SENSORY SENSITIVITY AS PREDICTIVE OF FRUIT AND VEGETABLE ACCEPTANCE IN YOUNG INFANTS

By

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ABSTRACT OF THE THESIS

Sensory Sensitivity as Predictive of Fruit and Vegetable Acceptance in Young Infants

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The early introduction of fruits and vegetables to infants is an area gaining interest due to the rapid rise of childhood obesity. There is a clear low intake of fruits and vegetables amongst all age groups in the United States. Sensory factors such as taste, smell, temperature, and texture may play a role in fruit and vegetable acceptance in infants who may be oversensitive. A number of sensitivity and temperament scales have been developed, but none have explored the relationship between actual fruit and vegetable consumption by infants and specific sensory properties of foods. The purpose of this study was to develop and implement a novel questionnaire assessing the relationship between sensory sensitivity and fruit and vegetable acceptance infants less than 1 year of age. The questionnaire combined questions from existing scales addressing food responsiveness, sensory threshold in the context of temperament, sensory sensitivity, and maternal and infant fruit and vegetable acceptance, as well as novel questions addressing sensory sensitivity.

Questionnaires were completed by mothers utilizing services at the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) in New Brunswick, NJ. After analyzing the data collected, results showed that when separated

into age groups, domains in the overall sensory sensitivity scale showed a relationship with fruit and vegetable acceptance, most notably in the youngest age group of 3 to 6 months. The more sensitive to these domains (i.e. taste, smell, texture, temperature, appearance) the infants were, the lower their fruit and vegetable acceptance. Additionally, the more fruits and vegetables the mother liked, the higher acceptance her infant had. Future findings, if consistent with ours, can lead to early nutrition interventions aimed to increase fruit and vegetable intake, creating a positive path and healthier future.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

I. INTRODUCTION

The early introduction of fruits and vegetables to infants is an area of study that has grown in interest due to the rapid rise of childhood obesity and its continued prevalence through adulthood. Over one-third (36.5%) of adults in the United States are obese, which is defined as a BMI (body mass index) of greater than 30 kg/m^2 (Ogden, Carroll, Fryar, & Flegal, 2015). In children and adolescents (ages 2 to 19 years), obesity is defined as having a BMI at or above the 95^{th} percentile of the sex-specific CDC BMI-for-age growth charts [Centers for Disease Control and Prevention (CDC), Childhood Obesity Facts, 2017]. Over 2011-2014, obesity affected approximately 12.7 million children and adolescents in the United States (Ogden et al., 2015). Magarey, Daniels, Boulton, and Cockington (2003) found that BMI at the age six years was a good indicator of BMI in adulthood. Obese adolescents have an 80% chance of becoming obese adults, placing them at greater risk for health problems throughout life (Guo & Chumlea, 1999). The 2015-2016 statistics on the prevalence of childhood obesity in the United States show that obesity among all children and adolescents (ages 2 to 19 years) has increased to 18.5% from 17.3% in 2013-2014 (Skinner et al., 2018). Specifically, there has been a sharp increase in prevalence of obesity in preschool-aged children (ages 2 to 5 years) from 9.3% in 2013-2014 to 13.7% in 2015-2016 (Skinner et al., 2018). This percentage in the preschool-aged population had been decreasing to a low of 8.3% in 2011-2012, but has unfortunately reached the highest reported percentage in the last decade (Skinner et al., 2018). Statistics on the general national population of infants are not available, however, the CDC reported that in 2014, 12.3% of 3- to 23- month-old infants enrolled in

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) had a higher-than-normal weight-for-length.

It has been shown in various studies that the regular consumption of fruits and vegetables is protective against many health problems such as coronary heart disease (Dauchet, Amouyel, Hercberg, & Dallongeville, 2006), hypertension (Boeing et al., 2012), some cancers (Boeing et al., 2012), stroke (Dauchet, Amouyel, & Dallongeville, 2005), and diabetes (Muraki et al., 2013). Therefore, one way to address the issue of obesity is the encouragement of the consumption of fruits and vegetables in an attempt to lower the future incidences of these diseases (Epstein et al., 2001). A worldwide prospective cohort study found that higher fruit, vegetable, and legume consumption was associated with lower risk of non-cardiovascular and total mortality in adults, with maximum benefits occurring at three to four servings per day (Miller et al., 2017). Additionally, a meta-analysis on the individual components of the Mediterranean diet and their benefits on cardiovascular disease revealed that the diet's protective effects are most attributable to fruits and vegetables, as well as olive oil and legumes, with an average reduced risk of 40% for cardiovascular disease risk and mortality (Grosso et al., 2017).

Although the most recent version of the Dietary Guidelines for Americans (2015-2020) does not address specific quantities of recommended fruit and vegetable intakes for any age group (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015), the CDC states that these recommendations for children range from 1 to 2 cups of fruit and 1 to 3 cups of vegetables daily depending on the child's age, gender, and level of physical activity (CDC, 2014). The "5 A Day" guidelines have also been suggested for use in children. The 5 A Day for Better Health Program is a nationwide

nutrition campaign to increase consumption of fruits and vegetables to an average of 5 to 9 servings a day (United States Department of Agriculture (USDA), Food and Nutrition Service, 5 A Day, 2017). Although there are no official guidelines for fruit and vegetable consumption in infancy, the Children's Hospital of Philadelphia (CHOP) and Johns Hopkins University School of Medicine provide information on serving sizes for fruits and vegetables for this population. Both organizations recommend 1- to 2- tablespoons of fruits and 1- to 2- tablespoons of vegetables once or twice a day for infants aged 4- to 6- months and 2- to 3- tablespoons of fruits and 2- to 3- tablespoons of vegetables twice a day for infants aged 7- to 8- months (CHOP, 2018; Johns Hopkins Medicine, 2018).

The State Indicator Report on Fruits and Vegetables, 2013 reported that the national average percentage of adults in the United States who reported consuming fruits and vegetables less than one time daily is 37.7% and 36.0%, respectively. The national average for adolescents is 36.0% for fruits and 37.7% for vegetables (CDC, 2013). Despite an increase in children's fruit intake from 2003 to 2010, 60% of children in the United States did not meet their recommendations for fruit intake, and 93% of children did not meet their recommended vegetable intake in 2007-2010 (CDC, 2014). The Feeding Infants and Toddlers Study (FITS) 2008 found that only 40% of infants aged 4- to 6- months were consuming any vegetable at least once a day and 42% were consuming any fruit at least once a day. Additionally, fewer than 10% of infants aged 4- to 14- months consumed dark green vegetables once a day (Deming, Reidy, Briefel, Fox, & Condon, 2012). Newer released data from the FITS 2016 study revealed a decrease in consumption with only 34% of infants in this age group consuming any vegetable and

37% consuming any fruit (Roess et al., 2018). These numbers raise an alarm about the lack of fruits and vegetables being consumed in the United States as early as childhood.

In a study conducted with 2- to 3- year-old children in a nursery, it was found that children preferentially choose animal products and starchy foods, avoiding vegetables (Nicklaus, Issanchou, & Boggio, 2005). These results further stress the importance of encouraging fruits and vegetables in children's diets. In addition, the types of fruits and vegetables that are being consumed the most are also an issue. The FITS 2008 found that white potatoes were the dominant vegetable eaten after infancy, and that there has been a downward shift in vegetable consumption in infants and toddlers since the original FITS 2002 study (Deming et al., 2012). Data from the 2009-2010 National Health and Nutrition Examination Survey (NHANES) found that potato products and fruit juice were the most consumed vegetable and fruit, respectively, among 2- to 5- year-old children (Ramsay, Eskelsen, Branen, Armstrong Shultz, & Plumb, 2014). Likewise, the 2015 Study on America's Consumption of Fruit and Vegetables reported that potatoes are the top consumed vegetable in the United States, and that orange juice is the top consumed fruit (Produce for Better Health Foundation, 2015). This data shows the overwhelming need for an increase in fruit and vegetable consumption in the United States among all age groups. Up until this point, the Dietary Guidelines for Americans has focused on the country's population that is above two years of age. However, public health's new interest in early nutrition and its link to health outcomes throughout the lifespan has brought about the Pregnancy and Birth to 24 months Project (United States Department of Agriculture (USDA), Center for Nutrition Policy and Promotion, 2018), leading Congress to mandate the inclusion of infants and toddlers (birth to two years) by the

2020-2025 edition (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015).

It is evident that low fruit and vegetable consumption and its effect on obesity, starting in infancy, is a pertinent area of study which needs to be explored further in order to understand the underlying causes for this alarmingly low consumption. This thesis will focus specifically on sensory sensitivity in infants as predictive of their fruit and vegetable intake.

II. REVIEW OF THE LITERATURE

The low consumption of fruits and vegetables in infants is multi-factorial, and therefore, the factors that influence this intake must be considered and explored. Maternal factors such as how early the mother introduces the infant to fruits and vegetables, the mother's personal food preferences, and maternal postpartum depression have all been explored. Additionally, it is of utmost importance to evaluate infant factors and characteristics such as food responsiveness, food selectivity and acceptance, temperament, and sensory sensitivity as they may be to be linked to infant fruit and vegetable consumption. Further exploration of many of these factors is warranted in order to better understand the roles that they play in fruit and vegetable consumption.

Time of fruit and vegetable introduction

There have been a variety of studies examining the relationship between early introduction of fruits and vegetables and fruit and vegetable intake in later years. In a study examining the fruit and vegetable intake of 2- to 6- year-old children, early introduction of fruits and vegetables was related to the child's later fruit and vegetable intake (Cooke et al., 2004). Fruit variety in 6- to 8- year-olds was predicted by either early fruit variety or early fruit exposure by 2 years of age in a study examining food-related experiences of school-aged children (Skinner, Carruth, Bounds, Ziegler, & Reidy, 2002). In an analysis of a cohort of children followed from infancy to six years of age, it was found that infrequent intake of fruits and vegetables during late infancy was associated with continued infrequent intake at six years of age (Grimm, Kim, Scanlon, & Yaroch, 2014). In a study where 4- to 6- month-olds were weaned exclusively with either fruits or with vegetables, repeated exposure to fruits increased fruit intake, and repeated

exposure to vegetables increased vegetable intake (Barends, de Vries, Mojet, & de Graaf, 2013). Analyses of the data from the prospective NOURISH study revealed that having tried a greater number of fruits and vegetables at 14 months predicted corresponding preferences and higher intakes at age 3.7 years (Mallan, Fildes, Daniels, & Magarey, 2016). Lastly, an earlier introduction (4 to 5 months) of vegetables was associated with less fussy eating behavior at 4 years of age in the Generation R Study (de Barse et al., 2017). These studies, collectively, suggest that early exposure to fruits and vegetables is important for their future intake.

Maternal influences

The effects of a mother's fruit and vegetable preferences have also been studied in order to examine a relationship between mother and child intakes. A broad study conducted by Skinner et al. (1998) analyzed all food types and all family members of 28- to 36- month-old children, and found that there was strong concordance of food preferences between the child and other family members. In addition, there was a significant association between the foods never offered to the child and the mother's dislikes, indicating that a mother is less likely to feed her child a certain food if she dislikes it herself. Skinner et al. (2002) also followed 70 infant-mother dyads from infancy to school-age, and found that vegetable variety in the children at ages 6 to 8 was predicted by the mother's vegetable preferences. In a study examining the relationship between mother's fruit and vegetable preferences and those tried by their preschool-aged children, it was found that mothers' likes correlated with fruits and vegetables that their children tried, but also limited the number of fruits and vegetables that their children tried (Worobey, Ostapkovich, Yudin, & Worobey, 2010). Therefore, mothers' lower reports of

fruit and vegetable preferences were associated with lower estimates of their children's fruit and vegetable preferences.

Food responsiveness

In addition to the mother's role in infant fruit and vegetable intake, various dimensions of the infant's innate properties have been explored in this context. Specifically, food responsiveness has been studied in order to develop a relationship with food acceptance and preference. The Child Eating Behavior Questionnaire (CEBQ) was developed in order to assess individual differences in eating styles amongst children aged 2- to 7- years- old (Wardle, Guthrie, Sanderson, & Rapoport, 2001). It includes a section on food responsiveness, in which the questions are designed to detect levels of appetite that could be viewed as maladaptive. This section also assesses the tendency to eat when prompted by external cues, which has been associated with higher adiposity (Carnell & Wardle, 2007). In a study using the CEBQ, it was found that food responsiveness was associated with reduced preferences for vegetables in children ages 2 to 5 years old (Russell & Worsley, 2016). A study assessing the lunch of preschoolers found that higher food responsiveness on the CEBQ was associated with higher intake of fruits and vegetables, but also a higher intake of white bread (Carnell et al., 2016). As mentioned, food responsiveness has also been directly related to obesity, which is another important factor to consider. Another study using the CEBQ found that food responsiveness was positively related to children's status of being obese (Demir & Bektas, 2017). Because the CEBQ does not apply to infants, the Baby Eating Behavior Questionnaire (BEBQ) was developed in order to accommodate milk-feeding practices in infants 0 to 3 months old (Llewellyn, van Jarsveld, Johnson, Carnell, & Wardle, 2011). This is the first

standardized tool to measure characteristic appetitive traits of infants, including food responsiveness, that may predict susceptibility to excess weight gain. The BEBQ was used in a study evaluating the relationship between loss of control eating during pregnancy in overweight and obese women and their infant's appetitive traits. It was found that maternal loss of control eating during early pregnancy was linked with infant's food responsiveness (Kolko, Salk, Sweeny, Marcus, & Levine, 2018).

Food rejection behaviors and food selectivity

Food rejection behaviors such as picky eating have been shown to limit children's intake of 'healthy' foods. Food selectivity and food acceptance are also included in this analysis. Using data from the FITS 2008 study, a study found that picky eaters were more likely to be neophobic and texture resistant, and that they consumed fewer vegetables than non-picky eaters (van der Horst, Deming, Lesniauskas, Carr, & Reidy, 2016). Another study conducted with toddlers found that food neophobia scores were significantly correlated with smell differential reactivity, but not with taste differential reactivity (Monnery-Patris et al., 2015). Infant food acceptance has been studied in various contexts. It has been shown that infants increase their acceptance of a novel food after repeated dietary exposure to that food (Sullivan & Birch, 1994). There is also evidence that it is easier to get new tastes and new complex flavors accepted in the early months of the introduction of solid foods, between 4 and 6 months of age (Harris & Mason, 2017).

Another pertinent area of study in children is food selectivity. Food selectivity often means only eating a narrow variety of foods by type, texture, or presentation, and is the most frequent feeding concern among children with Autism Spectrum Disorders

(ASD). These children usually have strong preferences for starches and snack and processed foods, while having a dislike for fruits, vegetables, and proteins (Sharp, Jaquess, & Lukens, 2013), sometimes limiting their diets to as few as five foods (Cermak, Curtin, & Bandini, 2010). Studies have been conducted in order to determine the rationale behind this feeding selectivity in children with ASD. There is research suggesting that sensory factors, such as smell, texture, color, and temperature can contribute to food selectivity in individuals with ASD (Cermak et al., 2010). In a sample of 200 children with ASD, greater than 90% of the children had sensory abnormalities and sensory symptoms (Leekam, Nieto, Libby, Wing, & Gould, 2007). Using the Sensory Profile, a parent questionnaire that assesses children's responses to every day sensory activities, a study found differences on 96% of the questionnaire items between children with Asperger syndrome, which is included in ASD, and typically developing children (Dunn, Myles, & Orr, 2002). *The Complete Guide to Asperger's Syndrome* states that the resistance to eating certain types of food may relate to texture or smell in these patients (Safford, 2006). Kern et al. (2007) also used the Sensory Profile to examine the relationship between auditory, visual, touch, and oral sensory dysfunction in autism. Results indicated that all the main modalities of multisensory processing appear to be affected, and therefore, concluded that sensory processing problems should be considered as part of ASD. Tactile defensiveness, or a hypersensitivity to certain tactile stimuli, was evaluated in children both with and without the condition using the Sensory Profile. Results reported that children who showed tactile defensiveness refused certain foods because of temperature, texture, and smell and were resistant to eating vegetables, with overall vegetable consumption being 50% of that of children without tactile

defensiveness (Smith, Roux, Naidoo, & Venter, 2005). A further analysis of sensory sensitivity measures is discussed later in this literature review.

Temperament

The relationship between temperament and food preferences has also been explored. A study measuring food neophobia, an unwillingness to ingest unfamiliar foods, and temperament in children ages 5 to 11 years old, found that both shyness and emotionality were related to food neophobia (Pliner & Loewen, 1997). Feldman, Gross-Rozval, Keren, & Tyano (2004) found that infants who are perceived to have difficult or demanding temperaments are more likely to experience feeding difficulties. A review on temperament and risk for childhood obesity analyzed two dimensions of temperament: negativity and self-regulation. Results revealed that greater levels of negative reactivity in early life may increase the risk of obesity, while self-regulation may be protective of this risk (Anzman-Frasca, Stifter, & Birch, 2012). Another review found an association between the temperament dimensions of poor self-regulation, distress to limitations, low and high soothability, and low negative affectivity and higher BMI in infants and pre-school aged children (Bergmeier, Skouteris, Horwood, Hooley, & Richardson, 2014). The Revised Infant Temperament Questionnaire (RITQ) (Carey & McDevitt, 1978) has been used in many studies analyzing temperament in infants. This questionnaire is designed for 4- to- 8- month-olds, and assesses various dimensions of infant temperament, including sensory threshold, or how sensitive the infant is in different modalities. However, it does not distinguish between the types of physical stimuli, rather, it groups them together under the 'sensitivity' category. In addition, most studies using the RITQ to evaluate feeding practices do not assess fruit and vegetable intake as a

whole. A study analyzing the acceptance of green beans by infants found that infants who scored higher in the approach category of the questionnaire ate more of the green beans and showed less distaste for the vegetable (Forestell & Mennella, 2012). In another study, infants were fed hummus and cottage cheese, testing their reactions to these novel foods. Results showed that infants who scored lower on the approach section of the questionnaire showed less acceptance of the first offer of the novel food than infants rated higher on approach (Moding, Stifter, & Birch, 2014). Both of these studies provide an insight into the relationship between temperament and food exposure in infants, however, neither evaluate a true relationship between the results of the RITQ and overall fruit and vegetable intake.

Sensory sensitivity

More specific than temperament, sensory sensitivity is a modality of great interest in the infant population. A review of the biological basis of sensory process sensitivity (SPS) found that SPS differentially engages brain regions involved in reward processing, memory, physiological homeostasis, self-other processing and awareness, and is therefore associated with greater empathy and awareness in response to social, emotional, and perceptual tasks (Acevedo, Aron, Pospos, & Jessen, 2018). Findings from a study on SPS in kindergarteners (ages 4 to 6) suggested that SPS may be a more proximal correlate of individual differences in susceptibility to environmental influences compared with the temperament construct of negative emotionality (Slagt, Dubas, van Aken, Ellis, & Deković, 2017). Thus, the further exploration of sensory sensitivity is warranted, especially in the understudied population of infants.

In addition to the Sensory Profile mentioned previously, there are a variety of instruments that have been created in order to assess sensory sensitivity, particularly in a younger population. The Sensory Profile (Dunn, 1999) itself has many derivatives that include a few questions relating to food intake. Overall, the instruments in this group address the following areas of sensory processing: general, auditory, visual, tactile, vestibular, and oral. The Short Sensory Profile (Dunn, 1999) includes a section for taste/smell sensitivity, which includes questions regarding taste, smell, temperature, and texture sensitivity. These questions, however, do not assess these sensory properties separately, and therefore, it is not possible to determine exactly which stimuli the child is sensitive to. Furthermore, the Short Sensory Profile was developed for children ages 3 to 8 years old, and has not been used for infants (Dunn, 1994). A study using the Short Sensory Profile evaluated the relationship between food acceptance and tactile sensitivity in children between the ages of four and ten years. Results demonstrated that the behavioral measures of tactile sensitivity were correlated to picky eating, specifically in the younger age group of 4-to 7.5-year olds (Nederkoorn, Jansen, & Havermans, 2015). Results from another study using the SSP suggested that children who were sensitive to taste and smell stimuli ate fewer fruits and vegetables, regardless of their mother's fruit and vegetable consumption (Coulthard & Blissett, 2008). The Infant Sensory Profile 2 (Dunn, 2014) is designed for infants from birth to 6 months of age, while the Toddler Sensory Profile 2 (Dunn, 2014) is for children 7 to 35 months of age, allowing for more oral sensory processing questions. These questions include one question for food selectivity and another regarding texture, but do not address any other aspects of the sensory profile in terms of those that may affect food preferences.

Biochemical mechanisms

All of the aforementioned properties have been shown to play a role in fruit and vegetable intake. However, these properties are all measured by assessing infant behaviors, most often in the form of questionnaires filled out by the mother. In contrast to this practice, it is important to note that there is a possible biochemical mechanism behind fruit and vegetable preferences in infants and the rest of the population. Keller and Adise (2016) conducted an extensive review on the ability to taste bitter thiourea compounds such as 6-n-propylthiouracil (PROP) and its connection to obesity risk in children. In humans, it has been found that there is a phenotypic variation in the PROP phenotype, making some of the population extremely sensitive to bitter thiourea compounds such as Brassica vegetables (e.g., broccoli, cabbage, etc.). Shen, Kennedy, and Methven (2016) investigated this phenotype measurement of taste sensitivity and its effects on brassica vegetable perception, liking, and intake in adults. Results showed that subjects with less sensitivity for PROP, or "non-tasters" tended to consume more brassica vegetables and other vegetables than those with greater sensitivity to PROP. A study performed with preschool-aged children found that those who were more sensitive to PROP had lower consumption of bitter vegetables, and children who were "non-tasters" consumed a higher amount of bitter vegetables (Bell & Tepper, 2006). These findings suggest that further research on this topic should be conducted in order to better understand this taste sensitivity in infants and younger children.

Summary and hypotheses

Research has shown that the early introduction of fruits and vegetables to infants is important for their future intake of fruits and vegetables, and that the intake of fruits

and vegetables is important in terms of their health, specifically in reducing the risk of obesity, in these children as future adults. There is a clear low intake of fruits and vegetables amongst all age groups in the United States and this is due to a variety of reasons. Some of the more underexplored reasons are related to infant food acceptance in the context of sensory sensitivity, temperament, and food responsiveness. A review evaluating the research on taste exposure, sensory learning, and nutrition education interventions emphasized that interacting with the sensory properties of food during tactile-play may benefit food neophobic children (Nekitsing, Hetherington, & Blundell-Birtill, 2018). However, this research has been conducted in the preschool-aged population, and is underexplored in the infant population. In addition, most research conducted in children with feeding problems has been in children with Autism Spectrum Disorders, rather than children without any diagnosed disorders. There are developed instruments that have been created and implemented for all of the dimensions mentioned, however, none of these instruments have broken down the sensory properties into the separate dimensions of taste, smell, temperature, appearance, and texture, in order to evaluate these sensory characteristics in infant feeding. There is a gap in the research between these missing differentiations among these sensory dimensions, and their comparisons to what infants are actually eating, especially when looking at fruit and vegetable intake. This is a novel area of study that may lead to answers about possible innate reasons as to why fruit and vegetable intake in infancy, and in turn, throughout the lifecycle, is so low in the United States. Establishing a relationship between these sensory properties and fruit and vegetable intake can lead to targeted interventions that aim to increase fruit and vegetable intake in infants, creating a positive path and healthier future

for the rest of their lives. In addition, temperament and food responsiveness may also play a role in both the sensory sensitivity of the infant and/or directly in the infant's fruit and vegetable intake. Lastly a mother's fruit and vegetable preferences may play a role in her feeding her infant these foods, especially when feeding more difficult foods, such as green vegetables, to infants who may be hypersensitive. These parameters must all be taken into consideration and put into the context of actual fruit and vegetable intake and likes and dislikes of an infant in order to evaluate a possible relationship among these factors. There is need for an instrument that includes all of these factors; this thesis will focus on the creation, implementation, and results of a novel questionnaire that is administered to mothers of 4- to- 12- month old infants.

We hypothesized that infants with a lower sensory threshold, in other words, infants who are more hypersensitive, would like fewer fruits and vegetables, compared with those infants with a higher sensory threshold. Additionally, mothers who liked more fruits and vegetables would have infants who like more fruits and vegetables, and older infants would be exposed to and therefore, like more fruits and vegetables than younger infants.

III. METHODS

Sample

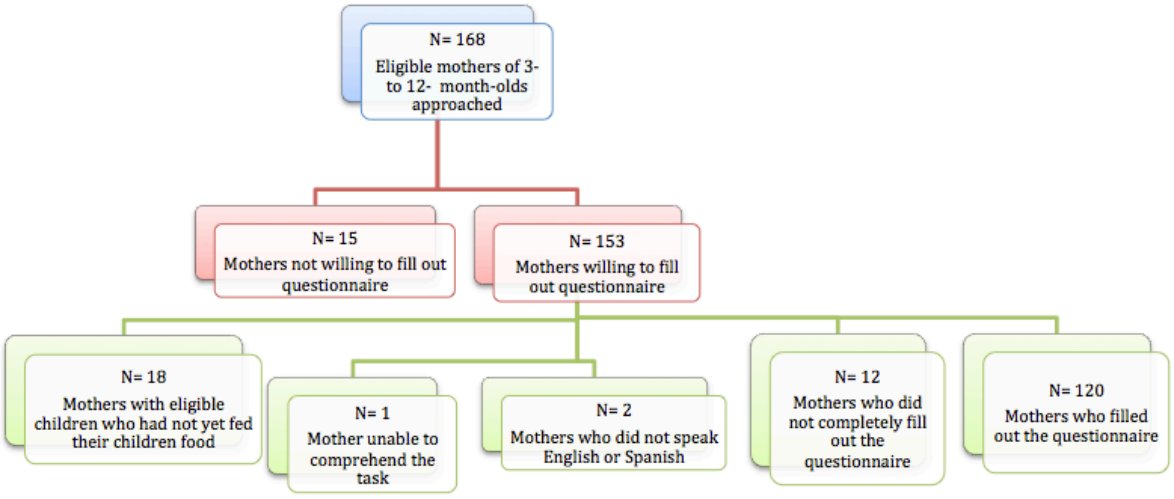
This study was approved by the Institutional Review Board of Rutgers University (Protocol #: E17-678). All subjects included in this study were mothers of 3- to 12-month-old infants utilizing services at The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), sponsored by the Visiting Nurse Association Health Group's Children and Family Health Institute, in New Brunswick, NJ. WIC eligibility guidelines include a stipulation of having a gross family income at or below 185% of the poverty line (USDA, WIC Eligibility Requirements, 2017). Therefore, all participants in this study were of low-income households. Mothers included in this study ranged in age from 15 to 45 years, with a mean age of 28.79 years. This was a multi-racial sample, with the majority of mothers identifying as Hispanic or Latina, Black/African-American, and Mexican.

Recruitment

A total of 168 eligible mothers were approached by the investigator during the period of July 2017 through August 2017, with 120 mothers being included in the final study. See *Figure 1* for a detailed depiction of the attrition in this study. Mothers in the waiting room at WIC were asked to fill out a questionnaire, which included questions about their infant and themselves. An English or Spanish written informed consent, depending on the mother's primary language, was given to the mother before filling out the questionnaire. See *Appendix* A for the English consent form and *Appendix* B for the Spanish consent form. As shown in *Figure 1*, out of the 168 mothers approached, 15 mothers were not willing to fill out the questionnaire. Of the 153 mothers who agreed to

complete the questionnaire, 18 had not yet fed their child solid foods (nine 4 month olds, one 5 month old, seven 6 month olds, and one 7 month old), and were therefore not eligible to fill out the questionnaire. One Spanish-speaking mother was unable to comprehend the questions on the questionnaire, and two mothers spoke only Arabic. 12 questionnaires were incomplete, with three of the mothers running out of time and the other nine mothers not wanting to complete the remainder of the questionnaire. Therefore, a total of 120 questionnaires were completed.

Figure 1. Participation of Mothers at WIC



Development and analysis of the questionnaire

A thorough review of the literature and current available measurement tools was conducted in order to develop a novel questionnaire addressing the various dimensions of interest (i.e. fruit and vegetable acceptance, food responsiveness, temperament, and sensory sensitivity). See *Appendix C*. Questions were included from a number of existing questionnaires as detailed below.

In order to first measure both mother and infant fruit and vegetable intake and preference to assess acceptance, a previously used Fruit and Vegetable Survey (Worobey

et al., 2010) was edited to reflect fruits and vegetables that were actually eaten in this population, in accord with the results from the Rutgers Infant Nutrition and Growth (RING) project. A total of 27 vegetables and 26 fruits were included. For each list, one for fruits and one for vegetables, mothers were directed to indicate if they had tried and liked the fruit or vegetable, and also if their infant had tried and liked the fruit or vegetable. In the analyses of our data, shown in the next section, fruit and vegetable acceptance was calculated by dividing the number of fruits or vegetables liked by the number of fruits or vegetables tried. Preference was determined simply by the number of fruits or vegetables liked.

The section assessing food responsiveness in the Baby Eating Behavior Questionnaire (BEBQ) (Llewellyn, et al., 2011) was included in order to detect infant behaviors that could be viewed as maladaptive. This section of the scale has been validated in infants, and has a Cronbach's alpha of 0.79 (Llewellyn, et al., 2011). These questions specifically addressed the infant's feeding habits before he or she was introduced to solid foods. Mothers were instructed to use a 5-point scale, for a total of five questions, in order to identify if each of the five items regarding their infants occurred 'always', 'often', 'sometimes', 'seldom', or 'never'. In our study, food responsiveness was determined by the mean score of these items.

Select questions from the Revised Infant Temperament Questionnaire (RITQ) (Carey & McDevitt, 1978) were included according to their relevance to the evaluation of the sensory threshold. The RITQ has been validated in the 4- to- 8-month old population with internal consistencies ranging from 0.66 to 0.86 (Carey & McDevitt, 1978). A total of ten questions were included and the same 5-point scale mentioned above was used to

have mothers indicate their answers to these questions. This set of ten questions, when analyzed using our data, had a Cronbach's alpha of 0.40. In our study, sensory threshold was calculated by the mean score of these items.

Overall sensory sensitivity was evaluated using select questions from the Short Sensory Profile (SSP) (Dunn, 1999), the Toddler Sensory Profile 2 (TSP2) (Dunn, 2014), and novel questions developed specifically for this questionnaire. Three questions regarding texture from the TSP2 were included, and two questions regarding taste and one regarding smell from the SSP were included. Because these questions did not fully cover all aspects of sensory properties, six novel questions were created assessing smell, temperature, color, and preference. This set of twelve questions collectively comprised the sensory evaluation in the questionnaire and used the 5-point scale mentioned above. Our scale, when evaluated for internal consistency, had a Cronbach's alpha of 0.73. In our study, overall sensitivity was determined by the mean score of the twelve questionnaire items taken from the SSP, TSP2, and the six novel questions created for the purpose of this study.

Additionally, in analyzing our results, sensitivity in the context of each of the five measured domains was determined by calculating the mean score of the set of questionnaire items measuring each sensory characteristic in the scale mentioned above. The items are listed below:

S6. My baby avoids tastes that other babies like. (Taste)

S7. My baby dislikes certain food smells. (Smell)

S8. My baby prefers foods that are smooth. (Texture)

S9. My baby will only eat certain tastes. (Taste)

S10. My baby prefers food to be warm. (Temperature)

S11. My baby likes foods that smell good. (Smell)

S12. My baby prefers foods that are crunchy. (Texture)

S13. My baby only likes certain food textures. (Texture)

S14. My baby likes food at room temperature. (Temperature)

S15. My baby avoids foods of a certain color. (Appearance)

S16. My baby likes vegetables and fruits the same.

S17. My baby dislikes foods that are green. (Appearance)

Taste was measured by computing the mean score of items S6 and S9. Smell was measured by computing the mean score of items S7 and S11. Texture was measured by computing the mean score of items S8, S12, and S13. Temperature was measured by computing the mean score of S10 and S14. Appearance was measured by computing the mean score of S15 and S17.

Lastly, anthropometric characteristics of both the mother and infant were asked as well as demographic information about the mother. These included weight, height, and age of both mother and baby, as well as the race or ethnicity of the mother. In cases where the mother was unsure of the infant's height and weight, the information was obtained from the infant's records at WIC if a nurse was available.

After the creation of the questionnaire, it was translated into Spanish to better accommodate the population in this study. See *Appendix D* for the Spanish version of the questionnaire.

IV. RESULTS

Statistical analyses

All statistical analyses were conducted using IBM SPSS Statistics, Version 24.0 (Armonk, NY). Descriptive demographics, anthropometrics, and infant fruit and vegetable intakes were analyzed using means and standard deviations. Differences between males and females were examined with independent sample t-tests. Pearson correlations were used to analyze the relationships between various measures such as infant and mother fruit and vegetable preferences, sensory properties, anthropometrics, and demographics. Statistical significance is indicated as $p<0.05$, noted with one asterisk (*) and $p<0.01$, noted with two asterisks (**).

Demographic and anthropometric data

Infant and mother demographic data are shown in Table 1. Mother's mean age was 28.8 years, ranging from 15 to 45 years. Infant's mean age was 8.4 months, ranging from 3 to 12 months. Maternal body mass index (BMI) was calculated using weight in kilograms divided by height in meters squared. Mean maternal BMI was 29.41 kg/m^2, indicating that the mothers were overweight on average, and that this mean was very close to the obesity parameter (BMI greater than 30 kg/m^2). Infant's weight-for-length and weight-for-age percentiles and z-scores were calculated using the CDC, National Center for Health Statistics infant weight-for-length and weight-for-age calculators. 37.8% of included infants had weight-for-length percentiles above the 95^{th} percentile, and 15.9% of included infants had weight-for-age percentiles above the 95^{th} percentile, indicating obesity.

Table 1. Characteristics of Mothers and Infants

	N	Mean	Standard Deviation
Mother's Age (years)	105	28.8	6.36
Mother's BMI (kg/m^2)	85	29.41	6.39
Infant's Age (months)	120	8.4	2.59
Infant's Weight-for-Length Percentile	45	66.47	35.76
Infant's Weight-for-Length Z-score	45	1.06	1.91
Infant's Weight-for-Age Percentile	88	48.47	35.93
Infant's Weight-for-Age Z-score	88	0.15	2.37

Race and ethnicity were determined by how the mother identified herself. The majority of the sample was Hispanic or Latina (42.4%), followed by Black/African-American (24.6%), Mexican (16.1%), White (9.3%), Native Hawaiian or Other Pacific Islander (3.4%), Asian (2.5%), and Asian Indian (1.7%). Table 2 displays these results.

Table 2. Race/Ethnicity of Mothers

	N	Percentage
Hispanic or Latina	40	42.4%
Black/African-American	29	24.6%
Mexican	19	16.1%
White	11	9.3%
Native Hawaiian or Other Pacific Islander	4	3.4%
Asian	3	2.5%
Asian Indian	2	1.7%

Fruit and vegetable intake

Fruit and vegetable intake was addressed in terms of number of fruits and number of vegetables tried and liked both by the mother and infant. For vegetables, the number indicates the number tried or liked out of a total of 27 vegetables, and for fruits the number indicates the number tried or liked out of a total of 26 fruits. Table 3 shows this data for all ages of infants in the sample, as well as mothers. Infant data were analyzed as a whole because gender differences were not found to be statistically significant. Fruit acceptance, was the only variable which approached significance between the two genders (p=0.054), however was still not statistically significant (data not shown). The data in Table 3 reveals that on average, both infants and mothers were exposed to more fruits than vegetables, and liked more fruits than vegetables.

Table 3. Number of Fruits and Vegetables Liked or Tried by Infants and Mothers

	N	Mean	Standard Deviation
Number of Veg. Tried by the Infant	81	10.4	7.18
Number of Veg. Liked by the Infant	112	8.1	5.82
Number of Fruits Tried by the Infant	71	12.6	6.92
Number of Fruits Liked by the Infant	113	11.2	6.01
Number of Veg. Tried by the Mother	71	17.7	8.93
Number of Veg. Liked by the Mother	68	14.2	8.40
Number of Fruits Tried by the Mother	66	18.8	7.95
Number of Fruits Liked by the Mother	66	16.8	7.76

This data were also analyzed when separating infants into age groups. Infant data were separated into groups of 3 to 6 months, 7 to 8 months, and 9 to 12 months in accordance to the previously mentioned infant introductory feeding practices. Tables 4, 5, and 6 show these data sets in order of increasing age group. When looking at each measure, the means increase as age increases, showing that the older infants were exposed to and liked more fruits and vegetables when compared to younger infants.

Table 4. Number of Fruits and Vegetables Liked or Tried by Infants Ages 3 to 6 Months

	N	Mean	Standard Deviation
Number of Veg. Tried by the Infant	25	6.3	5.31
Number of Veg. Liked by the Infant	33	5.5	4.35
Number of Fruits Tried by the Infant	24	8.7	5.84
Number of Fruits Liked by the Infant	35	7.6	4.85

Table 5. Number of Fruits and Vegetables Liked or Tried by Infants Ages 7 to 8 Months

	N	Mean	Standard Deviation
Number of Veg. Tried by the Infant	17	11.1	7.44
Number of Veg. Liked by the Infant	24	6.7	6.71
Number of Fruits Tried by the Infant	17	13.1	7.27
Number of Fruits Liked by the Infant	24	11.0	6.05

Table 6. Number of Fruits and Vegetables Liked or Tried by Infants Ages 9 to 12 Months

	N	Mean	Standard Deviation
Number of Veg. Tried by the Infant	39	12.7	7.11
Number of Veg. Liked by the Infant	55	10.2	6.25
Number of Fruits Tried by the Infant	30	15.5	6.17
Number of Fruits Liked by the Infant	55	13.7	5.46

Mother and infant demographic and fruit and vegetable correlations

Maternal age and BMI and well as fruit and vegetable intake and preferences were compared with infant anthropometrics as well as infant fruit and vegetable intake and preferences. Table 7 displays these results. The higher the mother's BMI, the lower was the infant's weight-for-length percentile ($p<0.01$) and weight-for-length z-score ($p<0.05$). Both the number of vegetables tried and number of vegetables liked by the infant were significantly correlated to the number of vegetables liked by the mother ($p<0.01$). The number of vegetables tried by the mother significantly correlated with the number of vegetables liked by the infant ($p<0.05$). The number of fruits liked by the mother significantly correlated with the number of vegetables tried by the infant ($p<0.05$), number of vegetables liked by the infant ($p<0.01$), number of fruits tried by the infant ($p<0.05$), and number of fruits liked by the infant ($p<0.01$). The number of fruits tried by the mother significantly correlated with the number of vegetables tried by the infant ($p<0.01$), as well as the number of fruits tried ($p<0.05$) and liked ($p<0.05$) by the

infant. Infant's age was not significantly correlated to any maternal measures. Additionally, mother's age was not significantly correlated to any infant measures, however the older the mother, the more fruits and vegetables she tried and fruits she liked ($p<0.05$) (data not shown).

Table 7. Mother and Infant Demographic and Fruit and Vegetable Correlations

		Infant's Age	Infant's Weight-for-Length Percentile	Infant's Weight-for-Length Z-score	Number of Veg. Tried by the Infant	Number of Veg. Liked by the Infant	Number of Fruits Tried by the Infant	Number of Fruits Liked by the Infant
Mother's Age	Pearson Correlation	0.025	-0.256	-0.179	-0.199	0.031	-0.196	-0.070
	Sig. (2-tailed)	0.803	0.115	0.275	0.089	0.760	0.124	0.495
	N	105	39	39	74	99	63	98
Mother's BMI	Pearson Correlation	-0.103	-0.464**	-0.375*	-0.011	0.009	-0.241	-0.151
	Sig. (2-tailed)	0.349	0.004	0.022	0.934	0.940	0.079	0.182
	N	85	37	37	63	79	54	80
Number of Veg. Tried by the Mother	Pearson Correlation	0.018	-0.097	0.059	0.244	0.248*	0.095	0.100
	Sig. (2-tailed)	0.879	0.609	0.756	0.056	0.043	0.480	0.423
	N	71	30	30	62	67	57	67
Number of Veg. Liked by the Mother	Pearson Correlation	-0.195	0.059	0.154	0.368**	0.400**	0.135	0.192
	Sig. (2-tailed)	0.111	0.769	0.442	0.004	0.001	0.331	0.126
	N	68	27	27	61	65	54	65
Number of Fruits Tried by the Mother	Pearson Correlation	-0.061	-0.016	0.100	0.431**	0.238	0.308*	0.266*
	Sig. (2-tailed)	0.628	0.941	0.633	0.001	0.060	0.019	0.035
	N	66	25	25	59	63	58	63
Number of Fruits Liked by the Mother	Pearson Correlation	-0.031	-0.020	0.066	0.304*	0.345**	0.324*	0.370**
	Sig. (2-tailed)	0.806	0.927	0.759	0.020	0.006	0.014	0.003
	N	66	24	24	58	62	57	63

Infant fruit and vegetable intake and sensory sensitivity correlations

The three scales used to evaluate sensitivity in the infants measured food responsiveness, sensory threshold, and overall sensitivity. No statistically significant correlations were found when comparing fruit and vegetable acceptance or preferences with scores obtained on the three sensitivity scales when evaluating the sample as a whole. Table 8 shows these results.

Table 8. Infant Fruit and Vegetable Acceptance and Preferences in the Context of Sensitivity Scales: All Ages

		Food Responsiveness	Sensory Threshold	Sensitivity
Infant Vegetable Acceptance	Pearson Correlation	-0.014	-0.105	-0.211
	Sig. (2-tailed)	0.908	0.417	0.086
	N	74	62	67
Infant Fruit Acceptance	Pearson Correlation	0.109	-0.240	-0.146
	Sig. (2-tailed)	0.390	0.080	0.269
	N	64	54	59
Number of Veg. Liked by the Infant	Pearson Correlation	0.140	-0.170	-0.064
	Sig. (2-tailed)	0.161	0.113	0.535
	N	102	88	95
Number of Fruits Liked by the Infant	Pearson Correlation	0.034	-0.127	-0.017
	Sig. (2-tailed)	0.736	0.241	0.870
	N	103	87	96

Because of the differences in number of vegetables eaten amongst age groups, in light of feeding recommendations based on increasing age, correlations between fruit and vegetable acceptance and preference and sensory sensitivity were conducted separately by age group, as well. Table 9 shows correlations in the 3- to- 6- month age group. The

more sensitive the infant according to the overall sensitivity score, the less vegetables he or she accepted ($p<0.05$). Similarly, in the 7- to- 8- month age group, the less vegetables preferred by the infant, the higher his or her overall sensitivity score ($p<0.01$). Additionally, infants with a lower sensory threshold had a lower fruit preference ($p<0.05$). This is shown in Table 10. No significant correlations were found in the 9- to- 12- month age group, shown in Table 11.

Table 9. Infant Fruit and Vegetable Acceptance and Preferences in the Context of Sensitivity Scales: 3 to 6 months

		Food Resp.	Sensory Threshold	Sensitivity
Infant Vegetable Acceptance	Pearson Correlation	-0.150	-0.324	-0.500*
	Sig. (2-tailed)	0.495	0.239	0.029
	N	23	15	19
Infant Fruit Acceptance	Pearson Correlation	-0.150	-0.248	-0.415
	Sig. (2-tailed)	0.494	0.372	0.077
	N	23	15	19
Number of Veg. Liked by the Infant	Pearson Correlation	0.151	-0.027	-0.111
	Sig. (2-tailed)	0.401	0.902	0.583
	N	33	23	27
Number of Fruits Liked by the Infant	Pearson Correlation	0.114	0.039	-0.276
	Sig. (2-tailed)	0.521	0.855	0.163
	N	34	24	27

Table 10. Infant Fruit and Vegetable Acceptance and Preferences in the Context of Sensitivity Scales: 7 to 8 months

		Food Resp.	Sensory Threshold	Sensitivity
Infant Vegetable Acceptance	Pearson Correlation	0.036	0.038	-0.030
	Sig. (2-tailed)	0.921	0.917	0.922
	N	10	10	13
Infant Fruit Acceptance	Pearson Correlation	-0.070	0.383	0.265
	Sig. (2-tailed)	0.857	0.275	0.405
	N	9	10	12
Number of Veg. Liked by the Infant	Pearson Correlation	-0.187	-0.456	-0.622**
	Sig. (2-tailed)	0.456	0.066	0.003
	N	18	17	21
Number of Fruits Liked by the Infant	Pearson Correlation	-0.159	-0.487*	-0.320
	Sig. (2-tailed)	0.528	0.047	0.157
	N	18	17	21

Table 11. Infant Fruit and Vegetable Acceptance and Preferences in the Context of Sensitivity Scales: 9 to 12 months

		Food Resp.	Sensory Threshold	Sensitivity
Infant Vegetable Acceptance	Pearson Correlation	0.251	0.208	0.090
	Sig. (2-tailed)	0.152	0.261	0.635
	N	34	31	30
Infant Fruit Acceptance	Pearson Correlation	0.167	0.156	-0.101
	Sig. (2-tailed)	0.404	0.446	0.654
	N	27	26	22
Number of Veg. Liked by the Infant	Pearson Correlation	0.086	0.028	-0.199
	Sig. (2-tailed)	0.546	0.851	0.176
	N	52	47	48
Number of Fruits Liked by the Infant	Pearson Correlation	0.000	0.018	-0.114
	Sig. (2-tailed)	0.999	0.904	0.443
	N	51	46	47

When comparing infant fruit and vegetable acceptance and preferences to the five senses measured in the overall sensitivity scale, only sensitivity to appearance was related to a lower infant vegetable acceptance ($p<0.05$). This is shown in Table 12. Tables 13, 14, and 15 also show these results separated by age group.

Table 12. Infant Fruit and Vegetable Acceptance and Preference in the Context of Senses: All Ages

		Taste	Smell	Texture	Temp.	Appearance
Infant Vegetable Acceptance	Pearson Correlation	-0.219	-0.092	-0.124	0.034	-0.230*
	Sig. (2-tailed)	0.061	0.431	0.306	0.772	0.046
	N	74	75	70	75	76
Infant Fruit Acceptance	Pearson Correlation	-0.127	-0.038	-0.155	0.022	-0.120
	Sig. (2-tailed)	0.313	0.759	0.229	0.861	0.333
	N	65	67	62	66	67
Number of Veg. Liked by the Infant	Pearson Correlation	-0.140	-0.022	0.090	-0.029	-0.091
	Sig. (2-tailed)	0.151	0.820	0.375	0.766	0.343
	N	107	107	99	107	110
Number of Fruits Liked by the Infant	Pearson Correlation	0.003	0.043	0.058	-0.053	-0.017
	Sig. (2-tailed)	0.977	0.657	0.567	0.585	0.861
	N	108	108	100	108	111

In the 3- to- 6- month age group, multiple significant correlations were observed. These are shown in Table 13. The lower the infant's vegetable acceptance, the more sensitive he or she scored in the categories of taste ($p<0.01$), smell ($p<0.01$), texture ($p<0.05$), and appearance ($p<0.01$). The lower the infant's fruit acceptance, the more sensitive he or she scored in the categories of smell ($p<0.05$), texture ($p<0.05$), and appearance ($p<0.05$). A lower vegetable preference significantly correlated with sensitivity to appearance ($p<0.05$), while a lower fruit acceptance significantly correlated with sensitivity temperature ($p<0.05$). Table 14 shows results in the 7- to- 8- month age

group. The more sensitive to taste and temperature, the lower the infant's vegetable preference ($p<0.05$) was in this age group. In the 9- to- 12- month age group, only sensitivity to taste indicated a lower vegetable preference ($p<0.05$). This is shown in Table 15.

Table 13. Infant Fruit and Vegetable Acceptance and Preference in the Context of Senses: 3 to 6 months

		Taste	Smell	Texture	Temp.	Appearance
Infant Vegetable Acceptance	Pearson Correlation	-0.595**	-0.639**	-.486*	-0.330	-.616**
	Sig. (2-tailed)	0.003	0.001	0.030	0.115	0.002
	N	23	23	20	24	23
Infant Fruit Acceptance	Pearson Correlation	-0.396	-.432*	-0.458*	-0.319	-.539**
	Sig. (2-tailed)	0.061	0.040	0.042	0.129	0.008
	N	23	23	20	24	23
Number of Veg. Liked by the Infant	Pearson Correlation	-0.134	-0.187	0.079	-0.159	-0.385*
	Sig. (2-tailed)	0.466	0.297	0.685	0.377	0.027
	N	32	33	29	33	33
Number of Fruits Liked by the Infant	Pearson Correlation	-0.257	-0.241	-0.086	-0.363*	-0.285
	Sig. (2-tailed)	0.149	0.170	0.658	0.035	0.102
	N	33	34	29	34	34

Table 14. Infant Fruit and Vegetable Acceptance and Preference in the Context of Senses: 7 to 8 months

		Taste	Smell	Texture	Temp.	Appearance
Infant Vegetable Acceptance	Pearson Correlation	0.139	0.086	0.205	-0.199	-0.272
	Sig. (2-tailed)	0.621	0.762	0.501	0.478	0.307
	N	15	15	13	15	16
Infant Fruit Acceptance	Pearson Correlation	0.530	-0.070	0.022	-0.050	0.004
	Sig. (2-tailed)	0.051	0.812	0.945	0.866	0.990
	N	14	14	12	14	15
Number of Veg. Liked by the Infant	Pearson Correlation	-0.418*	-0.283	-0.310	-0.521*	-0.358
	Sig. (2-tailed)	0.047	0.191	0.171	0.011	0.086
	N	23	23	21	23	24
Number of Fruits Liked by the Infant	Pearson Correlation	-0.269	-0.173	-0.276	-0.186	-0.058
	Sig. (2-tailed)	0.215	0.430	0.226	0.394	0.788
	N	23	23	21	23	24

Table 15. Infant Fruit and Vegetable Acceptance and Preference in the Context of Senses: 9 to 12 months

		Taste	Smell	Texture	Temp.	Appearance
Infant Vegetable Acceptance	Pearson Correlation	0.132	-0.072	0.191	0.161	0.121
	Sig. (2-tailed)	0.448	0.686	0.295	0.364	0.481
	N	35	34	32	34	36
Infant Fruit Acceptance	Pearson Correlation	-0.086	-0.113	0.036	0.094	-0.118
	Sig. (2-tailed)	0.668	0.581	0.868	0.648	0.550
	N	27	26	24	26	28
Number of Veg. Liked by the Infant	Pearson Correlation	-0.299*	-0.164	-0.002	0.131	-0.262
	Sig. (2-tailed)	0.030	0.246	0.987	0.354	0.056
	N	53	52	50	52	54
Number of Fruits Liked by the Infant	Pearson Correlation	-0.083	-0.164	0.089	0.002	-0.247
	Sig. (2-tailed)	0.557	0.250	0.543	0.989	0.075
	N	52	51	49	51	53

When evaluating each of the twelve questions in the overall sensitivity scale, significant correlations were found between specific questions and infant fruit and vegetable acceptance and preferences. These results are displayed in Table 16. Infants who were more sensitive to smell, denoted by their score on item S7, accepted less vegetables ($p<0.01$), as well as less fruits ($p<0.05$). Those sensitive to taste, based on their score on item S9, accepted ($p<0.05$) and preferred ($p<0.01$) less vegetables. Infants with a higher score on item S12 denoting preference of crunchy foods, preferred more fruits ($p<0.01$) and vegetables ($p<0.01$). Those infants scoring higher on item S16, indicating no preference between fruits or vegetables both accepted ($p<0.05$) and preferred ($p<0.01$) more fruits and vegetables.

Table 16. Infant Fruit and Vegetable Acceptance and Preference in the Context Individual Sensitivity Questions

		S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17
Infant Vegetable Acceptance	Pearson Correlation	-0.104	-0.297**	-0.055	-0.252*	-0.036	0.069	-0.024	-0.089	0.088	-0.156	0.226*	-0.201
	Sig. (2-tailed)	0.37	0.009	0.639	0.029	0.755	0.554	0.84	0.45	0.452	0.178	0.048	0.079
	N	76	76	74	75	77	75	75	74	75	76	77	77
Infant Fruit Acceptance	Pearson Correlation	-0.008	-0.306*	-0.127	-0.187	-0.049	0.154	-0.042	-0.047	0.09	-0.158	0.275*	-0.013
	Sig. (2-tailed)	0.946	0.012	0.315	0.134	0.694	0.214	0.733	0.707	0.473	0.202	0.023	0.913
	N	67	67	65	66	68	67	67	66	66	67	68	68
Number of Veg. Liked by the Infant	Pearson Correlation	0.016	-0.161	-0.058	-0.248**	-0.053	0.092	0.280**	-0.008	0.055	-0.099	0.320**	-0.04
	Sig. (2-tailed)	0.869	0.093	0.551	0.009	0.58	0.345	0.003	0.936	0.573	0.303	0.001	0.675
	N	109	110	109	109	110	107	107	105	108	110	112	111
Number of Fruits Liked by the Infant	Pearson Correlation	0.093	-0.045	-0.105	-0.091	-0.068	0.089	0.384**	-0.079	0.038	-0.063	0.243**	0.038
	Sig. (2-tailed)	0.334	0.64	0.275	0.342	0.477	0.358	0	0.423	0.693	0.511	0.01	0.69
	N	110	111	110	110	111	108	108	106	109	111	112	112

Correlations amongst measurement scales

Correlations were conducted and analyzed amongst the various measurement scales on the questionnaire. Table 17 shows correlations amongst food responsiveness, the sensory threshold, and overall sensitivity. There were no statistically significant correlations between any of the three scales.

Table 17. Measures of Sensitivity

		Food Resp.	Sensory Threshold	Sensitivity
Food Resp.	Pearson Correlation		-0.022	0.047
	Sig. (2-tailed)		0.835	0.654
	N		88	95
Sensory Threshold	Pearson Correlation			0.189
	Sig. (2-tailed)			0.085
	N			84
Sensitivity				

When evaluating the five senses measured on the overall sensitivity scale, all five senses (taste, smell, texture, temperature, and appearance) significantly correlated with each other ($p<0.01$). Table 18 shows these results.

Table 18. Senses Measured in Overall Sensitivity

		Taste	Smell	Texture	Temp.	Vision
Taste	Pearson Correlation		0.498**	0.523**	0.380**	0.587**
	Sig. (2-tailed)		0.000	0.000	0.000	0.000
	N		111	105	112	114
Smell	Pearson Correlation			0.401**	0.512**	0.505**
	Sig. (2-tailed)			0.000	0.000	0.000
	N			104	111	114
Texture	Pearson Correlation				0.505**	0.309**
	Sig. (2-tailed)				0.000	0.001
	N				105	106
Temp.	Pearson Correlation					0.402**
	Sig. (2-tailed)					0.000
	N					114
Vision						

Table 19 shows the correlations amongst the 12 questions in he overall sensitivity scale. Each question significantly correlated with at least two other questions in the scale, with most questions significantly correlating with each other.

Table 19. Overall Sensitivity Questions

		S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17
	Pearson Correlation		0.431**	0.271**	0.432**	0.419**	0.321**	0.235**	0.214*	-0.34	0.474**	-0.088	0.437**
S6	Sig. (2-tailed)		0.000	0.003	0.000	0.000	0.001	0.012	0.024	0.715	0.000	0.350	0.000
	N		116	115	115	116	113	113	111	115	116	116	117
	Pearson Correlation			0.184*	0.496**	0.306**	0.262**	0.284**	0.341**	0.119	0.580**	-0.201*	0.277*
S7	Sig. (2-tailed)			0.049	0.000	0.001	0.005	0.002	0.000	0.205	0.000	0.029	0.002
	N			115	116	117	115	114	111	115	117	117	118
	Pearson Correlation				0.512**	0.402**	0.283**	-0.055	0.390**	0.193*	0.227*	0.011	0.168
S8	Sig. (2-tailed)				0.000	0.000	0.003	0.563	0.000	0.040	0.014	0.906	0.071
	N				114	115	112	112	109	113	116	116	116
	Pearson Correlation					0.263**	0.179	0.076	0.427**	0.176	0.326**	-0.249**	0.343**
S9	Sig. (2-tailed)					0.004	0.058	0.424	0.000	0.061	0.000	0.007	0.000
	N					116	113	114	110	114	116	116	117
	Pearson Correlation						0.386**	0.136	0.190*	-0.004	0.371**	-0.026	0.265**
S10	Sig. (2-tailed)						0.000	0.149	0.045	0.963	0.000	0.782	0.004
	N						114	114	112	115	117	117	118
	Pearson Correlation							0.136	0.213*	0.298*	0.237*	0.016	0.293**
S11	Sig. (2-tailed)							0.151	0.026	0.001	0.011	0.863	0.001
	N							113	109	112	114	114	115
	Pearson Correlation								0.118	0.095	0.163	0.069	0.244**
S12	Sig. (2-tailed)								0.221	0.321	0.083	0.468	0.009
	N								109	112	114	114	115
	Pearson Correlation									0.451**	0.189*	-0.126	0.189*
S13	Sig. (2-tailed)									0.000	0.047	0.188	0.045
	N									111	111	111	112
	Pearson Correlation										0.130	-0.095	0.124
S14	Sig. (2-tailed)										0.167	0.310	0.186
	N										115	115	116
	Pearson Correlation											-0.082	0.287**
S15	Sig. (2-tailed)											0.382	0.002
	N											117	118
	Pearson Correlation												-0.133
S16	Sig. (2-tailed)												0.152
	N												118
S17													

Validity and reliability of the questionnaire

Validity and reliability were determined for the 12 questions on the overall sensitivity scale, in order to evaluate the six novel questions. Content validity was conducted by consulting and receiving feedback form an expert panel of faculty and graduate students in the Department of Nutritional Sciences at the School of Environmental and Biological Sciences at Rutgers University. Reliability, or internal consistency, of this section of the questionnaire was determined by running a Cronbach's alpha with a result of 0.733, which is considered acceptable. Table 20 shows the Cronbach's alpha values for each dimension of the scale. The scales of each individual dimension did not show as a high a consistency as the overall scale as a whole.

Table 20. Internal Consistency of the Sensitivity Scale

	Cronbach's alpha
Taste	0.60
Smell	0.39
Texture	0.33
Temperature	-0.01
Appearance	0.45
Overall Sensitivity	0.73

V. DISCUSSION

The early introduction of fruits and vegetables to infants is an important area of study due to the rapid rise in childhood obesity, and the effects of diet on this alarming increase. The data for this thesis showed that 37.8% of included infants had weight-for-length percentiles above the 95th percentile, and 15.9% of included infants had weight-for-age percentiles above the 95th percentile. Additionally, the mean maternal BMI in the sample was 29.41 kg/m^2, which is considered overweight, and is on the cusp of obesity (30 kg/m^2). Interestingly, a higher maternal BMI correlated with a lower infant weight-for-length and weight-for-height percentile. However, a study found that parental obesity more than doubles the risk of adult obesity in both obese and non-obese children under the age of 10 years (Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). Therefore, many infants in the sample, regardless of their current status, may have an increased chance of becoming obese adults. Additionally, a study assessing BMI associations between mother and offspring birth to 18 years of age found that BMI correlations became statistically significant starting at 5 years old in boys and 1.5 years old in girls (Swanton et al., 2017), showing that this association may not begin until an older age. Our results show an even higher percentage of infants in this sample at WIC having a higher-than-normal weight-for-length than the 12.3% reported by the CDC in 2014.

Mothers in the data sample who identified as Hispanic or Latina accounted for the greatest percentage (42.4%). Because of the WIC eligibility requirements, all mothers participating in this study were of low-income households. According to findings from the 2015-2016 National Health and Nutrition Examination Survey (NHANES), Hispanics had the highest age-adjusted prevalence of obesity in the United States at 47 percent.

Additionally, among women, obesity prevalence was lower in the highest income group than in the middle and lowest income groups among Hispanic women (CDC, Adult Obesity Facts, 2018).

The infant feeding guidelines recommended by both CHOP and Johns Hopkins University School of Medicine recommend introducing fruit and vegetables between 4- to- 6- months of age and increasing quantities between 7- to- 8- months of age. Our data showed that older infants were exposed to and liked more fruits and vegetables when compared to younger infants. This increase in quantity reflects an increase in variety, explaining the increases in fruits and vegetables tried and liked with increasing age in this sample of infants.

As predicted, there was a significant relationship between maternal and infant fruit and vegetable acceptance and preference. Skinner et al. (1998) found that there was a strong concordance of food preferences between a child and his or her other family members in a sample of toddlers. More specifically, Skinner et al. (2002) found that vegetable variety in children was predicted by their mother's vegetable preferences. Consistent with Worobey et al.'s study (2010) showing that mothers' likes correlated with fruits and vegetables that their children tried, our results showed the same relationship.

The main purpose of this study was to determine a relationship between sensory sensitivity and fruit and vegetable acceptance in young infants. Our results were reported in the context of the sample as a whole, as well as broken down into the following age groups: 3 to 6 months, 7 to 8 months, and 9 to 12 months. Our hypothesis was that infants with a lower sensory threshold, in other words, infants who were more hypersensitive,

would like fewer fruits and vegetables, compared with those infants with a higher sensory threshold. When examining the three sensitivity scales (food responsiveness, sensory threshold, and overall sensitivity) in the sample as a whole, there was no significant relationship found with infant fruit and vegetable acceptance or preference. However, amongst age groups, infants in the 3- to- 6- month age group who were considered more sensitive had lower vegetable acceptance. Infants in the 7- to- 8- month age group who were considered more sensitive had both a lower vegetable and lower fruit preference. These results, although specifically in infants, are consistent with Smith et al.'s findings (2005) that hypersensitive children were more resistant to eating vegetables. This study also showed that these children refused certain foods because of temperature, texture, and smell. One study, (van der Horst et al., 2016) also found that children who were texture resistant consumed fewer vegetables.

When evaluating each of the five domains in the overall sensitivity score for the sample as a whole, only sensitivity to appearance was related to a lower infant vegetable acceptance. However, in the 3- to 6- month age group, sensitivity to all five dimensions was significantly related to fruit or vegetable acceptance or preference. Increased sensitivity to taste, smell, texture, and appearance were all associated with a lower infant vegetable acceptance. Sensitivity to smell, texture, and appearance were associated with a lower infant fruit acceptance, while sensitivity to temperature was associated only with fruit preference. Among the 7- to 8- month olds, sensitivity to taste and temperature was related to infant vegetable preference, while only sensitivity to taste was related to infant vegetable preference in the 9- to- 12- month age group. Interestingly, a relationship was found with each dimension in the youngest age group. Research suggests that neonates

are born with all of their senses intact and functional (CHOP, 2018). The ability to sense flavors postnatally is initiated *in utero* with the development of the gustatory and olfactory systems, with development of both systems beginning in the first trimester (Ventura & Worobey, 2013). Additionally, a review of the gustatory and olfactory systems during infancy reported that both olfactory and taste receptors must be functional in order for a human fetus or infant to sense flavor, and that these receptors are formed and developed *in utero* (Lipchock, Reed, & Mennella, 2011). This review also states that these specific senses are the major determinants of whether young children accept a food and therefore, take on a greater significance in understanding the biologic basis for children's food choices. In our results, sensitivity to taste was related to vegetable preference or acceptance in each age group, while sensitivity to smell was related to vegetable acceptance only in the youngest age group. Consistent with these results, when analyzing the sensitivity scale items separately, infants more sensitive to smell accepted fewer vegetables and fewer fruits, and infants more sensitive to taste accepted and preferred fewer vegetables.

Interestingly, two positive correlations were found in our analysis of the separate sensitivity scale items in the sample as a whole. Infants who preferred crunchy foods preferred more fruits and vegetables. This questionnaire item may have been controversial because infants cannot chew crunchy foods per se, however some moms may have interpreted the fruit or vegetable in its original, raw state, regardless of cooking method or final presentation. A study analyzing preparation methods on children's liking of vegetables in a sample of 4- to- 6- year- olds found that vegetable liking was positively correlated to taste, as well as crunchiness (Zeinstra, Koelen, Kok, & de Graaf, 2010).

Additionally, a positive relationship was found between those infants with no preference for fruits or vegetables and fruit and vegetable preference and acceptance. This may indicate that these infants are less "picky" and therefore, eat more fruits and vegetables. Data from the FITS 2008 study showed that picky eaters were more likely to be neophobic, and that they consumed fewer vegetables than non-picky eaters (van der Horst, et al., 2016).

Strengths

There are few studies that evaluate fruit and vegetable consumption in young infants in the context of sensory sensitivity, and none that utilize an instrument designed for this purpose. Our study not only analyzed a novel subject, but also put forth a new instrument that can be adjusted and edited in order to better collect the information needed for this area of study. Additionally, the investigator was present for each and every questionnaire that was completed and interacted with each mother, and was therefore available to answer any questions and clarify any areas of confusion. Collecting our data at WIC allowed for a familiar setting for the mothers, as well as avoided an additional time burden, as the mothers were sitting in the waiting area while completing the questionnaires. This questionnaire was also available in both English and Spanish, which allowed for most of the mothers with eligible infants to participate in our study if desired. Although the investigator did not speak fluent Spanish, having the WIC staff, most of who were Spanish-speaking, was helpful when translation was needed.

Limitations

Our results are based on self-reported answers to the items on our questionnaire, rather than on primary data collection. Additionally, mothers' responses to the

questionnaire items were based on their perceptions of their infant's behavior and preferences. We also did not ask about fruit and vegetable consumption frequency. In our study, some mothers included in the study did not fully complete the questionnaire, hence there was some missing information in specific sections. There was also no follow-up in this study, as it was designed for a one-time data collection, rather than longitudinal in design. Additionally, some mothers did not speak English or Spanish and were therefore unable to participate. However, this was only the case for a few approached mothers. Although the overall sensitivity scale had an acceptable measure of internal consistency, the separate dimension scales resulted in lower Cronbach' alpha values, with the scale for temperature producing a value of zero.

Conclusion and Future Direction

Overall, our findings suggest that there is a relationship between fruit and vegetable consumption and sensory sensitivity in young infants, most prevalently in the youngest age group of less than 6 months of age. There is evidence that it is easier to get new tastes and new complex flavors accepted between the ages of 4 and 6 months, when the infant is first being introduced to solid foods (Harris & Mason, 2017). In terms of the other scales measured, we found no relationship between food responsiveness and fruit and vegetable consumption in this sample, and only one finding with sensory threshold in the context of temperament in the 7- to- 8- month age group.

The sensory sensitivity scale created in this study showed promising results in this sample of infants. All five domains measured on this scale significantly correlated with each other, showing a consistency in the measurement of overall sensory sensitivity, in addition to the scale having an acceptable value denoting internal consistency and

reliability. In the future, it may be beneficial for the items on the scale to be refined or altered. Specifically, questions S12 (regarding crunchy foods) and S16 (regarding preference between fruits and vegetables), as well as the items regarding temperature because of that scale's internal consistency results.

The results of this study warrant the use of this questionnaire, specifically the sections measuring sensory sensitivity and fruit and vegetable consumption, in larger samples with varying demographics in order to further analyze the relationship between sensory sensitivity and fruit and vegetable consumption in infants. A larger sample may also warrant the use of a factor analysis to further analyze the variability of the items in the scale. Additionally, this research may link to biochemical mechanisms, such as the PROP gene, which have been understudied in infants. An additional qualitative analysis of our findings may be beneficial in order to analyze the types of vegetables infants may dislike, secondary to their sensory sensitivity, such as bitter thiourea compounds including Brassica vegetables (e.g., broccoli, cabbage, etc.) (Keller & Adise, 2016).

Future findings, if consistent with ours, can lead to nutrition interventions at the early age of 4- to- 6- months when solid foods are first being introduced, rather than waiting until later in childhood or even adulthood. This would allow for targeted interventions to increase fruit and vegetable intake, creating a positive path and healthier future.

VI. REFERENCES

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VII. APPENDIX

Appendix A. English Informed Consent Form

CONSENT FORM
FOR ANONYMOUS DATA COLLECTION

You are invited to participate in a research study being conducted by Neeka Tabatabaei, a student in the Nutritional Sciences Department at Rutgers University. The purpose of this research is to see what makes young infants like or dislike fruits and vegetables.

This research is anonymous. Anonymous means that I will record no information about you that could identify you. This means that I will not record your name, address, phone number, date of birth, etc.

The research team and the Institutional Review Board at Rutgers University are the only parties that will be allowed to see the data, except as may be required by law. If a report of this study is published, or the results are presented at a professional conference, only group results will be stated. All study data will be kept for 5 years.

There are no foreseeable risks to participation in this study. In addition, you may receive no direct benefit from taking part in this study.

Participation in this study is voluntary. You may choose not to participate, and you may stop answering the questions at any time without any penalty. In addition, you may choose not to answer any questions with which you are not comfortable.

If you have any questions about the study or study procedures, you may contact me at Davison Hall, 26 Nichol Avenue, New Brunswick, NJ, 856-237-9492, nnt20@scarletmail.rutgers.edu. You can also contact my faculty advisor, John Worobey, at Davison Hall, 26 Nichol Avenue, New Brunswick, NJ, 848-932-0937, worobey@sebs.rutgers.edu.

If you have any questions about your rights as a research subject, please contact an IRB Administrator at the Rutgers University, Arts and Sciences IRB:

Institutional Review Board
Rutgers University, the State University of New Jersey
Liberty Plaza / Suite 3200
335 George Street, 3rd Floor
New Brunswick, NJ 08901
Phone: 732-235-2866
Email: humansubjects@orsp.rutgers.edu

Please keep a copy of this form for your records. By completing the questionnaire, then you agree to participation in this study.

For IRB Use Only. This Section Must be Included on the Consent Form and Cannot Be Altered Except For Updates to the Version Date.

IRB Stamp Box	**IRB Stamp Box**

Appendix B. Spanish Informed Consent Form

Forma De Consetimiento
Para Estudio Anónimo

Está invitado a participar en un estudio de investigación realizado por Neeka Tabatabaei, estudiante del Departamento de Ciencias Nutricionales de la Universidad de Rutgers. El propósito de esta investigación es ver lo que provoca que a los niños pequeños dejen de gustarles las frutas y vegetales.

Esta investigación es anónima. Anónimo significa que NO registraré ninguna información sobre usted que pueda identificarle. Esto significa que NO registraré su nombre, dirección, número de teléfono, fecha de nacimiento, etc.

El equipo de investigación y la Junta de Revisión Institucional de la Universidad de Rutgers son las únicas partes que podrán ver los datos, a excepción de lo requerido por la ley. Si se publica un informe de este estudio, o los resultados se presentan en una conferencia profesional, sólo se indicarán los resultados del grupo. Todos los datos del estudio se mantendrán durante 5 años.

No hay riesgos previsibles para la participación en este estudio. Además, es posible que no reciba ningún beneficio directo de participar en este estudio.

La participación en este estudio es voluntario. Usted puede optar por no participar, y puede dejar de contestar las preguntas en cualquier momento sin ninguna penalización. Además, puede optar por no responder a ninguna pregunta con la que no se sienta cómodo.

Si tiene alguna pregunta sobre el estudio o los procedimientos de estudio, puede ponerse en contacto conmigo en Davison Hall, 26 Nichol Avenue, New Brunswick, NJ, 856-237-9492, nnt20@scarletmail.rutgers.edu. También puede ponerse en contacto con mi consejero de la facultad, John Worobey, en Davison Hall, 26 Nichol Avenue, New Brunswick, NJ, 848-932-0937, worobey@sebs.rutgers.edu.

Si tiene alguna pregunta sobre sus derechos acerca de esta investigación, comuníquese con un administrador de IRB en la Rutgers University, Arts and Sciences IRB:

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Por favor guarde una copia de este formulario para sus registros. Al completar el cuestionario, usted acepta participar en este estudio.

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IRB Stamp Box	**IRB Stamp Box**

Appendix C. English Questionnaire

We want to learn more about mothers and what they feed their babies as they start solid foods. Participating in this survey is voluntary—You do not have to answer these questions.

These questions are about feeding your baby when s/he was only getting formula or breastmilk. Please check the box that best describes your baby's feeding habits ***before*** s/he was introduced to solid foods.

	Always	***Often***	***Sometimes***	***Seldom***	***Never***
My baby demanded a feed.	☐	☐	☐	☐	☐
If allowed to, my baby would take too much milk.	☐	☐	☐	☐	☐
Even when my baby had just eaten well, s/he was happy to feed again if offered.	☐	☐	☐	☐	☐
My baby wanted more milk than I provided.	☐	☐	☐	☐	☐
My baby had a big appetite.	☐	☐	☐	☐	☐

These questions are about how your baby eats **now**. Please check the box that best describes your baby's eating habits.

	Always	***Often***	***Sometimes***	***Seldom***	***Never***
My baby avoids tastes that other babies like.	☐	☐	☐	☐	☐
My baby dislikes certain food smells.	☐	☐	☐	☐	☐
My baby prefers foods that are smooth.	☐	☐	☐	☐	☐
My baby will only eat certain tastes.	☐	☐	☐	☐	☐
My baby prefers food to be warm.	☐	☐	☐	☐	☐
My baby likes foods that smell good.	☐	☐	☐	☐	☐
My baby prefers foods that are crunchy.	☐	☐	☐	☐	☐
My baby only likes certain food textures.	☐	☐	☐	☐	☐

My baby likes food at room temperature.	☐	☐	☐	☐	☐
My baby avoids foods of a certain color.	☐	☐	☐	☐	☐
My baby likes vegetables and fruits the same.	☐	☐	☐	☐	☐
My baby dislikes foods that are green.	☐	☐	☐	☐	☐

Please read through the following lists of fruits and vegetables. There are four statements to answer pertaining to each fruit or vegetable. Check each box to which the answer is yes.

I have tried this vegetable.	**I like this vegetable.**	**My baby has tried this vegetable.**	**My baby likes this vegetable.**	
☐	☐	☐	☐	Asparagus
☐	☐	☐	☐	Beans
☐	☐	☐	☐	Beets
☐	☐	☐	☐	Bell Pepper
☐	☐	☐	☐	Broccoli
☐	☐	☐	☐	Brussels Sprouts
☐	☐	☐	☐	Cabbage
☐	☐	☐	☐	Carrots
☐	☐	☐	☐	Cauliflower
☐	☐	☐	☐	Celery
☐	☐	☐	☐	Collard Greens
☐	☐	☐	☐	Corn
☐	☐	☐	☐	Cucumbers
☐	☐	☐	☐	Eggplant
☐	☐	☐	☐	Green Beans
☐	☐	☐	☐	Kale
☐	☐	☐	☐	Lettuce
☐	☐	☐	☐	Mushrooms
☐	☐	☐	☐	Peas
☐	☐	☐	☐	Snow Peas
☐	☐	☐	☐	Spinach
☐	☐	☐	☐	Squash
☐	☐	☐	☐	Sweet Potatoes
☐	☐	☐	☐	Tomatillo
☐	☐	☐	☐	Tomatoes
☐	☐	☐	☐	White Potatoes
☐	☐	☐	☐	Zucchini

I have tried this fruit.	**I like this fruit.**	**My baby has tried this fruit.**	**My baby likes this fruit.**	
☐	☐	☐	☐	Apples
☐	☐	☐	☐	Avocado
☐	☐	☐	☐	Bananas
☐	☐	☐	☐	Blackberries
☐	☐	☐	☐	Blueberries
☐	☐	☐	☐	Cassava
☐	☐	☐	☐	Fruit cocktail/mixed fruit
☐	☐	☐	☐	Grapefruit
☐	☐	☐	☐	Grapes
☐	☐	☐	☐	Guava
☐	☐	☐	☐	Kiwi
☐	☐	☐	☐	Mango
☐	☐	☐	☐	Melon
☐	☐	☐	☐	Nectarine
☐	☐	☐	☐	Oranges
☐	☐	☐	☐	Passion Fruit
☐	☐	☐	☐	Pear
☐	☐	☐	☐	Peaches
☐	☐	☐	☐	Pineapple
☐	☐	☐	☐	Plantain
☐	☐	☐	☐	Pomegranate
☐	☐	☐	☐	Prunes
☐	☐	☐	☐	Raspberries
☐	☐	☐	☐	Star Fruit
☐	☐	☐	☐	Strawberries
☐	☐	☐	☐	Watermelon

The following questions are about how your baby reacts to everyday things. Please check the box that best describes your baby.

	Always	Often	Sometimes	Seldom	Never
My baby indicates discomfort (fusses or squirms) when his/her diaper is soiled with a bowel movement.	☐	☐	☐	☐	☐
My baby ignores voices or other ordinary sounds when playing with a favorite toy.	☐	☐	☐	☐	☐
My baby notices (looks carefully at) when I change my appearance or dress (hairdo, unfamiliar clothing).	☐	☐	☐	☐	☐
My baby continues eating solid foods without reacting to differences in taste or consistency.	☐	☐	☐	☐	☐
My baby reacts (stares or startles) to sudden changes in lighting (flash lights, turning on lights).	☐	☐	☐	☐	☐
My baby responds to changes in temperature or type of milk or substitution of juice.	☐	☐	☐	☐	☐
My baby reacts even to a gentle touch (startle, wriggle, laugh, cry).	☐	☐	☐	☐	☐
My baby will take any food offered without seeming to know the difference.	☐	☐	☐	☐	☐
My baby reacts to a disliked food even if it is mixed with a preferred one.	☐	☐	☐	☐	☐
My baby acts the same when his/her diaper is wet as when dry (no reaction).	☐	☐	☐	☐	☐

Finally,

Your height: _____ Your weight: _____ Your age: _____

Baby's length: _____ Baby's weight: _____ Baby's age: _____

I consider myself:

American Indian or Alaska Native ____ Hispanic or Latino ____ Mexican ____

Asian_____ Asian Indian ____ Native Hawaiian or Other Pacific Islander ____

Black/African-American ____ White ____

Thank you very much for your help!

Appendix D. Spanish Questionnaire

Queremos aprender más sobre las madres y lo alimentan a sus bebés ya empiezan a alimentos sólidos. Participar en esta encuesta es voluntaria, no tienes que responder a estas preguntas.

Estas preguntas son sobre la alimentación de su bebé cuando sólo conseguía la fórmula o la leche materna. Por favor compruebe la caja que mejor describe los hábitos de alimentación de su bebé ***antes*** de la introducción de los alimentos sólidos.

	Siempre	**Muchas veces**	**Algunas veces**	**Casi nunca**	**Nunca**
Mi bebé exigió una alimentación	□	□	□	□	□
De ser permitido, mi bebé tomaría demasiada leche.	□	□	□	□	□
Aun cuando mi bebé acaba de comer bien, él/ella estaba feliz de alimentarse otra vez si se ofrece.	□	□	□	□	□
Mi bebé quiso más leche que había dado.	□	□	□	□	□
Mi bebé tiene un apetito grande.	□	□	□	□	□

Estas preguntas son acerca de cómo su bebé come ahora. Por favor marque la caja que mejor describe los hábitos alimenticios de su bebé.

	Siempre	**Muchas veces**	**Algunas veces**	**Casi nunca**	**Nunca**
Mi bebé evita gustos que otros bebés les gustan.	□	□	□	□	□
Mi bebé no le gusta ciertos olores de comida.	□	□	□	□	□
Mi bebé prefiere alimentos que son suaves.	□	□	□	□	□
Mi bebé sólo come ciertos sabores.	□	□	□	□	□
Mi bebé prefiere comida tibia.	□	□	□	□	□
Mi bebé le gusta comida que huele bien.	□	□	□	□	□
Mi bebé prefiere alimentos que son crujientes.	□	□	□	□	□
Mi bebé sólo le gusta ciertas texturas de alimentos.	□	□	□	□	□
Mi bebé le gusta la comida a temperatura ambiente.	□	□	□	□	□

Mi bebé evita los alimentos de cierto color.	□	□	□	□	□
A mi bebé le gustan verduras y frutas lo mismo.	□	□	□	□	□
Mi bebé no le gusta los alimentos que son verdes.	□	□	□	□	□

Por favor lea la siguiente lista de frutas y verduras. Hay cuatro declaraciones de respuesta correspondientes a cada fruta o verdura. Compruebe cada caja a la cual la respuesta es sí.

He probado este vegetal.	**Me gusta este vegetal.**	**Mi bebé ha tratado este vegetal.**	**Mi bebé le gusta este vegetal.**	
□	□	□	□	Espárragos
□	□	□	□	Frijoles
□	□	□	□	Remolachas
□	□	□	□	Pimiento morrón
□	□	□	□	Brócoli
□	□	□	□	Coles de Bruselas
□	□	□	□	Repollo
□	□	□	□	Zanahorias
□	□	□	□	Coliflor
□	□	□	□	Apio
□	□	□	□	Coles verdes
□	□	□	□	Maíz
□	□	□	□	Pepinos
□	□	□	□	Berenjena
□	□	□	□	Judías verdes
□	□	□	□	Col rizada
□	□	□	□	Lechuga
□	□	□	□	Hongos
□	□	□	□	Chícharos
□	□	□	□	Guisantes de nieve
□	□	□	□	Espinacas
□	□	□	□	Calabaza
□	□	□	□	Patatas dulces
□	□	□	□	Tomatillo
□	□	□	□	Tomates
□	□	□	□	Patatas blancas
□	□	□	□	Calabacín

He probado esta fruta.	**Me gusta esta fruta.**	**Mi bebé ha probado esta fruta.**	**Mi bebe le gusta esta fruta.**	
□	□	□	□	Manzana
□	□	□	□	Aguacate
□	□	□	□	Plátanos
□	□	□	□	Moras
□	□	□	□	Arándanos
□	□	□	□	Mandioca
□	□	□	□	Cóctel de frutas/ fruta mezclada
□	□	□	□	Pomelo
□	□	□	□	Uvas
□	□	□	□	Guayaba
□	□	□	□	Kiwi
□	□	□	□	Mango
□	□	□	□	Melón
□	□	□	□	Nectarina
□	□	□	□	Naranjas
□	□	□	□	Maracuyá
□	□	□	□	Pera
□	□	□	□	Melocotones
□	□	□	□	Piña
□	□	□	□	Plátano
□	□	□	□	Granada
□	□	□	□	Ciruelas pasas
□	□	□	□	Frambuesas
□	□	□	□	Fruta estrella
□	□	□	□	Fresas
□	□	□	□	Sandía

Las preguntas siguientes son sobre cómo su bebé reacciona a cosas diarias. Por favor compruebe la caja que mejor describe a su bebé.

	Siempre	Muchas veces	Algunas veces	Casi nunca	Nunca
Mi bebé indica malestar cuando su pañal está sucio con caca.	□	□	□	□	□
Mi bebé no hace caso de voces o otros sonidos ordinarios cuando juega con un juguete favorito.	□	□	□	□	□
Mi bebé se da cuenta (estudia cuidadosamente) cuando cambio mi apariencia o vestido (peinado, ropa desconocida).	□	□	□	□	□
Mi bebé sigue comiendo alimentos sólidos sin reaccionar a las diferencias en el sabor o consistencia.	□	□	□	□	□
Mi bebé reacciona (mira fijamente o asusta) a cambios repentinos en la iluminación (luces de flash, encender las luces).	□	□	□	□	□
Mi bebé responde a los cambios de temperatura o el tipo de leche o de sustitución del jugo.	□	□	□	□	□
Mi bebé reacciona incluso a un toque suave (susto, culebrea, risa, llanto).	□	□	□	□	□
Mi bebé tomará cualquier comida ofrecida sin parecer saber la diferencia.	□	□	□	□	□
Mi bebé reacciona a una comida disgustada aun si es mezclada con uno preferido.	□	□	□	□	□
Mi bebé actúa de la misma manera, cuando su pañal está mojado como cuando seco (ninguna reacción).	□	□	□	□	□

Finalmente,

Tu altura: _____ Tu peso: _____ Tu edad: _____

Longitud del bebé: _____ Peso del bebé: _____ Edad del bebé: _____

Me considero:

Indio americano o nativo de Alaska ____ Hispano o Latino ____

Mexicano ____ Asiático ____ Indio Asiático_____

Nativo de Hawai o de otra isla del Pacífico___ Negro/Afroamericano ____ Blanco ____

¡Muchas gracias por su ayuda!