REPEATED TEXTURE EXPOSURE INCREASED CHILDREN'S INTAKE OF LESS PREFERRED YOGURT TEXTURES: EVIDENCE FOR PRACTICE

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Authorization to Submit Thesis

This thesis of Siew Guan Lee, submitted for the degree of Master of Science with a major in Family and Consumer Sciences and titled "Repeated Texture Exposure Increased Children's Intake of Less Preferred Yogurt Textures: Evidence for Practice" has been reviewed in final form. Permission, as indicated by the signatures and dates given below, is now granted to submit final copies to the College of Graduate Studies for approval.

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Abstract

Texture can influence children's food consumption; however, the use of repeated exposure to influence children's food intake and preference development has not been examined. The purpose of this study was to determine whether repeated texture exposure (RTE) would increase children's liking and intake of different yogurt textures. Twenty preschoolers were offered six yogurt textures: smooth, pearly, gritty, grainy, lumpy, and ropy. Yogurt textures were manipulated with different carbohydrates and flavors of each yogurt were standardized. Ten texture preference activities were conducted: pre-exposure, eight repeated exposures, and post-exposure. Analysis included descriptive statistics, chi-square tests, and a generalized linear mixed model. Children's reported liking for gritty improved after RTE, but no other yogurt textures. Mean relative intake increased for all yogurt textures after RTE, and a significant increase was identified for gritty, grainy, and lumpy. Preliminary results indicate RTE can improve children's intake of less familiar textures, but further research is needed.

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Chapter One

Introduction

Healthful eating patterns in early childhood is critical in supporting children's growth and development and reducing the risks of chronic diseases in adulthood (Birch & Fisher, 1998; Ezzati & Riboli, 2013; World Health Organization [WHO], 2014; U.S. Department of Health and Human Services [HHS], 2017). Early childhood is the pivotal time to lay the foundation for children's food preferences (Fox, Condon, Briefel, Reidy, & Deming, 2010; Ventura & Worobey, 2013). Children's food acceptance and preferences influence children's food intake, and subsequently impacts children's future health status (Birch & Fisher, 1998; Birch, 1999; Jaramillo et al., 2006). Many factors influence children's food acceptance and preferences, such as genetic predispositions, sensory preferences, food neophobia, early experience, exposure, availability, socioeconomics, and environment (Birch, 1999; Branen & Fletcher, 1999; Nestle et al., 1998; Birch, 1987; Sullivan & Birch, 1990; Johnson, 2016; Ventura & Worobey, 2013). Several studies have shown that food texture also plays a key role in food preferences and consumption (Lukasewycz & Mennella, 2012; van der Horst, Deming, Lesniauskas, Carr, & Reidy, 2016; Werthmann et al., 2015; Scott & Downey, 2007; Field, Garland, and Williams, 2003). In adults, memory of food texture influences food expectations (Mojet, & Koster, 2005) and food disgust (Martins, & Pliner, 2006). For children, the development of the mouth and early experience with food influence children's preference for foods in various textures (Szczesniak, 1972; Stolovitz & Gisel, 1991; Le Reverend, Edelson, & Loret, 2014; Lundy et al., 1998), and thus facilitates children's dietary variety and supports future growth and health.

The complexity of textures in many nutrient-dense foods may be unfamiliar and less preferred to young children, and thus require exposure. Early experience with different textures can foster children's food preferences and consumption (Le Reverend et al., 2014; Lundy et al, 1998). Evidence has shown that children who are exposed to age-appropriate foods in different textures early in life are more willing to try more complex textured foods at a later age (Northstone et al., 2001; Coulthard,

Harris, & Emmett, 2009; Blossfeld, Collins, Kiely, & Delahunty, 2007). Additionally, the oral manipulation of textured foods, such as chewing, is predicted by children's experience of textured foods in the mouth rather than by growth (Gisel, 1991). Young children who are not exposed to age appropriate foods are found to have a delay in their skills in eating textured foods, as their opportunity to eat textured foods was not fostered (Beckett et al., 2002).

When children transition into eating solid foods, they also begin to experience food neophobia, or unwillingness to try novel foods (Birch & Fisher, 1998; Dovey, Staples, Gibson, & Halford, 2008). At ages two to six, this phenomena is at its peak, which can influence children's preference for foods (Ventura & Worobey, 2013). Furthermore, children in the second year of life also may start rejecting a food that is previously accepted due to sensory properties of the food such as color and texture (van der Horst et al., 2016). Supporting children to accept novel foods and previously rejected foods is an important part of establishing a healthy diet (Skinner, Carruth, Bounds, & Ziegler, 2002).

Previous studies have shown that children's liking for new foods increases with repeated exposure of taste preferences, and thus can increase intake (Birch, & Marlin, 1982; Birch, McPhee, Shoba, Pirok, & Steinberg, 1987; Sullivan & Birch, 1994). While it is known that texture has a great influence on the food children consume (Werthmann et al., 2015), relatively little is known about how repeated exposure to various textures influences children's food intake and fosters children's preference development.

Statement of Purpose

The purpose of this study was to identify children's food texture preferences of yogurt, and whether repeated exposure would influence children's preference development for different textures. This preliminary work can capture children's texture preferences to reinforce intake of nutrient-dense foods and support national efforts to identify child behaviors that can promote healthy development and growth in children. This study also provides evidence of children's texture development, which can be used to provide education for appropriate caregiver feeding practices to develop texture

preference for nutrient-dense foods that will establish healthful eating practices for disease prevention.

Research Objectives

The objectives of this study were to 1) examine young children's food preferences of yogurt; and 2) determine whether repeated texture exposure increases young children's liking and intake of different yogurt textures.

Limitations

This research study has several limitations. First, participants were primarily Caucasian from educated and higher socio-economic status families in Moscow, Idaho. Parents of the participants had a four-year Bachelor's degree or higher with a minimum household income of $59,000 per year, which does not represent a national population.

Second, there was no control group assigned in the study design. All children in the study participated in the treatment, i.e., repeated exposure on different textures of yogurts. Additionally, the study did not measure children's familiarity of the textures prior to the study. However, an expert panel was involved in the selection of yogurt textures prior to the tasting activities.

In addition, there might be synergistic effects from combining differences in flavor and texture together in the study, which masking the liking and disliking of the textures. Furthermore, a possible limitation is that children spit out yogurt, which could have accounted for intake. However, in observation of children's consumption the amount placed in the mouth and spit out was very small; thus likely having minimal impact on the results. Finally, a larger sample size of forty or more children would have provided greater statistical power (80%) to more precisely detect differences in intake and liking.

Definition of Terms

Food Aversion:

Avoid eating certain types of foods (Scott & Downey, 2007).

Food Neophobia:

An unwillingness to try new foods (Dovey et al., 2008).

Food Refusal:

Refusal to eat all or most foods presented, resulting in the child not getting enough food to meet calorie or nutritional needs (Field et al., 2003).

Food Selectivity by Texture:

Refusal to eat food textures that are developmentally appropriate (Field et al., 2003).

Oral Motor Delays:

Problems with chewing, tongue movement, lip closure or other oral motor areas as determined by a speech pathologies and/or occupational therapies (Field et al., 2003).

Picky Eaters:

Children who accepted a limited number of foods, were unwilling to try new foods, limited their intakes of vegetables and some other food groups, and exhibited strong food preferences; generally identified by mothers and caregivers (Carruth, Ziegler, Gordon, & Barr, 2004).

Repeated Exposure:

Introduction to a flavor or to a variety of flavors within a particular food group (e.g., fruits or vegetables) following 8-10 days of continuous food introductions (Mennella & Ventura, 2010).

Texture:

A sensory and functional manifestation of the structural, mechanical and surface properties of foods detected through the senses of vision, hearing, touch and kinesthetic (Szczesniak, 2002).

Summary

Chapter one includes an introduction of children's food preferences and explains the importance of food preference development in early childhood, particularly food texture preference development early in life. This chapter also states the purpose, research objectives, and definitions of terms related to this research. Chapter two is a review of the literature with greater details of the importance of healthful food intake during childhood for the prevention of obesity and other non-communicable diseases, current food intake and eating habits, sensory factors influencing young

children's food preferences, impact of repeated exposure on young children's food preferences, and the role of caregivers in the development of children's food preference and intake. Chapter three contains the methodology, results, discussions, and implications of this study. Since it is written in journal article format, some information from chapters one and two is repeated in chapter three.

Chapter Two

Review of the Literature

The development of food preferences begins early in life as it is a sensitive period for sensory, motor, learning experience, and growth (Ventura & Worobey, 2013; Schwartz, Scholtens, Lalanne, Weenen, & Nicklaus, 2011; Cashdan, 1998). Healthy eating habits established in early childhood contribute to dietary choices into adulthood (Anzman, Rollins, & Birch, 2010; Jaramillo et al., 2006; WHO, 2016; HHS, 2017). Understanding children's food choices and reinforcing their food preferences for nutrient dense foods has implications for disease prevention (Casey & Rozin, 1989; Skinner et al, 2002). Evidence shows that food texture plays a key role in children's food acceptance and consumption (Lukasewycz & Mennella, 2012; van der Horst et al., 2016; Field et al., 2003). Food texture manipulation demonstrated the greatest impact on food acceptance in young children in comparison to color and taste manipulation (Werthmann et al, 2015). Additionally, children's experience with foods in different textures early in life contributes to the acceptance of various textures later in life (Le Reverend et al., 2014; Lundy et al, 1998). Children with early experience to different textures are more willing to try more complex textured foods (Northstone et al., 2001; Coulthard et al., 2009; Blossfeld et al., 2007), thus facilitating children's dietary choices and supporting children's future growth and development.

Several studies have shown that children's liking for new foods increases with repeated exposure of taste preferences, and thus can increase intake (Birch, & Marlin, 1982; Birch et al., 1987; Sullivan & Birch, 1990). While it is known that texture has a great influence on the food children consume (Werthmann et al., 2015), relatively little is known about how repeated exposure to various textures influences children's food intake and fosters children's preference development. Therefore, the purpose of this study was to identify children's food texture preferences of yogurt, and whether repeated exposure would influence children's preference and intake of different yogurt textures.

This literature review begins with a discussion of the importance of healthful food intake during childhood for the prevention of obesity and other non-communicable diseases. The prevalence

of childhood obesity in the United States and its related health and economic consequences will be discussed. Next, young children's current food intake and eating habits are reviewed. The chapter will continue with an analysis of sensory factors influencing young children's food preferences, including flavor, taste, aroma, visual appearance, and texture within the context of physical and oral development. The impact of repeated exposure on young children's food preferences will then be examined. The final section will discuss the role of caregivers in the development of children's food preference and intake.

Importance of Healthful Intake during Childhood for the Prevention of Obesity and Other Non-Communicable Diseases

Globally, overweight and obesity have affected more than 1.9 billion adults and 41 million children under the age of five in 2014 (WHO, 2016). Overweight and obese conditions have important health and economic consequences. They are risk factors for many non-communicable diseases, including coronary heart disease, stroke, diabetes, and cancers (Centers for Disease Control and Prevention [CDC], 2017; WHO, 2016). Medical costs are associated with obesity and its related illnesses (Finkelstein, Trogdon, Cohen, & Dietz, 2009). Obese children are more likely to become obese adults (Field, Cook, & Gillman, 2005; Wang, Chyen, & Lee, 2008), and have an increased risk of hypertension, respiratory disease, and insulin resistance later in adulthood (WHO, 2016).

In the United States, the prevalence of obesity, and childhood obesity in particular, remains high (Ogden, Carroll, Kit, & Flegal, 2014; CDC, 2017). Overweight and obese conditions, especially among children, have emerged as serious threats to the nation's health (CDC, 2017). In 2011-2012, almost 17% of children and adolescents were obese (Ogden et al., 2014). Adequate dietary intake with quality nutrients is important during early childhood for growth and development (WHO, 2016). However, excessive intake is negatively linked to health and disease consequences (Daniels et al., 2005, Jaramillo et al., 2006). Identification of modifiable childhood obesity risk factors is crucial in improving children's overall dietary intakes and addressing the obesity epidemic (CDC, 2017).

Current Food Intake and Eating Habits of Young Children

Poor dietary intake is associated with an increased risk of obesity and its related chronic diseases (Ezzati & Riboli, 2013; United States Department of Agriculture [USDA], 2017; WHO, 2014). Currently, foods high in saturated fat and sodium, and low in fiber are frequently consumed by children (Skinner et al., 2002), with vegetables ranked the least favored foods consistent among different cultures (Cooke, 2007). According to the Scientific Report of the 2015 Dietary Guidelines Advisory Committee, the dietary intakes of U.S. children do not meet national dietary guidelines (HHS, 2017). Of particular concern, children's diets are too high in sugar and fat and too low in vegetables, fruits, grains, and calcium-rich food (HHS 2017; Munoz, Krebs-Smith, Ballard-Barbash, & Cleveland, 1997). About 30% of young children do not consume vegetables on a given day (Fox et al., 2010), and when vegetables or fruits are consumed, French fries, other potato products, as well as fruit juice were mostly consumed (Fox et al., 2010; Ramsay, Eskelsen, Branen, Armstrong Shultz, & Plumb, 2014). Thus, several objectives of the Healthy People 2020 are to improve the diet quality of young children by making healthy food choices available and accessible to support their growth and development (HHS, 2017).

Approximately 85% of young children consume low-nutrient, energy-dense sweetened beverages, desserts, or snacks (Fox et al., 2010). Sugar-sweetened beverage intake is negatively associated with milk intake, and an increase in sugar-sweetened beverage intake displaces milk from children's diets (Keller, Kirzner, Pietrobelli, St-Onge, & Faith, 2009; Mrdjenovic & Levitsky, 2003). Beverage consumption shifts significantly as children grow. With an increase in age, intake of sugar-sweetened beverages increases, whereas intake of milk tends to decrease (Frary, Johnson, & Wang, 2004; Fiorito, Marini, Mitchell, Smiciklas-Wright, & Birch, 2010; Keller et al., 2009; Mrdjenovic & Levitsky, 2003). Greater consumption of sugar-sweetened beverages also is associated with poor eating habits and inadequate nutrient intake, as well as increased development of childhood obesity (Frary et al., 2004; Mrdjenovic & Levitsky, 2003). The high consumption of sugar-sweetened beverages and less nutrient dense foods demonstrates the need to understand children's food

preference and intake, of which sensory aspects of foods has implication.

Sensory Factors Influencing Young Children's Food Preference and Intake

Sensory aspects of the food, such as flavor, taste, aroma, visual appearance, and texture can influence children's food preferences (Drewnowski, 1997; Szczesniak, 2002; Kildegaard, Olsen, Gabrielsen, Møller, & Thybo, 2011). Early sensory preferences are acquired in prenatal development (Drewnowski, 1997; Steiner, 1979), but can be changed with age and learning, all of which influence children's food acceptance and intake (Birch & Fisher, 1998; Birch, 1979; Guthrie & Morton, 2000; Resnicow et al., 1997). Each sensory factor is discussed below.

Flavor. Flavor experiences begin in utero as the gustatory and olfactory systems develop, which play an important role in food preferences early in life (Ventura & Worobey, 2013). The fetus is exposed to flavors consumed by the mother during pregnancy through amniotic fluid containing rich nutrients necessary for fetal growth (Mennella & Ventura, 2010). By the third trimester, the gustatory and olfactory systems are communicating with the central nervous systems regarding the flavors experienced by the fetus (Ganchrow & Mennella, 2003; Mennella & Ventura, 2010), which prepares the infant for exposure to breast milk or formula after birth (Mennella, Jagnow, & Beauchamp, 2001; Ventura & Worobey, 2013).

Taste. Genetically, children are born to like sweet and salty foods and dislike sour and bitter tastes (Steiner, 1979; Birch, 1999). The innate taste preferences can be seen as early as the first three days of an infant's life, in which the infant shows hedonic preference for sweet over bitter (Soussignan, Schall, Marlier, and Jiang, 1997). Literature suggests the genetic predisposition to prefer sweet taste may predispose the need for high energy foods usually found in sweet foods (Birch, McPhee, Steinberg, & Sullivan, 1990; Birch & Fisher, 1998), and to avoid toxic substances, which typically have a bitter taste (Rozin, 1990; Ventura & Worobey, 2013). The genetic predisposition to tastes may be beneficial and serve as a protective function for young children as they are still learning what to eat (Mennella & Ventura, 2010).

Aroma. Children's food preferences also are influenced by the aroma of the foods (Monnery-

Patris et al., 2015; Cooke & Fildes, 2011; Coulthard & Blissett, 2009). Coulthard and Blissett (2009) found that children aged two-to-five-years in the UK who consumed less fruit and vegetables were reported sensitive to taste and aroma by their parents. Children who reject novel foods can sniff further distance from foods (Bunce & Gibson, 2012) and may reject novel foods due to the smell before tasting them (Monnery-Patris et al., 2015). Additionally, foods that do not "smell right" (Monnery-Patris et al., 2015) to the child are perceived as "disgusting" (Martins & Pliner, 2006) signaling food spoilage and potential danger, and thus resulting in rejection to those foods.

Visual Appearance. While children may accept or reject a food due to its taste and/or aroma, visual appearance also can influence children's food perception and choices (Lafraire, Rious, Giboreau, & Picard, 2016; Kildegaard et al., 2011). Visual properties of a food provide information such as size, color, and shape (Kildegaard et al., 2011). Children may initially reject foods due to color, such as green (Harris, 1993) versus orange vegetables (Gerrish & Mennella, 2001), rather than taste (Macario, 1991; Rious, Picard, & Lafraire, 2016). Fruits that are presented in a visually appealing manner increase children's fruit acceptance and consumption (Jansen, Mulkens, & Jansen, 2010; Osborne & Forestell, 2012). Children who are identified as "picky eaters" by their parents exhibit strong food preferences, and are more likely to dislike mixed dishes that are hard to distinguish (Carruth et al., 2004). While visual appearance may have an effect on children's food choices, specifically fruit acceptance, it is noted that visual cues and exposure do not increase children's vegetable preference and consumption (Birch et al., 1987; Branen, Fletcher, & Hilbert, 2002).

Texture. Food texture also has a role in children's food acceptance and preferences (Drewnowski, 1997; Guinard & Mazzucchelli, 1996; Nederkoorn, Jansen, & Havermans, 2014). As a sensory property, texture comprises physical characteristics through the senses of vision, touch (including kinesthetic and mouthfeel), and sound (Szczeniak, 2002; Bourne, 2002). Visual clues of the foods, such as viscosity of the thick liquid or a shiny surface of a solid food, provides texture perception before ingestion begins (Wilkinson, Dijksterhuis, & Minekus, 2000; Guinard & Mazzucchelli, 1996). Touching a food with fingers stimulates texture impressions, such as the smooth

or rough surface of a food. For example, seeing and touching a sponge cake suggests a soft texture in the mouth (Szczeniak, 2002). Sensory experience from visual cues and touching a food item through the skin, to chewing it with coordination of the tongue, palate, and teeth; and the addition of hearing from the sound of crispy, crunchy, and crackly, provide textural information and ultimate enjoyment of food (Bourne, 2002).

As children transition from only liquids to solid foods, they also start to experience different textures, which influences children's liking or disliking of a food (Le Reverend et al., 2014; Northstone et al., 2001; Coulthard et al., 2009; Blossfeld et al., 2007; Lundy et al., 1998). Children in the second year of life also may start exhibiting preferences on the sensory properties of the food and they may reject a food that is initially accepted due to its color and texture (van der Horst et al., 2016).

Textures provide identity of the foods. As unseasoned foods are blended to modify the textures, only forty percent of foods can be identified from the smell or flavor of the foods (Schiffman, 1977). Memory of food texture influences food expectations (Mojet, & Koster, 2005) and food disgust (Martins, & Pliner, 2006). Individuals expect softness in a sponge cake and find it unpleasant when it is dry and coarse in the mouth (Szczesniak, 2002). Generally, people prefer crunchy or tender textures and reject soggy or lumpy foods; although texture acceptance also may depend on the type of food, and cultural and demographical factors (Szczesniak, 1972; Szczesniak & Kahn, 1971; Blossfeld et al, 2007). For instance, crispy rather than soggy are preferred as an indicator of freshness for fruits and vegetables (Szczesniak & Kahn, 1971; Jaeger, Andani, Wakeling & MacFie, 1998). Fresh apples are expected to be crispy and juicy whereas a soft texture in baked apples is acceptable (Szczesniak, 2002). In children, slimy or mushy textures were less appealing than other foods (Russell & Worsley, 2013). Vegetables that are prepared with a granular texture (Zeinstra, Koelen, Kok, & de Graaf, 2010) and eggs with a rubbery texture (van der Horst et al., 2016) are inversely related to liking compared to other preparation methods. Additionally, texture perception may vary between cultures (Szczesniak & Kahn, 1971). According to Szczesniak and Kahn (1971), the most preferred textured characteristics among Americans are crispy, crunchy, tender, juicy, and firm. Japanese, on the other hand, like

crispness and crunchiness in foods as well as hard, soft, and sticky foods (Guinard & Mazzucchelli, 1996).

Perceptions of textures have an even greater impact on children with feeding problems. Food selectivity by texture is one of the most common issues among children with feeding problems, including children with cerebral palsy, Down syndrome, autism spectrum disorders, and children identified as "picky eaters" (Seiverling, Hendy, & Williams, 2011; Najdowski et al., 2012; Patel, Piazza, Layer, Coleman, & Swartzwelder, 2005; Bandini et al., 2010), who refuse developmentally appropriate textured foods (Field et al., 2003). Both type and texture of food influence food acceptance among children with feeding problems (Patel, Piazza, Santana, & Volkert, 2002; Patel et al., 2005; Sharp & Jaquess, 2009), suggesting the importance of texture manipulation in the treatment to support food intake among children with feeding problems (Kadey, Pizza, Rivas, & Zeleny, 2013; Patel et al., 2005). Chewing and swallowing foods require oral motor skills, which impact children's food intake (Seiverling et al., 2011; Sharp & Jaquess, 2009; Patel et al., 2005). For example, children with oral motor delays, such as cerebral palsy and Down syndrome may experience feeding difficulties, and thus limit a variety of food and liquid textures they can otherwise safely consume (Benfer et al., 2015; Seiverling et al., 2011).

On the other hand, children with autism spectrum disorders exhibit more food selectivity with a single food or food group than typical developing children (Bandini et al., 2010), and eat mostly less textured foods such as pureed baby foods (Najdowski et al., 2012). Consumption of less textured foods limits their experience with eating, and consequently hinders their consumption of more complex textures of nutrient dense foods (Beckett et al., 2002; Patel et al., 2005; Sharp & Jaquess, 2009). Additionally, texture resistant also is commonly seen among children identified as "picky eaters" by their parents; they are characterized by a limited consumption of type and amount of food and are unwilling to try new foods (Carruth et al., 1998). Children identified as "picky eaters" are more likely to have negative reactions to food texture, such as raw vegetables, due to tactile sensitivity (van der Horst et al., 2016). Children with texture problems are associated with heavier weight status,

reduced diet variety, more food refusal, and limited food variety (Seiverling et al., 2011), which may result in a potential negative outcome in their overall nutritional status (Benfer et al., 2015). Therefore, strategies to support children's food preference and intake of nutrient dense foods are needed.

Impact of Repeated Exposure on Young Children's Food Preference and Intake

Children's food preferences are predisposed by their innate responses to sensory properties and food neophobia, but they can be changed through learning and exposure, determining children's food acceptance patterns (Birch & Fisher, 1998; Anzman-Frasca, Savage, Marini, Fisher, & Birch, 2012; Birch & Doub, 2014). Food neophobia, or rejection of new foods, is thought to be part of children's development link to the "learned safety" mechanism (Birch, 1979). Kalat and Rozin (1973) found that rats could learn to associate the taste of ingested food with subsequent gastrointestinal consequences, even after a long time interval. The "learned-safety" theory suggests that human and other animals learn the food is safe to eat and does not cause illness (Kalat & Rozin, 1973; Rozin, 1976). This mechanism of food selection is especially important among young children to learn not to eat harmful substances (Rozin, Hammer, Oster, Horowitz, & Marmora, 1986). Yet, food neophobia may reduce children's dietary variety, resulting in a lack of essential micronutrients that is fundamental for growth and health (Birch & Fisher, 1998; Birch, 1999; Cooke, 2007). Fortunately, the initial neophobic rejection of a new food is a transition that can be altered through learning and exposure (Branen & Fletcher, 1999)

Developmental Experience. Food preference development starts in utero. Flavors of the foods from the mother's diet are transmitted to the amniotic fluid and breastmilk (Mennella et al., 2001), thus fostering early childhood taste preference development (Mennella & Ventura, 2010; Cooke & Fildes, 2011; Beauchamp & Mennella, 2011). Flavor preferences can be seen shortly after birth as infants can orient their head towards the odor of their own amniotic fluid (Cooke & Fildes, 2011). After birth, maternal diet variety can enhance the flavors in breast milk, which may facilitate the acceptance of new foods for breastfed children during infancy (Mennella et al., 2001), including

vegetable intake (Sullivan & Birch, 1994; Maier, Chabanet, Schaal, Leathwood, & Issanchou, 2008). Healthful dietary intake during pregnancy and breastfeeding has the potential to result in better long-term dietary outcomes (Birch & Dietz, 2008; Cooke & Fildes, 2011).

Additionally, children whose mothers consumed carrot juice during the third trimester or the first 2 months of breastfeeding were more likely to consume a carrot-flavored cereal compared to those who did not (Mennella et al., 2001). Breast-fed children may also accept novel flavors such as caraway-flavored purees if they have exposed to the flavor via breast milk (Hausner, Nicklaus, Issanchou, Molgaard, & Moller, 2010). Further, Mennela and Beauchamp (2002) found that food preferences among four to five years old children were influenced by the type of formula being fed during infancy. Compared to children who were fed milk-based formulas, those were fed protein hydrolysate formulas were prone to accept flavor and odor associated with the formula, such as sour-flavored juices (Mennella & Beauchamp, 2002). All of these indicate sensory experience learned either in utero, during breastfeeding, or during formula feeding can improve children's acceptance of novel foods, which impact children's taste preference later in life (Mennella & Ventura, 2010; Sullivan & Birch, 1994; Mennella et al., 2001; Beauchamp & Mennella, 2011; Mennella & Beauchamp, 2002; Gerrish & Mennella, 2001; Cooke & Fildes, 2011).

In addition, demographical factors, especially age, are associated with texture acceptance and food preferences (Szcesniak, 2002; Northstone et al., 2001; Blossfeld et al., 2007). Szczesniak (1972) found that teenagers who were sensitive to complex textures were more willing to accept different textures as they became adults; and in children, the development of the mouth influenced children's liking for various food textures. At four to six months of age, children start to try solids and they learn to like textures that they can easily manipulate (Blossfeld et al., 2007). Children are more likely to reject food textures that are hard or stringy as they can be a challenge to be manipulated in the mouth (Lundy et al, 1998), which also has implications to prevent gagging or choking of a food (Szczesniak, 2002). Food preferences change with age (Lukasewycz & Mennella, 2012). As the coordination of the mouth, tongue, and jaws improves with aging, children can manipulate, and enjoy more complex

textures and thus consume a greater diversity of foods (Szczesniak, 1972; Stolovitz & Gisel, 1991).

Repeated Exposure. Repeated exposure to food increase children's preference and intake (Birch, & Marlin, 1982; Birch et al., 1987; Sullivan & Birch, 1994). The first year of life is a sensitive period to develop physical and oral-motor skills (Birch, 1998; Sullivan & Birch, 1994), thus is believed to be the pivotal time in repeatedly exposing children to foods (Coulthard et al., 2009). Birch (1979) indicated that children need multiple taste exposures before developing food preferences. The initial taste response to a new food can be altered through frequent exposures and associating positive consequences of eating (Birch, 1987; Birch & Marlin, 1982). Exposure increases familiarity and displays the food as safe, thus reduces food neophobia and increases liking (Cooke, 2007). Children's food acceptance increases with multiple exposures (Birch & Marlin, 1982; Wardle et al., 2003a; Wardle, Herrera, Cooke, & Gibson, 2003b), and repeated exposure of new foods supports children's liking for new foods which reinforces intake (Birch, & Marlin, 1982; Birch et al., 1987; Sullivan & Birch, 1990).

Use of repeated exposure has implications for texture preference development as well. Children need a variety of foods to support growth and development (WHO, 2016). The complexity of textures in many nutrient-dense foods may be unfamiliar to children and thus less preferred. However, early experience with different foods can foster children's food preferences and consumption (Northstone et al., 2001; Blossfeld et al., 2007). Children who are introduced to lumpy solids at the age of 6 months are more likely to consume a variety of foods later, compared to those who are exposed at ten months or older (Northstone et al., 2001; Coulthard et al., 2009). Similarly, Blossfeld et al. (2007) also indicated that twelve-month-old children who were previously offered mashed or chopped foods were more likely to accept and consume more complex foods, such as chopped carrots of more advanced texture. Introducing appropriate foods from weaning into early childhood is therefore critical in the development of children's food preferences and feeding skills (Coulthard et al., 2009; Nicklaus, 2011).

Role of Caregivers in the Development of Children's Food Preference and Intake

Young children are dependent on parents and caregivers to provide foods that will promote optimal health and growth (Anzman et al., 2010). Parents act as the gatekeepers in the development of children's eating patterns and beverage consumption behaviors, and therefore can influence children's eating patterns (Birch, & Davison, 2001; Anzman et al., 2010; Pinard, Davy, & Estabrooks, 2011).

Home Environment. Parents can influence children's healthy eating behaviors by offering nutritious foods (Anzman et al., 2010; Birch & Fisher, 1998) and modeling food intake (Anzman et al., 2010; Birch & Fisher, 1998), which can influence food acceptance. Parents serve as the "nutritional gateway" (Larson & Story, 2009) providing availability and accessibility of healthy food options to the children (Birch, & Davison, 2001; Pinard et al., 2011). Young children's diets are reflective of their food environments and the patterns of the household (Fox et al., 2010), and family members will likely prefer the same foods (Calfas, Sallis, & Nader, 1991).

Beliefs and Self-Efficacy. Parents' beliefs shape their own behaviors, and therefore their beliefs impact their feeding behaviors as well as their children's food preferences (Russell & Worsley, 2013). For instance, some British parents believe that children's food preferences are fixed and resistant to change (Hart, Herriot, Bishop & Truby, 2003), which may affect how they feed their children (Russell & Worsley, 2013). Additionally, parents' self-efficacy beliefs also may reflect how confident they feel to influence children's eating behaviors (Russell & Worsley, 2013). Parents' beliefs may determine what kind of foods to purchase and how to feed their children, which influence their children's food preference and consumption (Johnson, 2016).

Verbal Communication. Parents and caregivers often use verbal strategies during mealtimes, both at home and in child care settings, with the intention to increase children's food consumption (Orrell-Valente et al., 2007; Ramsay et al., 2010). The verbal strategies may include food reward, praise, pressure/demand to eat, which employ statements such as "Eat your peas and then you can have some chocolate ice cream", "You ate all your chicken, good job!", "When I say eat, you eat!" (Birch, Marlin, & Rotter, 1984; Orrell-Valente et al., 2007). Yet, these verbal communications may

decrease children's preferences for the target food (Ventura & Worobey, 2013) and override children's internal hunger and satiation cues (Orrell-Valente et al., 2007; Ramsay et al., 2010) that may have an effect on long-term dietary patterns. Appropriate communication about texture could have implications for intake as well.

Feeding Practices. Childhood food habits are associated with a child's relationship with food later in life (Birch, 1998; Branen, & Fletcher, 1999; Skinner et al, 2002). Several studies have shown that food aversions may originate during childhood (DeSilva & Rachman, 1987; Scott & Downey, 2007). Birch (1998) reported that negative parent-child feeding interactions during childhood have an impact on food acceptance and intake later in life. Children may develop negative eating behaviors if they are forced to eat a food by their parents, such as vegetables (Birch & Fisher, 1998; Birch, 1999). Children who eat fewer vegetables are more likely to eat fewer vegetables as an adult (Haire-Joshu, Kreuter, Holt & Steger-May, 2004; Ramsay, Rudley, Tonnemaker, & Price, 2016). Food preferences among older adults continue to be influenced by their childhood experience with foods (Scott & Downey). In addition, efficacy of chewing correlates with the child's experience of eating textured foods in the mouth rather than growth (Gisel, 1991). Beckett et al. (2002) reported that children who were not exposed to age appropriate foods have a delay in their skills to eat textured foods later at age six, as they didn't learn how to eat these foods. Children rely on their parents for food exposure and learning experiences with eating (Birch, 1998; Branen, & Fletcher, 1999). Thus, parents need to recognize the value of repeatedly offering children foods that are previously rejected, particularly those foods in various textures.

Summary

Early childhood is a sensitive period for learning and development (Ventura & Worobey, 2013; Schwartz et al, 2011; Cashdan, 1998). Healthy eating patterns in early childhood are supportive of both children's growth and development and reducing the risks for many chronic diseases later in life, including obesity and its related illnesses (Institute of Medicine, 2005; WHO, 2016). Many factors influence children's food acceptance and preferences, including sensory preferences, early

experience, and exposure (Birch, 1999; Branen & Fletcher, 1999; Nestle et al., 1998; Birch, 1987; Sullivan & Birch, 1990; Birch, 1999; Johnson, 2016; Ventura & Worobey, 2013). Several studies have shown that food texture also has a key role in children's food acceptance and consumption (Lukasewycz & Mennella, 2012; van der Horst et al., 2016; Field et al., 2003). Food texture manipulation demonstrated the greatest impact on food acceptance in young children in comparison to color and taste manipulation (Werthmann et al., 2015). Early experience with different textures has increased the likelihood of children trying and consuming more complex textured foods (Blossfel et al., 2007), fostering dietary variety and improving overall health.

Food texture influences food perception and preferences (Lukasewycz & Mennella, 2012). While it is known that exposure can increase familiarity and thus build acceptance of a food (Anzman-Frasca et al, 2012; Birch, 1999; Birch & Fisher 1998; Birch & Doub, 2014; Rozin, 1990; Cooke, 2007), whether repeated texture exposures impose children's preference and intake should be examined. Therefore, the purpose of this study was to identify children's food texture preferences of yogurt, and whether repeated exposure would increase children's preference and intake for different textures.

Repeated Texture Exposure Increased Children's Intake of Less Preferred Yogurt Textures: Evidence for Practice

Chapter Three

Introduction

Children need a variety of foods to support growth and development (WHO, 2017; HHS, 2017). Adequate dietary intake with quality nutrients promotes a healthy life, and children's dietary patterns play an important role in children's development and prevention of future diseases (Ezzati & Riboli, 2013; WHO, 2017; HHS, 2017). Food preferences have an impact on children's food consumption and dietary patterns (Birch & Fisher, 1998; Birch, 1979; Skinner et al., 2002; Drewnowski, 1997). Understanding children's food consumption can foster children's food preference development and improve overall health. Food texture influences food perception and preferences (Lukasewycz & Mennella, 2012; Scott & Downey, 2007). Food texture manipulation has the greatest impact on food acceptance in young children compared to color and taste manipulation (Werthmann et al., 2015). Children with early exposure to different textures are more willing to try and consume foods with more complex textures (Blossfel et al., 2007), creating the potential for a more diverse food intake to support nutrient needs.

Children's food experience is associated with subsequent food acceptance and preferences (Skinner et al., 2002), as well as a child's relationship with food later in life (Branen, & Fletcher, 1999). Healthy eating patterns in early childhood are supportive of both children's growth and development and reducing the risks of chronic disease in adulthood (Institute of Medicine, 2005; WHO, 2016). Previous studies have shown that children's liking for new foods increases with repeated exposure, and thus can increase intake (Birch, & Marlin, 1982; Birch et al., 1987; Sullivan & Birch, 1994). While it is known that texture has a great influence on the food children consume (Werthmann et al., 2015), relatively little is known about how repeated exposure to various textures influences children's food intake and fosters children's preference development. Therefore, the purpose of this study was to identify children's food texture preferences of yogurt, and how repeated

exposure impacts children's preference and intake for different textures.

Materials and Methods

Children (n=20) aged three to five years from the University of Idaho Child Development Laboratory (CDL) in Moscow, Idaho participated in this quasi-experimental study. Out of twenty-seven children initially selected, two parents opted not to have their child involved, three children refused to participate, and two left the preschool during the study. The remaining twenty children completed ten texture preference activities with yogurt over a nine-week period: a pre-exposure trial, eight repeated exposures, and a post-exposure trial. The study was approved by the University of Idaho Institutional Review Board.

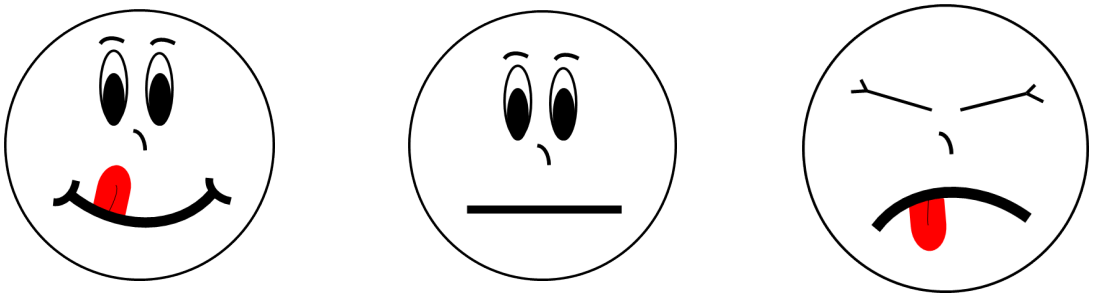
Participants and Recruitment. The CDL Director, Dr. Suzanne Planck, assisted with participant recruitment. Fliers (see Appendix F) were posted at the entrances to the CDL in the Niccolls Building of the University of Idaho, and a research assistant was available to answer questions and inform parents about the study. All parents of children attending the preschool received a letter with the purpose, explanation, and the length of the study prior to participation. In families who chose to participate in the study, one parent designated as the primary caregiver completed a written consent form allowing his or her child to participate in the study, and a demographic questionnaire (see Appendix C). No food allergies or intolerances were reported for any child in the study.

The demographic questionnaire was used to collect the children's and parents' socio-demographic and economic information, including the child's date of birth, gender, parent's height, weight, race, relationship to the child, education level, household income, employment status, and current marital status. Questions about children's frequency of yogurt intake at home and parents' purchasing habits of yogurt, such as the amount of yogurt children consumed at meals and snacks, type and brand of yogurt purchased were included in the questionnaire.

Yogurt Selection for Texture Preference Activities. In preliminary assessment, nine yogurt textures were developed: smooth, firm, runny, lumpy, gritty, grainy, lumpy, gel-like, and ropy.

Several experts, including a child feeding expert, a registered dietitian nutritionist, one food scientist, one sensory scientist, and a food science research assistant selected six out of nine yogurt textures based on differences in texture familiarity, consistency, and mouthful. Selected yogurt textures comprised smooth, runny, gritty, grainy, lumpy, and ropy. The intention was to offer yogurts with three familiar textures and three less familiar textures. A tasting trial was conducted with the children to familiarize them with the three-point hedonic scale ("Yummy", "Just Okay", and "Yucky") (see Figure 1) to assess preference (Sullivan & Birch, 1990) and capture their familiarity of the six yogurt textures. Children indicated preference of four out of six yogurt textures, with smooth and runny being the most preferred textures. As smooth was the control, pearly was substituted for runny in the subsequent ten tasting activities to ensure a new texture was offered. Therefore, the final six yogurt textures presented to the children were smooth, pearly, gritty, grainy, lumpy, and ropy.

Figure 1: Hedonic Faces Used in Texture Preference Activities



Yummy Just Okay Yucky

*Faces developed by S. A. Ramsay, adapted from Birch, 1979.

Production of Yogurt for Texture Preference Activities. Yogurt samples were prepared in a food-grade laboratory on a weekly basis. Flavors of each yogurt were standardized using 1.5 ml/L liquid vanilla flavor before and after inoculation of each texture. To ensure that yogurts manufactured at different time points were similar, the final yogurt pH was kept to 4.5±0.05 and yogurt viscosity was measured at room temperature (22±2°C) and 12 rpm using an RV Brookfield Viscometer equipped with a #3 spindle to ensure each yogurt texture was at the desired viscosity. All yogurts

were prepared according to the protocol and recipes (see Appendix D and E). Yogurts were stored at 4°C until used for the tasting activities.

Preparation of Yogurt for Texture Preference Activities. Yogurt samples were measured into 2-ounce portion cups with colored labels underneath the serving cups to identify each texture. Smooth, lumpy, and ropy yogurts were pre-measured in 10.0±0.1 g portions. Pearly and gritty yogurts were prepared using 10 g of smooth yogurt mixed with 2.5 g of cooked tapioca pearls and cooked corn grits, respectively, prior to serving. Grainy yogurts were prepared by mixing 1 g of uncooked rice flour with grainy yogurt. The addition of carbohydrate to create different textures did not significantly change the flavor of yogurt. Samples were given to children within 60 minutes of portioning.

Conducting the Texture Preference Activities. Texture preference testing activities were conducted in the University of Idaho's Eating Laboratory. The laboratory was equipped with a child-sized table and two chairs, one for the researcher and one for the child. Arranged on the table were a pitcher, a water cup, and a napkin. A three-point hedonic scale ("Yummy", "Just Okay", and "Yucky"), three hunger dolls ("Full", "Neutral", "Hungry") (Ramsay, Roe, Davis, Price, & Johnson, 2017) (see Figure 2), a pointer, and six yogurt texture samples (smooth, pearly, gritty, grainy, lumpy, and ropy) were placed on a cart next to the researcher.

Figure 2: Hunger Dolls

FULL **NEUTRAL** **HUNGRY**

*Hunger dolls developed by S. A. Ramsay, 2014.

The taste preference protocol was adapted from Birch (1979) and modified for the current study (see Appendix A). A trained researcher closely followed the script of the protocol. Each child

was brought into the laboratory by the researcher. Child assent was obtained by asking the question, "Would you like to play the tasting game today?"

To capture the child's level of hunger, each hunger doll was presented to the child one at a time with a brief explanation (e.g., "This one is very hungry. See her tummy is very empty? That means she is very hungry."). After three hunger dolls were explained, they were put up in front of the child and the child was asked to point to the doll that matched the statement, "Can you point to the doll that shows how hungry you are feeling right now?" The child's reported hunger was recorded. The script of hunger assessment is provided in Appendix B.

Once the child's level of hunger was assessed, the child was presented with three faces representing a hedonic liking scale. Each face was presented one at a time, with a brief explanation (i.e., "This is the yummy face. See how he is smiling? That means he likes the food and he thinks the food is yummy."). After three faces were explained, the child's understanding was checked by asking the child to respond to the question (i.e., "If you tried a food and you thought the food was yummy, which face would you point to?").

After the child demonstrated understanding of the hedonic scale, the faces were placed in order from left to right, "Yummy", "Just Okay", and "Yucky". The six yogurts were presented diagonally on a tray in a pre-determined order that was the same for the subsequent taste activities: smooth, pearly, gritty, grainy, lumpy, ropy. Each sample was offered pre-measured in the 2-ounce portion cups served with a child-sized spoon.

The tray was placed in front of the child and the child was asked to self-select a yogurt sample, one at a time. Once the child took a sample, the tray was removed from the child's sight and placed on the cart next to the researcher to prevent distraction. If the child did not like the yogurt, the child was told he or she could spit the yogurt out into an empty cup provided. Children were never forced to eat any of the yogurts. They could refuse to try any sample at any point during the study. After the child tasted a yogurt sample, the child was asked to categorize it into "Yummy", "Just Okay", or "Yucky" and put the cup in front of the face representing their preference. The tray was

then placed in front of the child to select another yogurt sample in the same manner previously described until all yogurts were tasted. At the end of the rating for each yogurt, if more than one yogurt was placed in front of the same face, the child was asked to rank which yogurt was "the yummiest" and "the yuckiest". Children were told they could re-taste multiple yogurt samples in front of the same face if they needed to. The order of the child's yogurt selection and the preferences for each yogurt were documented. The behavior towards each yogurt was documented, including "refused", "spit", "licked", and "swallowed." Once all yogurt samples were ranked, the texture preference activity was concluded and the children were offered a sticker for their participation. Each tasting session took approximately twenty minutes to complete. The texture preference activity was repeated for eight exposures followed by a post-exposure trial.

Data analysis

Descriptive analysis was conducted from the demographic questionnaire, children's yogurt intake at home, and children's reported hunger, taste preference, and responses to each yogurt texture. Children's preference for each texture was analyzed using analysis of variance and chi-square tests of association to examine the effect of texture and repeated texture exposure on taste preferences.

Relative intake was calculated to capture the change in intake for each yogurt texture for pre- and post-exposure as:

$$\text{Relative Intake} = \frac{\text{(pre-serving weight) - (post-tasting weight)}}{\text{(pre-serving weight)}}$$

Both pre-serving and post-tasting weights were measured in grams and the relative intake was recorded in proportion. A generalized linear mixed model was used to assess the significance of the change in relative intake and preference for pre- and post-exposure assuming a normal or a binomial distribution, respectively. Texture and exposure were assumed to be fixed effects with children as random effects. The association between children's reported preference and intake of yogurt textures was examined using Spearman's rank correlation. Statistical tests were assessed at a significance level $\propto = 0.05$. A post hoc power analysis was computed for the current sample size of twenty, and the

power to determine intake difference was 48%. All analyses were conducted using Statistical Analysis Software, SAS Version 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

Demographics. Twenty children, twelve boys and eight girls, aged three to five years, were enrolled in the study by their parents. Parents of the children were primarily Caucasian, and from educated and higher socioeconomic status with a four-year Bachelor's degree or higher. Forty-two percent of parents (n=8) had a normal BMI, thirty-two percent were overweight, and twenty-six percent were obese. Full demographics are reported in Table 1.

Table 1. Characteristics of 20 Parent and Child Dyads Participating in Texture Preference Activities

Demographic Characteristics	Sample, n (%)
Total Sample	20 (100)
Child's Age Category (years)	
Three	4 (20)
Four	16 (80)
Child's Gender	
Male	12 (60)
Female	8 (40)
Parent's Race/Ethnicity	
Caucasians	20 (100)
Parent's Relationship to the Child	
Mother	19 (95)
Father	1 (5)
Parent's Education Level	
High school diploma or GED	1 (5)
Some college	4 (20)
2-year degree (Associate's degree)	2 (10)
4-year degree (Bachelor's degree)	11 (55)
Graduate Doctoral Degree	2 (10)
Household Income	
$35,000 - $41,999/year	2 (10)
$42,000 - $51,999/year	3 (15)
$52,000 - $58,999/year	1 (5)
$59,000 - $73,999/year	5 (25)
Over $74,000/year	8 (40)
No response	1 (5)
Parent's Employment Status	
Not working in order to be home with child/children	10 (50)
Work part-time	5 (25)
Work full-time	4 (20)
Other	1 (5)

Parent's Current Marital Status	
Married or in a committed relationship	19 (95)
Widowed	1 (5)
Parent's Body Mass Index (BMI)*	
Normal Weight 18.5-24.9	8 (40)
Overweight 25-29.9	6 (30)
Obese >29.9	5 (25)
No response	1 (5)

* CDC weight category of BMI (kg/m^2)

Parents' Report of Children's Yogurt Intake at Home. More than 70% of parents reported that children did not eat yogurt at home on a regular basis. If parents reported eating yogurt, children typically consumed yogurt as a snack (n=7, 39%), at lunch (n=7, 35%), or at breakfast (n=6, 30%). Most families bought regular yogurt (n=11; 55%) rather than low-fat (n=4, 20%) or non-fat/Greek yogurts (n=6, 30%).

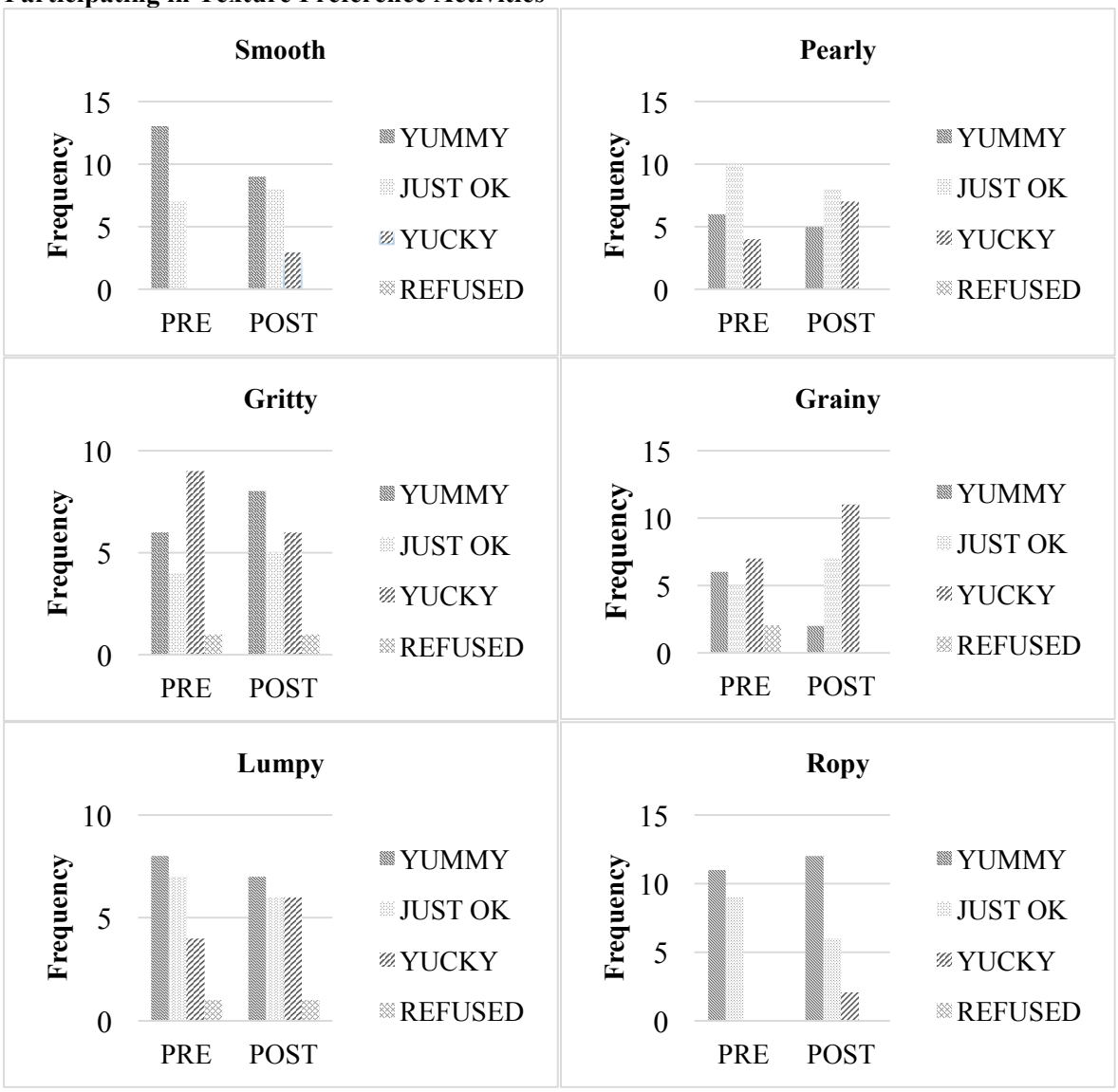
Children's Reported Hunger. Hunger was assessed as a potential factor that could affect children's intake and preference of yogurt. However, no significant difference in reported hunger was identified at pre- and post-exposure, and therefore hunger was not included as a cofactor in analysis. See Table 2 for children's reported hunger at tasting activities.

Table 2. Reported Hunger of Full, Neutral, and Hungry at Pre- and Post-Exposure

	Pre-Exposure, n (%)	Post-Exposure, n (%)
Full	5 (25)	3 (15)
Neutral	6 (30)	7 (35)
Hungry	9 (45)	10 (50)

Children's Yogurt Preference. At pre-exposure, the majority of children reported liking for smooth texture, followed by ropy and lumpy textures. Pearly, gritty, and grainy textures were reported as less preferred. Nine children reported disliking of gritty texture, seven children reported disliking of grainy texture, and four children reported disliking of pearly and lumpy textures (see Figure 3).

Figure 3. Reported Preference of Yogurt Textures at Pre- and Post-Exposure for 20 Children Participating in Texture Preference Activities



All children swallowed smooth and ropy yogurts, followed by pearly and lumpy yogurts. Five children spit out gritty, three spit out grainy, and one spit out pearly. A total of four children refused to try at least one of the yogurts at pre-exposure, including two children who refused grainy, one who refused gritty, and one who refused lumpy (see Table 3).

Table 3. Behavioral Responses to Each Yogurt Texture at Pre- and Post-Exposure

	Swallowed, n (%)	Licked, n (%)	Spit, n (%)	Refused, n (%)
		Pre-Exposure		
Smooth	20 (100)	0	0	0
Pearly	19 (95)	0	1 (5)	0
Gritty	14 (70)	0	5 (25)	1 (5)
Grainy	15 (75)	0	3 (15)	2 (10)
Lumpy	19 (95)	0	0	1 (5)
Ropy	20 (100)	0	0	0
		Post-Exposure		
Smooth	18 (90)	1 (5)	1 (5)	0
Pearly	16 (80)	0	4 (20)	0
Gritty	14 (70)	1 (5)	4 (20)	1 (5)
Grainy	15 (75)	0	5 (25)	0
Lumpy	17 (85)	0	2 (10)	1 (5)
Ropy	19 (95)	0	1 (5)	0

After eight repeated exposures, over half of the children (n=12, 60%) reported liking of ropy texture, followed by smooth (n=9, 45%) at post-exposure. Forty percent of children reported liking of gritty, 35% reported liking of lumpy, and 25% reported liking of pearly. Grainy was the least preferred yogurt texture with only two children reported liking and eleven children reported disliking at post-exposure. Seven children reported disliking of pearly, six children reported disliking of gritty as well as lumpy (see Figure 3). Additionally, almost all children swallowed or licked ropy and smooth yogurts at post-exposure. Fewer children swallowed grainy, pearly, and gritty, including five children spit out grainy and four children spit out pearly and gritty. Only two children refused to try yogurt at post-exposure (see Table 3).

Effect of Repeated Texture Exposure on Yogurt Preference. To analyze the effect of each yogurt texture and repeated texture exposure on yogurt taste preferences at pre- and post- exposure, the level of taste preferences was collapsed into two levels as binomial: liking and disliking. Children

demonstrated similar eating behavior (i.e., swallowed or licked) as they reported "Yummy" or "Just Okay" and therefore were grouped into liking response; whereas "Yucky" and refusal to try were grouped into disliking response (see Table 4). The results indicated that texture significantly influenced taste preferences (F = 5.20; p = 0.04, DF = 5; n = 20). No significant effect was found for repeated texture exposure (pre- versus post-exposure) on taste preferences (F = 1.97; p = 0.21; DF = 1; n = 20). In addition, no significant effect of texture by repeated texture exposure interaction on children's reported taste preferences (X^2 = 0.93; p = 0.97; DF = 5; n = 20).

Table 4. Frequency of Reported Taste Preference at Pre- and Post-Exposure

	Liking		Disliking	
Texture	Pre-exposure, n	Post-exposure, n	Pre-exposure, n	Post-exposure, n
Smooth	20	17	0	3
Pearly	16	13	4	7
Gritty	10	13	10	7
Grainy	11	9	9	11
Lumpy	15	13	5	7
Ropy	20	18	0	2

Children's Yogurt Intake. Proportion of estimated means and standard deviations of relative intake at pre-exposure are given in Table 5. Lumpy, ropy, smooth, and pearly texture relative intake levels were approximately 0.30 compared to gritty and grainy textures which were 0.17. After eight repeated exposures, relative intake for all yogurts increased at post-exposure. In particular, lumpy was the most consumed yogurt texture (0.49) followed by smooth (0.38) whereas pearly and grainy were the least consumed yogurts (both at 0.34; Table 5).

Table 5. Proportion of Mean Relative Intake at Pre-Exposure, Post-Exposure, and Difference of Mean Relative Intake After Repeated Texture Exposure

	Relative Intake		Difference of Mean Relative Intake	Significance of Difference p > F
Texture	Pre-exposure M (SD)	Post-exposure M (SD)	After RTE M (SD)	
Smooth	0.30 (0.25)	0.38 (0.26)	0.09 (0.05)	0.08
Pearly	0.29 (0.25)	0.34 (0.28)	0.05 (0.05)	0.27
Gritty	0.17 (0.18)	0.37 (0.27)	0.20 (0.05)	<0.01*
Grainy	0.17 (0.21)	0.34 (0.27)	0.16 (0.05)	<0.01*
Lumpy	0.34 (0.29)	0.49 (0.29)	0.15 (0.06)	0.01*
Ropy	0.31 (0.25)	0.36 (0.26)	0.06 (0.06)	0.37

Abbreviations: M = mean; SD = standard deviation; RTE = repeated texture exposure
* Significance level $p \leq 0.05$

Effect of Repeated Texture Exposure on Yogurt Intake. Repeated texture exposure increased children's intake of yogurt across six different textures. The increase in mean relative intake was significantly different from zero for gritty ($p < 0.01$), grainy ($p < 0.01$), and lumpy ($p = 0.01$) textures, while smooth, pearly, and ropy textures demonstrated a positive trend in intake, but the changes were not significant.

Relationship between Preference and Intake of Yogurt Textures. A Spearman's correlation was computed to examine the association between children's reported preference and intake of yogurt textures. There was a positive monotonic correlation between preference and intake ($r_s = 0.38$, $p < 0.01$). On the hedonic scale, children reported an increased liking of gritty after repeated texture exposure, however, no other textures showed an increase in liking, regardless of the identified increase in intake.

Discussion

The aim of this study was to identify children's food texture preferences of yogurt, and whether repeated exposure would foster children's preference development for different textures. The results indicated that children's intake of yogurt was influenced by texture. Children reported different preferences and consumed different amounts of yogurt based on yogurt texture. Repeated texture exposure improved children's intake for all yogurt textures, with children's intake of less familiar yogurt textures indicating a significant increase in relative intake. However, the results showed that children may not indicate increased liking of these textures, regardless of their increased intake after repeated exposure.

Food texture influences children's food acceptance (Lukasewycz & Mennella, 2012; Russell & Worsley, 2013). In a recent study, Werthmann et al. (2015) found that texture manipulation (i.e., lumpy with fruit pieces versus smooth strawberry-raspberry yogurt) but not color or taste manipulations affected children's yogurt intake. Our findings are in line with the results that texture

affects children's food intake as indicated by the differences in mean relative intake of yogurts with standardized palatable flavor at pre- and post-exposure. Exposing children to different textures paired with palatable flavors could be a valuable technique to promote children's food acceptance on nutrient dense foods without adding extra calories.

The present study is in line with previous research, which has shown that children's food acceptance increases with multiple exposures (Birch & Marlin, 1982; Wardle et al., 2003a; Wardle et al., 2003b). Children's food preferences are predisposed by their innate preferences for certain flavors and tastes, such as liking for sweet and salty foods and disliking for sour and bitter tastes (Steiner, 1979; Sullivan & Birch, 1994), but the initial taste response to a new food can be altered through frequent exposures and associating positive consequences of eating (Birch, 1987; Birch & Marlin, 1982). While children's taste preferences are impacted by innate predispositions to basic tastes (Birch, 1999), little research has been conducted on repeated exposure for texture preference. In the present study, children's intake increased for all yogurt textures after eight repeated exposures. In particular, a significant increase in mean relative intake was identified for less familiar textures, including gritty, grainy, and lumpy. The results add to existing literature that show repeated exposures increase children's intake of foods (Birch, & Marlin, 1982; Birch et al., 1987; Sullivan & Birch, 1994). However, this study is the first to show that child texture preferences benefit from the use of repeated exposure, particularly preferences for unfamiliar textures.

Most dairy products such as yogurt and sour cream are expected to be "smooth, uniform, free from lumps or graininess" (Lucey, 2004) and possibly the yogurt textures people are familiar with. Children in the present study consumed a greater amount of yogurt with textures that were familiar (i.e., smooth) versus less familiar (i.e., grainy). Children eat food that is familiar and they tend to demonstrate neophobic behavior and reluctance to try new foods (Birch, 1979). Familiarity of food is commonly seen among humans and other animals with the "learned safety" interpretation that consuming a new food does not lead to negative consequences (Kalat & Rozin, 1973; Rozin, 1976), and thus resulting in reduced neophobic response and increased acceptance (Birch, 1999). This

mechanism of food selection is especially important among young children to learn not to eat harmful substances (Rozin et al., 1986). The results from this study confirmed that children's intake of familiar textures of yogurt, such as ropy and smooth, were consumed in greater amounts than less familiar textures, such as gritty and grainy, during tasting activities. Furthermore, children's intake and preference of ropy and smooth were not significantly different at pre- and post-exposure.

In addition, consistent with previous studies that show children's dislike for less acceptable textures (Lukasewycz & Mennella, 2012; Szczesniak, 2002; Zeinstra et al., 2010), children in the present study were less likely to prefer yogurt with a granular texture, such as grainy and gritty, prior to exposure. This may have been partially due to children's oral development for manipulation of more complex texture in their mouth (Szczesniak, 2002), which can be offset as children grow and learn how to better control oral processing of foods with complex textures. With repeated texture exposure, children's intake for all yogurt textures improved, including a significant increase of mean relative intake for grainy and gritty. The findings were in line with the previous study that showed infants' previous experience with different textures is positively related to their acceptance of more complex textured foods (Blossfel et al., 2007), and exposure increased children's experience and familiarity improving intake of less preferred textures.

Food preferences influence food acceptance and consumption patterns (Birch, 1987; Birch, 1999; Cooke, 2007). Yet, other variables such as physiological, behavioral, environmental, social, and economic factors also impact food preferences and the amount of food consumed (Drewnowski, 1997; Nestle et al., 1998). Children in the present study were found to consume yogurts even though they did not report them as "Yummy." For example, a child consumed all of a yogurt texture sample and responded, "It was Just Okay." This indicates that while children "eat what they like" (Cooke, 2007), they also eat what they think is neutral or "Just Okay." Therefore, children's reported liking should be considered within the context of other cofactors, such as variations during taste activities and time of day.

There are several limitations in the present study, which should be addressed in the future

research. First, participants were primarily Caucasian from educated and higher socio-economic status families in Moscow, Idaho. Parents of the participants had a four-year Bachelor's degree or higher with a minimum household income of $59,000 per year, which does not represent a national population. Next, the present study demonstrated the effect of repeated texture exposure on intake of less preferred yogurt textures, however, there was no control group assigned in the study design. Additionally, future study can extend the present study using less familiar foods prepared in various textures, and randomly assign children to control and treatment groups. The effects of flavor and texture together can be studied, as there may be synergistic effects from combining differences in flavor and texture together. Furthermore, a possible limitation is that children spit out yogurt, which could have accounted for intake. However, in observation of children's consumption the amount placed in the mouth and spit out was very small; thus likely having minimal impact on the results. Finally, a larger sample size of forty or more children would have provided greater statistical power (80%) to more precisely detect differences in intake and liking.

Implications for Future Studies

This study provides evidence of increased intake for less preferred yogurt texture among young children after repeated texture exposure. Early childhood is the pivotal time to lay the foundation for children's food preferences (Fox et al., 2010). Early experience with different textures can foster children's food intake and preferences (Blossfeld et al., 2007), and repeated exposure to foods has the potential to modify innate preferences and food neophobia (Birch, 1999; Cooke, 2007). The results demonstrating increased intake for all yogurt textures after repeated exposure are of practical significance, particularly for less familiar textures.

Health care professionals, registered dietitian nutritionists, practitioners, and caregivers of young children will find the results of this study valuable in that texture influences food intake, but repeated exposure can facilitate intake of foods with less preferred textures. As many nutrient-dense foods have textures that may be unfamiliar to young children, registered dietitian nutritionists can encourage intake of nutritious foods by guiding children's texture preference and using repeated

exposure in children's food preference development to establish increased intake and support future health.

Reference

Anzman, S. L., Rollins, B. Y., & Birch, L. L. (2010). Parental influence on children's early eating environments and obesity risk: implications for prevention. *International Journal of Obesity*, 34, 1116-1124.

Anzman-Frasca, A., Savage, J. S., Marini, M. E., Fisher, J. O., & Birch, L. L. (2012). Repeated exposure and associative conditioning promote children's liking of vegetables. *Appetite*, 58, 543-553.

Bandini et al. (2010). Food selectivity in children with autism spectrum disorders and typically developing children. *Journal of Pediatrics*, 157(2), 259-264.

Beauchamp, G. K., & Mennella, J. A. (2011). Flavor perception in human infants: Development and functional significance, *Digestion*, 83, 1-6.

Beckett, C., Bredenkamp, D., Castle, J., Groothues, C., O'Connor, T., & Rutter, M. (2002). Behavior patterns associated with institutional deprivation: A study of children adopted from Romania. *Journal of Developmental & Behavioral Pediatrics*, 23(5), 297-303.

Benfer, K. A., Weir, K. A., Bell, K. L., Ware, R. S., Davies, P. S. W., & Boyd, R. N. (2015). Food and fluid texture consumption in a population-based cohort of preschool children with cerebral palsy: Relationship to dietary intake. *Developmental Medicine & Child Neurology*, 57, 1056-1063.

Birch, L. L. (1979). Dimensions of preschool children's food preferences. *Journal of Nutrition Education*, 11(2), 91-95.

Birch, L. L. (1987). The role of experience in children's food acceptance patterns. *Journal of American Dietetic Association*, 87(9), S36-S40.

Birch, L. L. (1998). Development of food acceptance patterns in the first years of life. *Proceedings of the Nutrition Society*, 57, 617-624.

Birch, L. L. (1999). Development of food preferences. *Annual Reviews Nutrition*, 19, 41-62.

Birch, L. L., & Davision, K. K. (2001). Family environmental factors influencing the developing behavioral controls of food intake and childhood overweight. *Pediatrics Clinics of North America*, 48(4), 893-907.

Birch, L. L., & Dietz, W. (2008). *Eating behaviors of the young child*. Elk Grove Village, IL: American Academy of Pediatrics.

Birch, L. L., & Doub, A. E. (2014). Learning to eat: birth to age 2 y. *American Journal of Clinical Nutrition*, 99, 723S-728S.

Birch, L.L., & Fisher, J. O. (1998). Development of eating behaviors among children and adolescents. *Pediatrics*, 101, S539-S549.

Birch, L. L. & Marlin, D. W. (1982). I don't like it: I never tried it: effects of exposure on two-year old children's food preferences. *Appetite*, 3(4), 353-360.

Birch, L. L., Marlin, D. W., & Rotter, J. (1984). Eating as the "means" activity in a contingency: Effects on young children's food preference. *Child Development,* 55(2), 431-439.

Birch, L. L., McPhee, L., Shoba, B. C., Pirok, E., & Steinberg, L. (1987). What kind of exposure reduces children's food neophobia? Looking vs. tasting. *Appetite,* 9(3), 171-178.

Birch, L. L., McPhee, L., Steinberg, L., & Sullivan, S. (1990). Conditioned flavor preferences in young children. *Physiology & Behavior*, 47(3), 501-505.

Blossfeld, I., Collins, A., Kiely, M., & Delahunty, C. (2007). Texture preferences of 12-month-old infants and the role of early experiences. *Food Quality and Preference, 396-404.*

Bourne, M. (2002). *Food texture and viscosity: concept and measurement.* San Diego, CA: Academic Press.

Branen, L. J., & Fletcher, J. (1999). Comparison of college students' current eating habits and recollections of their childhood food practices. *Journal of Nutrition Education*, 31(6), 303-374.

Branen, L. J., Fletcher, J., & Hilbert, L. (2002). Snack consumption and waste by preschool children served "cute" versus regular snacks. *Journal of Nutrition Education*, 34(5), 279-282.

Bunce, C. & Gibson, E. L. (2012). Sniffing, eating and disgust in food neophobic children. *Appetite,* 59, 622.

Calfas, K. J., Sallis, J. F., & Nader, P. R. (1991). The development of scales to measure knowledge and preference for diet and physical activity behavior in 4- to 8- Year old children. *Developmental and Behavioral Pediatrics*, 12(3), 185-190.

Carruth, B. R., Skinner, J., Houck, K., Moran III, J., Coletta, F., & Ott, D. (1998). The phenomenon of "picky eater": A behavior marker in eating patterns of toddlers. *Journal of the American College of Nutrition* 17, 180-186.

Carruth, B. R., Ziegler, P. J., Gordon, A., & Barr, S. I. (2004). Prevalence of picky eaters among infants and toddlers and their caregivers' decisions about offering a new food. *Journal of the American Dietetic Association*, 104, 57-64.

Casey, R., & Rozin, P. (1989). Changing children's food preferences: parent opinions. *Appetite*, 12(3), 171-182.

Cashdan, E. (1998). Adaptiveness of food learning and food aversions in children. *Social Science Information,* 37, 613-632.

Centers for Disease Control and Prevention. (2017). Childhood obesity facts. Retrieved from https://www.cdc.gov/healthyschools/obesity/facts.htm

Cooke, L. (2007). The importance of exposure for healthy eating in childhood: A review. *Journal of Human Nutrition and Dietetics,* 20, 294-301.

Cooke, L., & Fildes, A. (2011). The impact of flavor exposure in utero and during milk feeding on food acceptance at weaning and beyond. *Appetite,* 57, 808-811.

Coulthard, H., & Blissett, J. (2009). Fruit and vegetable consumption in children and their mothers. Moderating effects of child sensory sensitivity. *Appetite,* 52(2), 410-415.

Coulthard, H., Harris, G., & Emmett, P. (2009). Delayed introduction of lumpy foods to children during the complementary feeding period affects child's food acceptance and feeding at 7 years of age. *Maternal and Child Nutrition*, 5, 75-85.

Daniels et al. (2005). Overweight in children and adolescents: Pathophysiology, consequences, prevention, and treatment. *Circulation,* 111(15), 1999-2012.

DeSilva, P., & Rachman, S. (1987). Human food aversions: Nature and acquisition. *Behavior Research and Therapy*, 25, 457-468.

Dovey, T.M., Staples, P.A., Gibson, E.L., & Halford, J.C. (2008). Food neophobia and 'picky/fussy' eating in children: A review. *Appetite*, 50, 188-193.

Drewnowski, A. (1997). Taste preferences and food intake. *Annual Review Nutrition,* 17, 237-253.

Ezzati, M., & Riboli, E. (2013). Behavioral and dietary risk factors for noncommunicable diseases. *The New England Journal of Medicine,* 369, 954-964.

Field, A. E., Cook, N. R., & Gillman, M. W. (2005). Weight status in childhood as a predictor of becoming overweight or hypertensive in early adulthood. *Obesity Research,* 13, 163-169.

Field, D., Garland, M., & Williams, K. (2003). Correlates of specific childhood feeding problems. *Journal of Pediatric and Child Health,* 39, 299-304.

Finkelstein, E. A., Trogdon, J. G., Cohen, J. W., & Dietz, W. (2009). Annual medical spending attributable to obesity: Payer-and service-specific estimates. *Health Affairs,* 28(5), w822-831.

Fiorito, L. M., Marini, M., Mitchell, D. C., Smiciklas-Wright, H., & Birch, L. L. (2010). Girls' early sweetened carbonated beverage intake predicts different patterns of beverage and nutrient intake across childhood and adolescence. *Journal of the American Dietetic Association*, 110(4), 543-550.

Fox, M. K., Condon, E., Briefel, R. R., Reidy, K. C., & Deming, D. M. (2010). Food consumption patterns of young preschoolers: are they starting off on the right path? *Journal of the American Dietetic Association*, 9(2), S52-S59.

Frary, C. D., Johnson, R. K., & Wang, M. Q. (2004). Children and adolescents' choices of foods and beverages high in added sugars are associated with intakes of key nutrients and food groups. *Journal of Adolescent Health*, 34(1), 56-63.

Ganchrow, J. R., & Mennella, J. A. (2003). The ontogeny of human flavor perception. In: Doty, R. L. (2nd Eds.), *Handbook of Olfaction and Gustation* (pp. 823−846). New York: Marcel Dekker, Inc.

Gerrish, C. J., & Mennella, J. A. (2001). Flavor variety enhances food acceptance in formula-fed infants. *The American Journal of Clinical Nutrition,* 73, 1080-1085.

Gisel, E. G. (1991). Effect of food texture on the development of chewing of children between six months and two years of age. *Developmental Medicine & Child Neurology*, 33, 69-79.

Guinard, J. X., & Mazzucchelli, R. (1996). The sensory perception of texture and mouthfeel. *Trends in Food Science & Technology,* 7, 213-219.

Guthrie, J. F., & Morton, J. F. (2000). Food sources of added sweeteners in the diets of Americans. *Journal of the American Dietetic Association*, 100, 43-51.

Haire-Joshu, D., Kreuter, M. K., Holt, C., & Steger-May, K. (2004). Estimates of fruit and vegetable intake in childhood and adult dietary behaviors of African American Women. *Journal of Nutrition Education and Behavior,* 36, 309-314.

Harris, G. (1993). Introducing the infant's first solid food. *British Food Journal,* 95(9), 7-10.

Hart, K. H., Herriot, A., Bishop, J. A., & Truby, H. (2003). Promoting healthy diet and exercise patterns amongst primary school children. A qualitative investigation of parental perspectives. *Journal of Human Nutrition and Dietetics*, 16, 89-96.

Hausner, H., Nicklaus, S., Issanchou, S., Molgaard, C., & Moller, P. (2010). Breastfeeding facilities acceptance of a novel dietary flavor compound. *Clinical Nutrition,* 29, 141-148.

Institute of Medicine. (2005). *Preventing childhood obesity: Health in the balance*. Washington, D.C.: The National Academies Press.

Jaeger, S. R., Andani, Z., Wakeling, I. N., & Macfie, H. J. H. (1998). Consumer preferences for fresh and aged apples: A cross-cultural comparison. *Food Quality and Preference,* 9(5), 355-366.

Jansen, E., Mulkens, S., & Jansen, A. (2010). How to promote fruit consumption in children. Visual appeal versus restriction. *Appetite,* 54(3), 599-602.

Jaramillo, S. J., Yang, S.-J., Hughes, S. O., Orlet-Fisher, J., Morales, M., & Nicklas, T. A. (2006). Interactive computerized fruit and vegetable preference measure for African American and Hispanic preschoolers. *Journal of Nutrition Education and Behavior*, 38, 352-459.

Johnson, S. L. (2016). Developmental and environmental influences on young children's vegetable preferences and consumption. *Advances in Nutrition: An International Review Journal,* 7(1), 220S-231S.

Kadey, H., Pizza, C. C., Rivas, K., & Zeleny, J. (2013). An evaluation of texture manipulations to increase swallowing. *Journal of Applied Behavior Analysis,* 46, 539-543.

Kalat, J. W., & Rozin, P. (1973). "Learned safety" as a mechanism in long-delay taste- aversion learning in rats. *Journal of Comparative and Physiological Psychology,* 83(2), 198-207.

Keller, K. L., Kirzner, J., Pietrobelli, A., St-Onge, M., & Faith, M. S. (2009). Increased sweetened beverage intake is associated with reduced milk and calcium intake in 3- to 7-year-old children at multi-item laboratory lunches. *Journal of the American Dietetic Association*, 109 (3), 497-501.

Kildegaard, H., Olsen, A., Gabrielsen, G., Møller, P., & Thybo, A. K. (2011). A method to measure the effect of food appearance factors on children's visual preferences. *Food Quality and Preference*, 22, 763-771.

Lafraire, J., Rioux, C., Giboreau, A., & Picard, D. (2016). Food rejections in children: Cognitive and social/environmental factors involved in food neophobia and picky/fussy eating behavior. *Appetite*, 96(1), 347-357.

Larson, N. & Story, M. (2009). A review of environmental influences on food choices. *Annals of Behavioral Medicine*, 38, 56-73.

Le Reverend, B. J. D., Edelson, L. R., & Loret, C. (2014). Anatomical, functional, physiological and behavioral aspects of the development of mastication in early childhood. *British Journal of Nutrition,* 111(3), 403-414.

Lucey, J. A. (2004). Cultured dairy products: An overview of their gelation and texture properties. *International Journal of Dairy Technology*, 57(2-3), 77-84.

Lukaseqycz, L. D., & Mennella, J. A. (2012). Lingual tactile acuity and food texture preferences among children and their mothers. *Food Quality Preference,* 58-66.

Lundy et al. (1998). Food texture preferences in infants versus toddlers. *Early Child Development and Care,* 146, 69-85.

Macario, J. F. (1991). Young children's use of color in classification: Foods and canonically colored objects. *Cognitive Development,* 6(1), 17-46.

Maier A, Chabanet C, Schaal B, Leathwood P, Issanchou S. (2008). Breastfeeding and experience with variety early in weaning increase infants' acceptance of new foods for up to two months. *Clinical Nutrition*, 27(6), 849-857.

Martins, Y. & Pliner, P. (2006). "Ugh! That's disgusting!": Identification of the characteristics of foods underlying rejections based on disgust. *Appetite,* 46(1), 75-85.

Mennella, J. A., & Beauchamp, G. K. (2002). Flavor experiences during formula feeding are related to preferences during childhood. *Early Human Development*, 68, 71-82.

Mennella, J. A., & Ventura, A. K. (2010). Understanding the basic biology underlying the flavor world of children. *Current Zoology*, 56(6), 834-841.

Mennella, J. A., Jagnow, C. P., & Beauchamp, G. K. (2001). Prenatal and postnatal flavor learning by human infants. *Pediatrics*, 107(6), E88.

Mojet J. & Koster, E. P. (2005). Sensory memory and food texture. *Food Quality and Preference,* 16(3), 251-266.

Monnery-Patris, S., Wagner, S., Rigal, N., Schwartz, C., Chabanet, C., Issanchou, S., & Nicklaus, S. (2015). Smell differential reactivity, but no taste differential reactivity, is related to food neophobia in todders. *Appetite*, 95(1), 303-309.

Mrdjenovic, G., & Levitsky, D. A. (2003). Nutritional and energetic consequences of sweetened drink consumption in 6- to 13-year-old children. *Journal of Pediatrics*, 142(6), 604-610.

Munoz, K. A., Krebs-Smith, S. M., Ballard-Barbash, R., & Cleveland, L. E. (1997). Food intakes of US children and adolescents compared with recommendations. *Pediatrics*, 100, 323-329.

Najdowski, A. C., Tarbox, J., & Wilke, A. E. (2012). Utilizing antecedent manipulations and reinforcement in the treatment of food selectivity by texture. *Education and Treatment of Children,* 35(1), 101-110.

Nederkoorn, C., Jansen, A., & Havermans, R. C. (2015). Feel your food. The influence of tactile sensitivity on picky eating in children. *Appetite,* 84, 7-10.

Nestle et al. (1998). Behavioral and social influences on food choice. *Nutrition Reviews,* 56(5), S50-S74.

Nicklaus, S. (2011). Children's acceptance of new foods at weaning. Role of practices of weaning and of food sensory properties. *Appetite*, 57, 812-815.

Northstone, K., Emmett, P., Nethersole, F., & ALSPAC study team. (2001). The effect of age of introduction to lumpy solids on foods eaten and reported feeding difficulties at 6 and 15 months. *Journal of Human Nutrition and Dietetics*, 14, 43-54.

Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2014). Prevalence of childhood and adult obesity in the United States, 2011-2012. *Journal of the American Medical Association,* 311(8), 806-814.

Orrell-Valente, J. K., Hill, L. G., Brechwald, W. A., Dodge, K. A., Pettit, G. S., & Bates, J. E. (2007). "Just three more bites": An observational analysis of parents' socialization of children's eating at mealtime. *Appetite,* 48, 37-45.

Osborne, C. L., & Forestell, C. A. (2012). Increasing children's consumption of fruit and vegetables: Does the type of exposure matter? *Physiology & Behavior,* 106(3), 362-368.

Patel, M. R., Piazza, C. C., Layer, S. A., Coleman, R., & Swartzwelder, D. M. (2005). A systematic evaluation of food textures to decrease packing and increase oral intake in children with pediatric feeding disorders. *Journal of Applied Behavior Analysis,* 38(1), 89-100.

Patel, M. R., Piazza, C. C., Santana, C. M., & Volkert, V. M. (2002). An evaluation of food type and texture in the treatment of a feeding problem. *Journal of Applied Behavior Analysis,* 35(2), 183-186.

Pinard, C. A., Davy, B. M., & Estabrooks, P. A. (2011). Beverage intake in low-income parent-child dyads. *Eating Behaviors,* 12(4), 313-316.

Ramsay, S. A., Branen, L. J., Fletcher, J., Price, E., Johnson, S. L., & Sigman-Grant, M. (2010). "Are you done?" Child care providers; verbal communication at mealtimes that reinforce or hinder children's internal cues of hunger and satiation. *Journal of Nutrition Education and Behavior,* 42 (4), 265-270.

Ramsay, S. A., Eskelsen, A. K., Branen, L. J., Shultz, J. A., & Plumb, J. (2014). Nutrient intake and consumption of fruit and vegetables in young children. *Infant, Child, & Adolescent Nutrition*, 6(6), 332-344.

Ramsay, S. A., Roe, A. J., Davis, J. N., Price, W. J., & Johnson, S. L. (2017). Repeated exposures and child centered nutrition phrases increases young children's consumption and liking of lentils. *Food Quality and Preference*, http://dx.doi.org/10.1016/j.foodqual.2017.03.002

Ramsay, S. A., Rudley, M., Tonnemaker, L. E., & Price, W. J. (2016). A comparison of college students' reported fruit and vegetable liking and intake from childhood to adulthood. *Journal of the American College of Nutrition*, 36(1), 28-37.

Resnicow, K., Davis-Hearn, M., Smith, M., Baranowski, T., Lin, L. S., Baranowski, J., Doyle, C., & Wang, D. T. (1997). Social-cognitive predictors of fruits and vegetable intake in children. *Health Psychology*, 16(3), 272-276.

Rioux, C., Picard, D., & Lafraire, J. (2016). Food rejection and the development of food categorization in young children. *Cognitive Development,* 40, 163-177.

Rozin, P. (1976). The selection of foods by rats, humans, and other animals. *Advances in the Study of Behavior*, 6, 21-76.

Rozin, P. (1990). Acquisition of stable food preferences. *Nutrition Reviews*, 48(2), 106-114.

Rozin, P., Hammer, L., Oster, H., Horowitz, T., & Marmora, V. (1986). The child's conception of food: Differentiation of categories of rejected substances in the 16 months to 5 year age range. *Appetite*, 7, 141-151.

Russell, C. G., & Worsley, A. (2013). Why don't they like that? And can I do anything about it? The nature and correlates of parents' attributions and self-efficacy beliefs about preschool children's food preferences. *Appetite*, 66, 34-43.

Schiffman, S. (1977). Food recognition by the elderly. *Journal of Gerontology,* 586-592.

Schwartz, C., Scholtens, P., Lalanne, A., Weenen, H., & Nicklaus, S. (2011). Development of healthy eating habits early in life: Review of recent evidence and selected guidelines. *Appetite*, 57, 796-807.

Scott, C. L., & Downey, R. G. (2007). Types of food aversions: animal, vegetable, and texture. *Journal of Psychology*, 141(2), 127-134.

Seiverling, L., Hendy, H. M., & Williams, K. (2011). The screening tool of feeding problems applied to children (STEP-CHILD): Psychometric characteristics and associations with child and parent variables. *Research in Developmental Disabilities,* 32(3), 1122-1129.

Sharp, W. G., & Jaquess, D. (2009). Bite size and texture assessment to prescribe treatment for severe food selectivity in autism. *Behavioral Interventions,* 24, 157-170.

Skinner, J., Carruth, B. R., Bounds, W., & Ziegler, P. (2002). Children's food preferences: A longitudinal analysis. *Journal of the American Dietetic Association*, 102, 1638-1647.

Soussignan, R., Schall, B., Marlier, L., & Jiang, T. (1997). Facial and autonomic responses to biological and aritfical olfactory stimuli in human neonates: re-examining early hedonic discrimination of odors. *Physiology and Behavior*, 62(4), 745-758.

Steiner, J. E. (1979). Human facial expressions in response to taste and smell stimulation. *Advances in Child Development and Behavior*, 13, 257-295.

Stolovitz, P. & Gisel, E. G. (1991). Circumoral movements in response to three different food textures in children 6 months to 2 years of age. *Dysphagia,* 6, 17-25.

Sullivan, S. A., & Birch, L. L. (1990). Pass the sugar, pass the salt: Experience dictates preference. *Developmental Psychology,* 26(4), 546.

Sullivan, S. A., & Birch, L. L. (1994). Infant dietary experience and acceptance of solid foods. *Pediatrics,* 93(2), 271-277.

Szczesniak, A. S. (1972). Consumer awareness of and attitudes to food texture II. Children and teenagers. *Journal of Texture Studies,* 3(2), 206-217.

Szczesniak, A. S. (2002). Texture is a sensory property. *Food Quality and Preference,* 13, 215-225.

Szczesniak, A. S., & Kahn, E. L. (1971). Consumer awareness of and attitudes to food texture. *Journal of Texture Studies,* 2(3), 280-295.

U. S. Department of Agriculture [USDA]. (2017). Choose MyPlate. Retrieved from http://www.choosemyplate.gov/

U.S. Department of Health and Human Services [HHS], Office of Disease Prevention and Health Promotion. (2017). *Healthy People 2020*. Retrieved from https://www.healthypeople.gov/2020/topics-objectives/topic/nutrition-and-weight-status

van der Horst, K., Deming, D. M., Lesniauskas, R., Carr, B. T., & Reidy, K. C. (2016) Picky eating: Associations with child eating characteristics and food intake. *Appetite*, 103, 286-293.

Ventura, A. V. & Worobey, J. (2013). Early influences on the development of food preferences. *Current Biology,* 23(9), R401-R408.

Wang, L. Y., Chyen, D., Lee, S., et al (2008). The association between body mass index in adolescence and obesity in adulthood. *Journal of Adolescent Health,* 42(5), 512-518.

Wardle, J., Cooke, L. J., Gibson, E. L., Sapochnik, M., Sheiham, A., & Lawson, M. (2003a). Increasing children's acceptance of vegetables; a randomized trial of parent-led exposure. *Appetite*, 40(2), 155-162.

Wardle, J., Herrera, M., Cooke, L. J., & Gibson, E. L. (2003b). Modifying children's food preferences: the effects of exposure and reward on acceptance of an unfamiliar vegetable. *European Journal of Clinical Nutrition,* 57, 341-348.

Werthmann, J., Jansen, A., Havermans, R., Nederkoorn, C., Kremers, S., & Roefs, A. (2015). Bits and pieces. Food texture influences food acceptance in young children. *Appetite,* 84, 181-187.

Wilkinson, C., Kijksterhuis, G. B., & Minekus, M. (2000). From food structure to texture. *Trends in Food Science & Technology*, 11, 442-450.

World Health Organization [WHO]. (2014). *Global status report on noncommunicable diseases 2014*. Retrieved from http://apps.who.int/iris/bitstream/10665/148114/1/9789241564854_eng.pdf

World Health Organization [WHO]. (2016). Obesity and overweight fact sheet. Retrieved from http://www.who.int/mediacentre/factsheets/fs311/en/

World Health Organization [WHO]. (2017). Child health. Retrieved from http://www.who.int/topics/child_health/en/

Zeinstra, G. G., Koelen, M. A., Kok, F. J., & de Graaf, C. (2010). The influence of preparation method on children's liking for vegetables. *Journal of Food Quality and Preference*, 906-914.

Appendix A

Tasting Protocol

Tasting Protocol (Yummy, Just okay, Yucky)

List of yogurt products (vanilla flavored) in various textures:

1) Smooth
2) Pearly
3) Gritty
4) Grainy
5) Lumpy
6) Ropy

Food items needed and details about specifics for purchasing:

Purchasing food: All yogurt ingredients and final products are developed and provided in the Food Science Lab by Dr. Helen Joyner, University of Idaho School of Food Science.

Preparing Yogurt: Each yogurt products will be pre-portioned in a 2-ounce cup prior to the tasting activities.

Equipment:
Tasting Bags (1 per tester and 1 extra)

- Faces in stands (Yummy, Just Okay, Yucky)
- Pitcher of water (1/table)
- Small cup for water
- Clipboard (1)
- Pen writing in indelible ink
- Stickers
- Hand sanitizer
- Small spoons
- Assessment forms (paper)
- Protocol

Additional Equipment and Set-up Kit

- Assessment tablet for electronic data collection
- Trays - small (1 per tester)
- Gloves
- Paper towels
- Spray bottle of bleach and water solution (2 tablespoons of bleach diluted in 32 oz of water) or sanitation wipes.
- Trash can
- Cups (4) the number of study preferences (i.e. if you are testing 6 participants you would need 24 cups)
- Lids (4 the number of taste preferences)
- Permanent Marker Sharpie
- Child tables (1) and chairs (2)

Setting up the testing environment:
Tasting should be performed in an area where distractions to the child being tested are minimal. Use tables and chairs that are attractive and comfortable to the children and on their level.

Setting up the dining room:
The Niccolls Eating Laboratory will be used to host children. At each taste activity, one child sized table, and two chairs will be arranged in the room. All furniture arrangement and place settings will be consistent for each taste activity for all participant dyads.

A. The child size table will be arranged in the same position (see figure 1).
B. The child size chairs in the same position (see figure 1)
C. Camera will be placed so that child's reactions and facial expressions can be captured.
D. Set up: napkins, spoon, water pitcher and small water cup(see figure3)
E. Décor set up. Plants, carpet and other accessories will be used to decorate the dining area and placed in the same position (see figure 2).

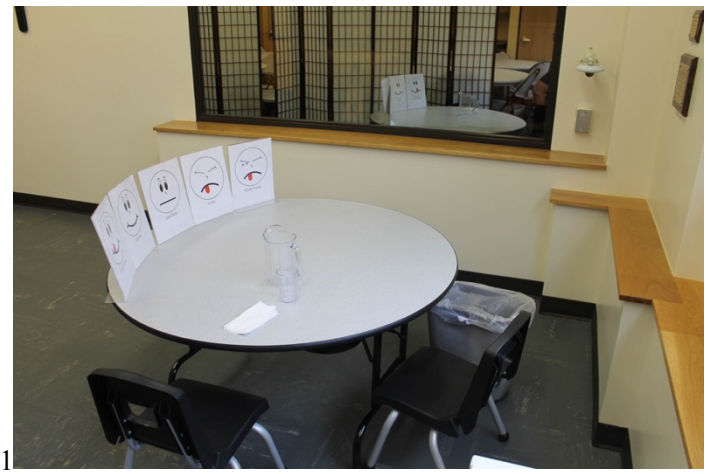
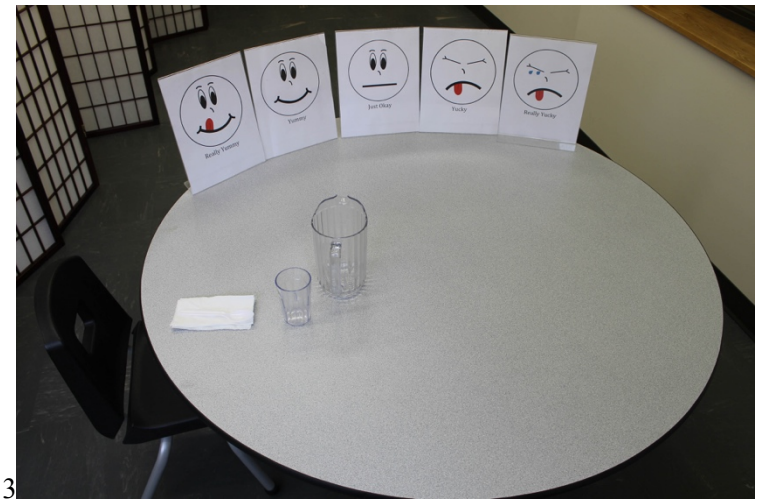
Figure 1 

Figure 2 

Figure 3 

Food Textures	Portion size	Number of portions on serving cup
Smooth	10 grams	1
Pearly	12.5 grams	1
Gritty	12.5 grams	1
Grainy	11 grams	1
Lumpy	10 grams	1
Ropy	10 grams	1

Presentation:
The tables will be set up with a water pitcher, disposable drinking cups, disposable napkins and spoon. The child will be presented with a tray with six disposable cups, each containing different textures per cup.

Serving the Snack:

A. Portion control in serving dishes. Portion control for child will include five yogurt textures each weighing approximately _____.
   a. *Weigh each yogurt products*. Prior to presenting yogurt products in the dining area, the yogurt in each serving dish will be weighed and recorded.
   b. Record data on the spreadsheet and tablet
B. Place all cups in the same order on the serving cart.
   a. Serve food by bringing the serving cart into the Eating Laboratory and placing the cups on the table in the SAME ORDER and SAME LOCATION.
   b. Each cup of yogurt will be presented in the same order for each child.
C. Conduct Snack Activity

Snack Activity:

Child Code: _____ Date: _____ Time of snack: _____

Exposure #: _____

Ask *"Would you like to help us with the project today?"*
Child assent given? YES ☐NO ☐

Ask *"Can we video tape the tasting activity?"*
Child assent given? YES ☐NO ☐

- Obtain child assent. If the child does not give assent, reschedule for another day.

Does the child have any allergies?: (circle) YES NO NO RESPONSE

Ask the child "Do you eat yogurt?": (circle) YES NO NO RESPONSE

- ALWAYS CHECK FOR ALLERGIES BEFORE YOU BEGIN TESTING A CHILD!

- Hunger Dolls give children a visual to assess their own hunger. Hunger is a cofactor for how much yogurt a child consumes.

- Each child is asked to rate his or her preferences for yogurt products in different textures. There are six textures to be presented and served:

Textures

1) Smooth
2) Pearly
3) Gritty
4) Grainy
5) Lumpy
6) Ropy

- ALWAYS CHECK FOR ALLERGIES BEFORE YOU BEGIN TESTING A CHILD!

- The containers of all samples will be placed on a tray table out of the child's line of sight to prevent distraction.

Tell the child:

"I'd like to ask you to play the tasting game. In the tasting game, you get to taste some yogurts and then tell me how they taste to you."

- [Present the three cartoon pictures, talking about each one, one at a time]

Yummy Just OK Yucky

"You will use these 3 pictures to tell me how you think the foods taste. "

- Pick up the *Yummy* face and show it to the child. Tell the child:

"This is a picture of a Yummy face. See how he/she is smiling? That means he/she likes it and thinks that it is yummy. "

- Pick up the *Yucky* face and show it to the child. Tell the child:

"This picture is of a Yucky face. See how he/she is frowning? That means he/she doesn't like it and thinks that it is yucky.

- Pick up the *Just OK* face and show it to the child. Tell the child:

"This is the Just OK face. See how he/she isn't smiling and isn't frowning? That means he/she thinks it's Just OK. It's not yummy or yucky."

- Stack three faces together and stand one picture up on table and ask:

"What face is this?"

If the child answers correctly, stand another picture up on table and ask, one at a time.

"So this is the Yummy face, he/she is smiling; this is the Yucky face, he/she is frowning; this is the Just OK face, he/she isn't smiling and frowning.

Check for understanding:

- Hand the point to the child and ask:

"If you thought a food was Yummy and you liked it, which face would you point to?" (The child should point to the Yummy face)

"If you thought a food was Yucky and you didn't like it, which face would you point to?" (The child should point to the Yucky face)

"If you thought a food was Just OK, which face would you point to?" (The child should point to the Just OK face)

"Great! Now we are ready to play the tasting game! Let's try some yogurts."

If the child is not able to point to the correct faces, re-teach the task and ask them to identify the faces again. If the child is not able to identify faces correctly after two attempts, reschedule for another day.

After a clear understanding of the faces has been established:

- Place all the yogurts on a tray and show them to the child. Ask the child to select a yogurt to try.

Say, *"Please take one cup to try."*

- If the child takes the serving spoon out of the cup, but doesn't take the cup from the tray, encourage him or her to take the whole cup.
- Once the child takes the cup, take the tray away and set it aside.
- Note the order in which the child chose the yogurt by assigning a 1 to the first yogurt the child chooses to try, and do so consecutively until the last yogurt the child tries is number 5.
- If the child refuses, encourage the child once. When encouraging a child, you can say something like:

"Go ahead and take a bite, and if you want you can spit it back out."

- If a child refuses first five yogurt textures, the last yogurt cup handled can be given an Order (1). The rest will only get marked as Refusal.
- After the child takes a bite, say to the child:

"Put the cup in front of the face that looks like how it tastes to you."

- You may need to prompt them with: *"Is the yogurt Yummy? Yucky? Or Just Ok?"* Always use a blank face expression when prompting them.
- After they place it in front of a face, ask them for the name of the face.

"What face is that?'

- And then verify by asking:

"*Does that mean that you think it is Yummy? Yucky? Or Just Ok?"*

- Make sure to record the appropriate rating and order under the appropriate face in line with the appropriate yogurt textures.
- If more than one texture is placed in front of a face (Yummy, Yucky, or Just Okay) ask the child:

"Which of these yogurts did you think was the yummiest?"

- Mark a 1 under "Rank" for the yogurt the child signifies as the yummiest.
- Mark a 2 under "Rank" for the yogurt the child *did NOT* signify as the yummiest i.e. the second yummiest of the two yogurts
- If the child placed yogurts in front of different faces, leave the "Rank" column empty.

"*Great! Maybe we can play it again sometime"*

"Can we go next door and measure your height and weight? It's pretty neat if you want to try."

Take the child to be measured:

- Have the child remove his/her shoes
- Have the child stand in front of the tape measurer with heels pressed against the wall.
- Make sure the child is not leaning against the wall.
- Have the child look straight ahead, at the stickers on the wall in front of the child. (make sure the child's chin is down).
- Measure the child's height accurately by placing a clipboard on the child's head. ASK FIRST
    - After you get the measurement point to the tape measure to show the child how tall he/she is.
- Bring the child to the scale and have the child stand still on it so that you can accurately gather the child's weight.

Finishing Activity:

I. From the observation room, closing of the activity will be noted and server will be informed to collect the food items.
II. After activities, all cups and serving dishes will be gathered onto the serving cart and brought back into the Food Laboratory.

Reminder: *The importance of writing notes after an assessment cannot be overemphasized.* If any part of the assessment seems a bit unusual to you, take the time to write a note before you start again with another child.

NOTES:

DEFINITIONS:

DO NOT CHOOSE A FACE FOR THE FOLLOWING:

Refusal: not interacting with the **food** in anyway – not touching, tasting, smelling, licking, etc. **If a child picks up the cup but does not touch the food it is a refusal**. If they pick up the cup but do not display any other behaviors, you can **mark an order, but not a face**. Each type of yogurt is separate from the next and the test should continue on as long as the child is willing or able regardless if they refuse previous yogurt or not.

Touching: is the process of physically touching the yogurt. You cannot mark a face if all they do is touch it.

AT THIS POINT, YOU CAN WRITE AN ORDER, AND A FACE:

Smelling: is the process of inhaling odor with your nasal passage (nose)

Licking: is the action of passing the tongue over a surface.

Spitting: is when the child has placed it in their mouth and then taken it back out again.

Swallowing: is the process of passing food into the mouth, down the pharynx, and into the esophagus.

Between Testing Children

- Double check your recording sheet or tablet. Did you record:
  - Child ID
  - Assessor initials
  - Date and Time
  - Does EVERY yogurt have an order, rating, and behavior OR is "refused" marked
- Throw out the tasting cups. Any cup that is presented and served, regardless of whether or not the child touched the cup, must be disposed of.
- Wipe down trays and testing station with bleach and water solution.
- Prepare a tasting tray for the next child.

Taking down the testing stations:

- Clean up station. Wipe down table and chairs with water and bleach solution. Wipe trays and faces with water/bleach solution after final testing.

- Clean up any spilled yogurt.

- Dispose of all cups, lids, water bottles, etc. Pack up all supplies in identified tubs and bags. Check for any extra yogurt or trays not used and keep in the refrigerator (in a.m.), or dispose of left overs (in p.m.).

Appendix B

Hunger Dolls

FULL	NEUTRAL	HUNGRY
		

Match the sex of the doll with the sex of the child i.e. his/hers

Tell the child:

"*I have some friends I'd like you to meet. Do you want to meet them?"*

Pull out the hunger dolls one at a time, beginning with the hungry hunger doll, followed by neutral hunger doll and end of full hunger doll. Say:

"This one is very hungry. See how his/her tummy is very empty? That means he/she is very hungry."

"This one is not really hungry and not really full. See how his/her tummy is not really full and not really empty? That means that he/she is not really hungry and not really full."

"This one is really full. See how his/her tummy is filled all the way up? That means he/she is really full."

Check for understanding: Mix the dolls up and ask:

"Can you show me which one of my friends is really hungry?"
Wait for the child to point to the hungry doll.
"Yes, you can point to this doll if your tummy is feeling really hungry."

"Can you show me which one of my friends in not really hungry and not really full?"
Wait for the child to point to the neutral doll.
"Yes, you can point to this doll if your tummy is not really hungry and not really full."

"Can you show me which one of my friends is really full?"
Wait for the child to point to the full doll.
"Yes, you can point to this doll if your tummy feeling really full."

Wait for the child to correctly identify each doll, and then ask:
"Can you tell me how hungry you're feeling right now?"

Appendix C

Demographic Survey

Thank you for participating in our study! We would like to learn about your child's consumption of yogurt.

Yogurt is in the Dairy Group. The USDA's Choose My Plate counts 1 cup (8 fluid ounces) of yogurt as 1 serving in the Dairy Group. 1 small container (6 ounces) is considered ¾ serving.

Please answer the following questions. If you have more than one child who is between the ages of 3-5 years, please select the child who will be participating in the study.

1. In a typical DAY, how many servings of yogurt products does your child consume for:
   Breakfast _____cups
   Lunch _____cups
   Dinner _____cups

2. In a typical DAY, how many servings of yogurt products does your child consume for:
   Snack one _____cups
   Snack two _____cups
   Snack three _____cups

3. What type of yogurt do you typically select for your child?
   a. Regular
   b. Low-fat
   c. Non-fat or Greek

4. What brand of yogurt do you typically purchase?
   a. Yoplait
   b. Chobani
   c. Fage
   d. Dannon
   e. Dannon Activia
   f. Dannon Oikos
   g. Nancy's Organic Yogurt
   h. Other _____

Child's Information

1. What is your child's birthday (MM/DD/YYYY) _____

2. What is your child's gender? (Mark one)
   - □ Male
   - □ Female

3. Does your child have milk allergies or lactose intolerance? (Circle one)
   No Yes If yes, please specify _____
4. What is your relationship to this child? (Circle one)
   a. Mother
   b. Father
   c. Grandparent
   d. Childcare provider
   e. Other (please specify_____)

Your Information

1. What is your highest level of education? (Mark one)
   - □ Some high school
   - □ High school diploma or GED
   - □ Some college
   - □ 2 year degree (Associate's degree)
   - □ 4 year degree (Bachelor's degree)
   - □ Graduate Master's Degree
   - □ Graduate Doctoral Degree

2. What is your total household income? (Mark one)
   - □ Less than $35,000/year
   - □ $35,000 - $41,999/year
   - □ $42,000 - $51,999/year
   - □ $52,000 - $58,999/year
   - □ $59,000 - $73,999/year
   - □ Over $74,000/ year

3. What is your current employment status? (Mark one)
   - □ I chose not to work in order to be home with my child/children
   - □ Unemployed and looking for work
   - □ I work part-time
   - □ I worked full-time
   - □ Other, please tell us_____

4. Which group best describes you? (Mark one)
   - ☐ White
   - ☐ Hispanic or Latino
   - ☐ Black or African American
   - ☐ American Indian or Alaska Native
   - ☐ Asian or Asian American
   - ☐ Hawaiian or North Pacific Islander
   - ☐ Other (please specify): _____

5. What is your current marital status? (Mark one)
   - ☐ Single
   - ☐ Divorced
   - ☐ Separated
   - ☐ Married or in a committed relationship

6. What is your current weight? _____ Pounds *or* _____ kg
   (if you are pregnant, was your pre-pregnancy weight)

7. What is your height? _____ Feet _____ Inches *or* _____ cm

Thank you for completing the questionnaire!! Please contact Dr. Ramsay if you have questions.

Appendix D

Yogurt Production Protocol

1) Weigh the ingredients as per recipe.
2) Mix the dry ingredients with milk and stir until dissolving but don't whip.
3) Pasteurize the mix at 85 degrees Celsius for 30 minutes in the Microprocessor Controlled 280 Series Water Bath.
4) Homogenize at 500/1000 PSI using Microfluidics M-110 P Homogenizer.
5) Check the temperature to make sure the mix is at 42.2 degrees Celsius.
6) Add 1 ml/l vanilla flavor to the mix before inoculation.
7) Add specific 2-3% starter culture per recipe to the mix for and incubate for 6-8 hours at 42.2. Check pH of the mixture every hour until pH reaches no greater than 4.6.
8) Break the gels at pH 4.6 with mild agitation.
9) Package and refrigerate.
10) Measure the viscosity using Brookfield Viscometer to ensure the viscosity is at the desired level (at room temperature).
    - select the right spindle number, which is number 3 for medium viscose materials (the min viscosity range is obtained by using the largest spindle at the highest speed).
    - Use 12 rpm for speed and let it run for 8-10 revolutions.

Appendix E

Yogurt Recipes

Smooth Yogurt

	Ingredients	Amount
1.	1% Milk	283 g
2.	Skim Milk	639 g
3.	Sucrose	65 g
4.	Skim Milk Powder	9 g
5.	Crown™ Stabilizer	12 g

Desired viscosity: 20-25 Pa/s
Culture type: YO-MIX™ Culture 511

Grainy Yogurt

	Ingredients	Amount
1.	1% Milk	283 g
2.	Skim Milk	639 g
3.	Sucrose	65 g
4.	Skim Milk Powder	6 g
5.	Hi Dress 6682 Stabilizer	16 g

Desired viscosity: 10-15 Pa/s
Culture type: YO-MIX™ Culture 511

Lumpy Yogurt

	Ingredients	Amount
1.	1% Milk	284 g
2.	Skim Milk	619 g
3.	Sucrose	75 g
4.	Skim Milk Powder	2 g
5.	Crown™ Stabilizer	30 g

Desired viscosity: 65-70 Pa/s
Culture type: YO-MIX™ Culture 495

Ropy Yogurt

	Ingredients	Amount
1.	1% Milk	282 g
2.	Skim Milk	639 g
3.	Sucrose	65 g
4.	Skim Milk Powder	19 g

Desired viscosity: 12-17 Pa/s
Culture type: YO-MIX™ Culture 495

Appendix F

University of Idaho

Does your child eat yogurt?

We are inviting your child between the ages of 3 and 5 participate in our study. Your child will attend the Niccolls Eating Laboratory to complete taste preference activity of yogurt 1-2 times a week for 10 weeks from 9/14/15 through 11/20/15 (both days inclusive). The activities will occur before morning and afternoon snack time to coincide with preschool schedules. Following the study, children will receive their regular snacks.

* **At the end of the study we are offering a $20 gift card.**

To learn more, please call, text, or E-mail:

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U of Idaho IRB has reviewed and approved this project for human subject participation

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