” If you taste something that is “super bad” point to this face.

(Point to the face in the middle, “maybe good, maybe bad”) This last face in the middle is for something that you taste that is not good, but not bad either. Use this face if something is in the middle, or if you just can’t decide.
Testing the child’s understanding of the scale.

What is your favorite food? So, if I gave you some (favorite food) to taste, which face would you point to? (Allow child to point to the face to make sure they understand. If the child points at “good” or “super good” the child’s response is correct and assume they understand).

What is your least favorite food, or a food you think is yucky? So, if I gave you some (least favorite food) to taste, which face would you point to? (Allow child to point to the face to make sure they understand. If the child points at “bad” or “super bad” the child’s response is correct and assume they understand).

Great work, now one more question and we will start our tasting game. What if I gave you something to taste and it you couldn’t decide if it was good or bad? What face would you point to? (Allow child to point to the face to make sure they understand. Most children will point to the middle face, but some children point to “bad” or “good” and give additional explanations why. We have counted these responses as correct, as long as they don’t pick “super good” or “super bad.”)

If the child does not understand, go through the explanation again.

Okay, let’s start the game. Ready?

Give child one food item at a time, allowing them to taste and rate each one. Have them sip water between each food.

Smiley Face Scale Refresher Script

For use when a child comes back after their first visit, to make sure they remember how to use the scale.

“It’s so great to see you again. Did you have fun last time? We are going to play another tasting game today. Do you remember our smiley faces? Can you remind me again how to use them? (Have child go through the explanation of each face. If they have trouble remembering, remind them what each face means. If the child does not remember, go through Parts 1 and 2 above again).
Appendix E: Supplemental Data

Chapter 3

Fig. A1 Mean test meal item liking scores

Mean test meal intake by mass

Test Meal Intake, by number of servings
Chapter 4

Correlations between continuous potential moderators and liking/intake

<table>
<thead>
<tr>
<th>Nutrition Knowledge</th>
<th>Entire Meal</th>
<th>Low Energy Density Foods</th>
<th>High Energy Density Foods</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Liking (g)</td>
<td>Intake (kCal)</td>
<td>Liking (g)</td>
</tr>
<tr>
<td>.00</td>
<td>- .04</td>
<td>.04</td>
<td>.11</td>
</tr>
<tr>
<td>Food Prep Time</td>
<td>-.01</td>
<td>-.18</td>
<td>.10</td>
</tr>
<tr>
<td>Restaurants</td>
<td>-.19</td>
<td>.163</td>
<td>.23</td>
</tr>
<tr>
<td>Per capita income</td>
<td>.07</td>
<td>.19</td>
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</tr>
<tr>
<td>BMI percentile</td>
<td>.03</td>
<td>- .02</td>
<td>.02</td>
</tr>
<tr>
<td>Age</td>
<td>.15</td>
<td>.35&quot;</td>
<td>.10</td>
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</table>

\* p < .1    \*p < .05    ** p < .01

Effects of Gender on Children's Food Liking and Intake

<table>
<thead>
<tr>
<th>Intake (kCal)</th>
<th>Liking (Summed Scores)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boys</td>
</tr>
<tr>
<td>All Foods</td>
<td>640</td>
</tr>
<tr>
<td>High ED</td>
<td>589</td>
</tr>
<tr>
<td>Low ED</td>
<td>29</td>
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</table>

Effects of Family Factors on Food Liking and Intake

<table>
<thead>
<tr>
<th>Intake (kCal)</th>
<th>Liking (Summed Scores)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>All Foods</td>
<td>Stay At Home</td>
</tr>
<tr>
<td></td>
<td>Financial Assistance</td>
</tr>
<tr>
<td></td>
<td>WIC Income Eligibility</td>
</tr>
<tr>
<td></td>
<td>Nutrition Label Reading</td>
</tr>
<tr>
<td>High ED</td>
<td>Stay At Home</td>
</tr>
<tr>
<td></td>
<td>Financial Assistance</td>
</tr>
<tr>
<td></td>
<td>WIC Income Eligibility</td>
</tr>
<tr>
<td></td>
<td>Nutrition Label Reading</td>
</tr>
<tr>
<td>Low ED</td>
<td>Stay At Home</td>
</tr>
<tr>
<td></td>
<td>Financial Assistance</td>
</tr>
<tr>
<td></td>
<td>WIC Income Eligibility</td>
</tr>
<tr>
<td></td>
<td>Nutrition Label Reading</td>
</tr>
</tbody>
</table>
Interaction plot: Effect of label reading on low ED food liking/intake

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B</th>
<th>p</th>
<th>r</th>
<th>r²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>41.326</td>
<td>.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liking</td>
<td>.717</td>
<td>.951</td>
<td>0.431</td>
<td>0.182</td>
</tr>
<tr>
<td>LabelRead</td>
<td>12.522</td>
<td>.350</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interaction</td>
<td>23.601</td>
<td>.087</td>
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</tr>
</tbody>
</table>
Interaction plot: Effect of parental education on overall food liking/intake

Regression analysis for parental education / entire test meal

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B</th>
<th>p</th>
<th>r</th>
<th>r²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
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<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liking</td>
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<td>.143</td>
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<td></td>
</tr>
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<td>Education</td>
<td>15.567</td>
<td>.352</td>
<td>0.283</td>
<td>0.08</td>
</tr>
<tr>
<td>Interaction</td>
<td>-32.268</td>
<td>.099</td>
<td></td>
<td></td>
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Appendix F: Descriptions of Additional Study Measurements

Preschool Adjusted Liking Scale (PALS)

Preschool Adjusted Liking Scale is a generalized hedonic (liking) scale that captures parental reports of child liking of various food and non-food items on continuous horizontal line scales, with vertical anchors at the ends as well as in the middle of each scale. Parents used the visual analog scale to record their children’s liking of eighteen food items, including three fruits (apple juice, strawberries, and watermelon), six vegetables (carrots, sweet potatoes/yams, broccoli, spinach/collard greens, corn, and tomatoes), seven fat/sugar foods (cookies/cake, ice cream, soda pop, candy bar, French Fries, snack foods/Cheetos/Pretzels/Doritos, butter/margarine), lunch meat/hot dogs/bologna, and whole milk. Parents also rated their child’s liking of three pleasant (taking a bath, brushing teeth, and getting dressed) and one unpleasant (the sound of a loud siren) non-food items. Using non-food items allows for cross-modal matching, which allowed liking scores to be adjusted and compared between individuals. This instrument was adapted in collaboration with the authors of the original tool by adding additional food and non-food items to gather more expansive information about children’s food preferences.
**Foods in PALS and Child Reported Liking Survey**

<table>
<thead>
<tr>
<th>Fruit</th>
<th>Vegetables</th>
<th>Sweets</th>
<th>Grains</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oranges</td>
<td>Peas</td>
<td>Cake or Cupcakes</td>
<td>White Bread</td>
</tr>
<tr>
<td>Bananas</td>
<td>Green Beans</td>
<td>Cookies</td>
<td>Whole Grain Bread</td>
</tr>
<tr>
<td>Grapes</td>
<td>Broccoli</td>
<td>Candy</td>
<td>White Rice</td>
</tr>
<tr>
<td>Apples</td>
<td>Tomatoes</td>
<td>Ice Cream</td>
<td>Brown Rice</td>
</tr>
<tr>
<td></td>
<td>Carrots</td>
<td>Chocolate</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dairy</th>
<th>Starchy Vegetables</th>
<th>Savory Snacks</th>
<th>Sweet Beverages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
<td>Potatoes</td>
<td>French Fries</td>
<td>100% Fruit Juice</td>
</tr>
<tr>
<td>Cheese</td>
<td>Corn</td>
<td>Fried Snacks</td>
<td>Fruit-Flavored Drinks</td>
</tr>
<tr>
<td>Yogurt</td>
<td>Sweet Potatoes</td>
<td>Baked Snacks</td>
<td>Soda</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Proteins</th>
<th>Breakfast Items</th>
<th>Compound Items</th>
<th>Non-Food Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicken nuggets</td>
<td>Toaster Pastries</td>
<td>PB&amp;J</td>
<td>Dancing to Music</td>
</tr>
<tr>
<td>Lunch Meat</td>
<td>Pancakes and waffles</td>
<td>Macaroni and Cheese</td>
<td>Playing on a Playground</td>
</tr>
<tr>
<td>Eggs</td>
<td>Unsweetened cereal</td>
<td>Burgers</td>
<td>Reading</td>
</tr>
<tr>
<td>Bologna</td>
<td>Sweetened cereal</td>
<td>Soup</td>
<td>Taking a Bath</td>
</tr>
<tr>
<td>Fish</td>
<td></td>
<td>Pizza</td>
<td>Playing Video Games</td>
</tr>
<tr>
<td>Legumes</td>
<td></td>
<td>Grilled Cheese</td>
<td>Watching TV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Garlic Bread</td>
<td>Riding a Bike</td>
</tr>
</tbody>
</table>

*PALS online interface*
**Child Reported Liking Survey**

Children rated their liking of a variety of food and non-food items by using an age-appropriate activity adapted from PALS [268]. Children were asked directly about their preferences because parental reports of children’s behavior are often subject to bias [141]. This measure also allowed children to directly report their preferences for a wider variety of foods than would be feasible for a tasting protocol.

Children within this study’s age range generally have difficulty understanding and with seriation and scaling, so linear scales (such as the original PALS) are not appropriate measurements for hedonic testing in this age group [269, 270] without extensive[271] training,. Using the same 5 point smiley-face scale used in the tasting protocol [169], children indicated how much they liked both food and non-food items shown on 8x11” laminated pictures.

Foods were shown as full color photographs and non-food activities were shown as full color cartoon illustrations. The children were asked to rate how much they liked each item. Because young children often try to please experimenters and may answer in the affirmative regardless of the question, they were urged to tell the researcher their true feelings about each food. They were also assured that saying that they disliked a given item would not hurt the researcher’s feelings [165]. Pictures were shown one at a time, and children were asked “Have you tried [item]? How much do like it?” for each item. Because children often have limited attention spans and long tasks can be mentally fatiguing[206], children were allowed to take breaks at any time during the activity.
Freddy Fullness Scale

The Freddy Fullness Scale is a visual analogue scale (VAS) without written anchors used to assess perceived fullness in children. This scale was developed and validated for use with imagined eating scenarios in 3-5 year-olds [271], but has not been used in actual eating scenarios with children in this age group. 8” x 11” sheets of printer paper with an image the Freddy doll were placed in a folder pocket with a 2 cm wide slider that children could push up and down the length of the stomach to communicate perceived fullness.

In this study, children were given an explanation of how the device works (“As Freddy eats more, his stomach fills up”) and then asked to try out the scale, indicating how full they would feel after eating one cookie, a few more cookies, and a meal that made them feel mostly full. After the children demonstrated their understanding of the scale, they were asked to rate their current, pre-meal perceived fullness by moving the slider to the appropriate spot on Freddy. The researcher marked the paper at the slider and, after the visit, used a ruler to measure the position of the line from the bottom anchor. Fullness ratings range from 0 (not full at all) to 150 mm (completely full). Fullness was rated before and after the test meal on different sheets of paper, and independent pre-meal and post-meal as well as difference scores were calculated.
Figure  Keller and colleagues’ Freddy Fullness Scale [271]
Parents have an unquestionable impact on children’s eating habits and weight status [84, 112, 244, 272-275]. Data related to parents’ feeding practices and concerns was collected using the Child Feeding Questionnaire, a parental report of feeding attitudes and practices, developed by Birch and colleagues [276]. This measure was originally used to assess the relationship between parental feeding practices and child eating and weight-related behaviors. [84, 112, 244, 272-275]. It contains 31 items, which load onto 7 factors, including perceptions of parental weight status, child weight status, feeding responsibility (e.g. “When your child is home, how often are you responsible for feeding him/her?”), concern about child weight (e.g. “How concerned are you about your child having to diet to maintain a desirable weight?”), and use of controlling feeding practices, including monitoring (e.g. “How much do you keep track of the sweets (candy, ice cream, cake or pastries) that your child eats?”), restriction (e.g. “I intentionally keep some foods out of my child’s reach.”), and pressure to eat (e.g. “If my child says “I’m not hungry” I try to get him/her to eat anyway”). Responses are captured using 5-point Likert scales and mean scores are calculated for items corresponding to each construct, resulting in a total of seven scores.


122. Duffey, K.J. and P. Gordon-Larsen, *Differential associations of fast food and restaurant food consumption with 3-y change in body mass index: the Coronary*
128


185. Usda, Healthy Eating for Preschoolers. 2012.


