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Early Childhood Temperament And Eating Behaviors

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EARLY CHILDHOOD TEMPERAMENT AND EATING BEHAVIORS

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ABSTRACT

Childhood obesity is a nationwide epidemic associated with serious metabolic and mental health issues, as well as increased risk for obesity in adulthood. Many factors influence the development of obesity in childhood, including individual factors such as deficits in self-regulatory behaviors. This study examined associations among aspects of self-regulation and eating behaviors of young children. We hypothesized that 1) children with lower attention scores would be rated as having greater food responsiveness (FR) and poorer satiety responsiveness (SR); 2) children with poor inhibitory control would be rated as having greater FR; 3) children with poorer emotion regulation abilities would be rated as engaging in more emotional overeating (EO). Participants were 2.5-year-old children and their mothers (N=43). Children were observed during four behavioral tasks to examine attention, inhibitory control, and emotion regulation. Mothers completed questionnaires to assess child temperament and eating behavior (i.e., Early Childhood Behavior Questionnaire, Short-Form and Child Eating Behavior Questionnaire). Simple Pearson correlations and multiple linear regression modeling with interactions and adjustment for covariates were used to examine these associations. Results showed a statistically significant inverse linear relationship between attention to video and SR when PPVT was low ($-.04 \pm .02$, $p < .05$), but not when PPVT was high ($.010 \pm .02$, $p > .05$), and no association of attention with FR. In other words, for children with a low PPVT raw score, poor attention was associated with greater response to satiety cues as compared to children with high attention. This finding was opposite to that hypothesized.

Data from this cohort did not support the hypothesis that inhibitory control was associated with FR. Finally, children with fewer escape attempts from the high chair had higher EO scores (β = -.34, $p < .05$), which was contrary to *a priori* hypothesis. These results extend the literature by showing poor attention is associated with SR in very young children. More research is needed to understand the mechanisms that underlie this association and to clarify the role of other self-regulatory behaviors in eating and weight gain among very young children.

Keywords: self-regulation, eating behavior, toddlers, attention, inhibitory control, emotion regulation

DEDICATION

This project is dedicated to all the wonderful toddlers in my study and all the other toddlers, too. May we all greet the world with as much interest, curiosity, wonder, and joy as toddlers do, and just a little bit of the drama.

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TABLE OF CONTENTS

Page

ABSTRACT ii

DEDICATION iv

ACKNOWLEDGMENTS v

LIST OF TABLES ix

LIST OF FIGURES x

INTRODUCTION 1

- Prevalence of Childhood Obesity 1
- Health Problems Associated with Childhood Obesity 1
  - Metabolic Health Problems 1
  - Mental Health Problems 2
- Genetic and Environmental Influences on Childhood Obesity 3
  - The Role of Genotype in Obesity 4
  - Intrauterine Environment 6
  - Home Environment 7
- The Role of Eating Behavior and Self-regulation in Childhood Obesity 10
  - Attention 12
  - Inhibitory Control 13
  - Emotion Regulation 15
  - Developmental Level 17
- Hypotheses 18

METHODS 20

- Participants 20
- Protocol 20
- Measures 21
  - Peabody Picture Vocabulary Test, Fourth Edition (PPVT™-4) 21
  - Questionnaires 22
    - Child Eating Behavior Questionnaire (CEBQ) 22
    - Early Childhood Behavior Questionnaire – Short Form (ECBQ-SF) 24
    - Positive Affect Negative Affect Scale (PANAS) 25

Confusion Hubbub & Order Scale (CHAOS) 26
U.S. Household Food Security Survey Module 26
Observational Measures of Behavior 27
Attention Assessment 29
Video task. 29
Cards tasks. 30
Inhibitory Control 30
Food task 30
Non-food task 31
Emotion Regulation 31
High chair task.. 32
Coding Toddler Behaviors 32
Attention assessment: video task. 33
Attention assessment: cards tasks 34
Inhibitory control:food and non-food delay tasks. 35
Emotion regulation: high chair task. 36
Anthropometrics 37
Data Analysis 37
Hypothesis 1 38
Hypothesis 2 39
Hypothesis 3 40

RESULTS 42

Hypothesis 1 47
Hypothesis 2 51
Hypothesis 3 51
Exploratory Analyses 52

DISCUSSION 53

Attention 53
Inhibitory Control 57
Emotion Regulation 58
Influence of Development and Adiposity 60
Limitations and Future Directions 61
Conclusions 63

REFERENCES 65

APPENDICES 98

A UAB INSTITUTIONAL REVIEW BOARD APPROVAL LETTER 98

B CODING SHEETS 100

C TABLE C: DESCRIPTIVE STATISTICS FOR BEHAVIORAL OBSERVATION MEASURES ... 107

D TABLE D: DESCRIPTIVE STATISTICS FOR EARLY CHILDHOOD BEHAVIOR QUESTIONNAIRE ... 109

E TABLE E: DESCRIPTIVE STATISTICS FOR CHILD EATING BEHAVIOR QUESTIONNAIRE ... 111

F TABLE F: CORRELATION COEFFICIENTS FOR OUTCOME VARIABLES AND MEASURES OF ADIPOSITY AND PPVT-4 RAW SCORE ... 113

G TABLE G: CORRELATION COEFFICIENTS FOR BEHAVIORAL OBSERVATION MEASURES, EARLY CHILDHOOD BEHAVIOR QUESTIONNAIRE, AND CHILD EATING BEHAVIOR QUESTIONNAIRE ... 115

H TABLE H: CORRELATION COEFFICIENTS FOR EARLY CHLDHOOD BEHAVIOR QUESTIONNAIRE AND CHILD EATING BEHAVIOR QUESTIONNAIRE ... 117

LIST OF TABLES

Table *Page*

1 Order of Observed Behavioral Tasks 28

2 Cohen's Kappa for Video Coding 33

3 Primary Linear Regression Models for Each Hypothesis 38

4 Demographics 43

5 Correlation Coefficients for Behavioral Observation of Video Task and ECBQ-SF 45

6 Correlation Coefficients for Behavioral Observation of Cards Task and ECBQ-SF 45

7 Correlation Coefficients for Behavioral Observation of Delay Tasks and ECBQ-SF 46

8 Correlation Coefficients for Behavioral Observation of High Chair Task and ECBQ-SF 46

9 Correlation Coefficients for Behavioral Observation Measures, ECBQ-SF, and CEBQ 49

LIST OF FIGURES

Figure *Page*

1 Interaction Effect of Video Attention Variables and PPVT-4 Raw Score on Satiety Responsiveness 50

INTRODUCTION

Prevalence of Childhood Obesity

Obesity affects approximately one-third of individuals in the United States (Ogden, Carroll, Kit, & Flegal, 2014). Children are not immune from obesity, with approximately 17% obesity among 2 – 19-year-olds (Ogden et al., 2014). Although current obesity rates reflect dramatic increases over the last few decades, there is some evidence that the prevalence may be stabilizing in both adults and children. In preschool-age children, rates of obesity have decreased from 13.9% in 2003-2004 to 8.4% in 2011-2012 (Ogden et al., 2014). However, certain portions of the population still remain at high risk for obesity. For example, approximately 14% of preschoolers in families at or below the poverty level are obese (Ogden et al., 2014), and 20.8% of African American preschoolers are obese, compared to 15.9% of Caucasian preschoolers (Anderson & Whitaker, 2009).

Health Problems Associated with Childhood Obesity

Metabolic Health Problems

Childhood obesity is associated with serious metabolic health conditions. Obesity-related diseases once thought to only affect adults are becoming more prevalent in children, including high blood pressure, type 2 diabetes, and non-alcoholic fatty liver disease (Daniels, 2006). Obesity in childhood may set up a lifetime of obesity and comorbid health problems, with obese children having a much greater risk of becoming obese as adults, as well as having more severe obesity than those who were not obese during childhood (Biro & Wien, 2010; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). A review by Serdula and colleagues (1993) found that the risk of adult obesity was at least twice as high for obese, compared to non-obese children, and these findings were maintained for all studies and across all ages reviewed. As with obesity itself, there are disparities in obesity-related metabolic health problems, with overweight and obese African American children having a greater incidence of sleep-disordered breathing, type II diabetes mellitus, hypertension, and greater systolic blood pressure (Weiss & Kaufman, 2008). In addition, overweight and obese children of families with low socioeconomic status are more likely to develop type II diabetes and obesity in adulthood (Tamayo, Christian, & Rathmann, 2010). Consequently, it is important to understand the etiology of obesity, particularly in high-risk groups, so that the development of obesity may be prevented during childhood.

Mental Health Problems

In general, children who are overweight or obese are more likely than normal weight peers to suffer from psychological disorders, behavior problems, disordered eating, low self-esteem, and sleep issues (Pulgarón, 2013). A review found that overweight and obese children have higher rates of depression and anxiety (Kalarchian & Marcus, 2012). In addition, children who are overweight or obese have considerably higher rates of attention deficit/hyperactivity disorder (ADHD) (Cortese et al., 2008; Erhart et al., 2012; Ptacek, Kuzelova, Paclt, Zukov, & Fischer, 2009). ADHD is one of the most common behavioral disorders in children that involves problems with inattention, hyperactivity, and impulsiveness which affects social interactions, work or school productivity, and self-esteem (American Psychiatric Association, 2013). The direction of the association between obesity and ADHD is not yet clear, but studies have shown that ADHD symptoms in childhood increase the risk of obesity in adulthood (Cortese et al., 2013). Furthermore, the more ADHD symptoms there are, the greater the risk of obesity (Fuemmeler, Ostbye, Yang, McClernon, & Kollins, 2011). One proposed underlying mechanism is that the impulsivity, inattention, and poor behavioral regulation that is characteristic of ADHD contributes to weight gain via dysregulated eating patterns (Davis, 2010). Additionally, school-age children and adolescents with ADHD may have a propensity to use food as gratification more than peers without ADHD (Agranat-Meged et al., 2005; Waring & Lapane, 2008). To date, however, relatively few studies have examined whether the symptoms associated with ADHD are also associated with specific eating behaviors in early childhood that would ultimately increase the risk for obesity.

Genetic and Environmental Influences on Childhood Obesity

The etiology of childhood obesity is complex and likely due to multiple factors ranging from genetics to individual differences in children's eating behaviors. The following is a brief review of what is known about the role of genes and environment on children's risk for obesity, followed by a more specific focus on the role of children's behavior in the development of obesity.

The Role of Genotype in Obesity

In rare cases, obesity may be due to the effect of one genetic mutation. However, in most cases, obesity is a polygenic disorder attributed to a variety of genes and tempered by gene-gene and gene-environment interactions (Spruijt-Metz, 2011). In epidemiological studies, heritability of obesity in children has been shown to be variable and may change with age (Carnell, Haworth, Plomin, & Wardle, 2008; Haworth et al., 2008; Pietilainen et al., 1999; Wardle, Carnell, Haworth, & Plomin, 2008). The rapid increase in the prevalence of obesity in the last few decades however, argues against an evolutionary change in genetics as the main explanation for obesity (Hewitt, 1997). Furthermore, despite the identification of a number of genetic loci that are associated with obesity, research suggests that the cumulative effect of these polymorphisms on obesity is modest, explaining less than 1% of the variance in body mass index (BMI) (Li et al., 2010). Thus, although underlying genotype may contribute to obesity risk, it is likely that the environment also plays a significant role in obesity either independently, or through interactions with genotype. Indeed, one prevailing hypothesis that is consistent with an interactive contribution of genotype and environment refers to a "thrifty genotype". This hypothesis posits that individuals were more likely to survive and reproduce under food scarcity conditions if they could efficiently conserve and store energy, but now in an environment characterized by abundant energy dense foods, those "thrifty" genes may contribute to obesity (Hill, Wyatt, Reed, & Peters, 2003; Neel, 1962). Consequently, although genotype may be a useful marker of risk for obesity, effects of genotype may only be unmasked by specific features in the environment.

Another hypothesis that focuses on the combination of a biological basis of obesity is the reward deficiency syndrome (Blum, Cull, Braverman, & Comings, 1996). An individual with this deficiency lacks a sufficient number of dopamine 2 receptors in the striatum. These receptors are mediators for pleasure; the theory notes that individuals engage in behaviors that increase dopamine concentrations to create homeostasis (Blum, Sheridan, et al., 1996). In regard to eating behaviors, researchers suggest that binge-eating may be a behavior engaged in to compensate for a hypoactive dopaminergic system (Volkow, Fowler, Wang, & Swanson, 2004). Obese adults have been shown to have low dopamine receptor density (Wang et al., 2001), less dopamine receptor availability (Chen et al., 2008), and reduced dopamine D2 receptors (Michaelides et al., 2012) than non-obese adults; moreover, obese subjects share similar dopamine reductions as individuals addicted to substances (Blum, Thanos, & Gold, 2014). In obese children, imaging research has shown less brain activation in the dopaminergic reward system in response to food cues (Davids et al., 2010) and to food consumption compared to normal weight children (Stice, Spoor, Bohan, & Small, 2008), suggesting the need for more stimuli to receive a similar reward response in the brain.

FMRI studies have shown that individuals addicted to food may have less sensitivity to satiety, especially when consuming highly palatable foods (Gearhardt et al., 2011). Specifically, hypoactivation was found in the lateral orbitofrontal cortex, which is responsible for inhibitory control in the presence of reward cues (Goldstein et al., 2007). Much like a drug addiction, bingeing takes place as tolerance of highly palatable foods increases; it takes more of a food to feel the same "high" or reduction of anxiety or pain (Fortuna, 2012). Reward circuitry in the brain overlaps with neurocircuitry of energy metabolism, with these regions having increased sensitivity during food deprivation and decreased sensitivity during satiety, so that disruption of either of these systems may contribute to obesity through overeating (Volkow, Wang, & Baler, 2011). As is seen in overweight adults, overweight school-age children have been shown to be more sensitive to reward, making them more likely to overeat highly palatable foods (Davison & Birch, 2004; Pagoto et al., 2009; Verbeken, Braet, Lammertyn, Goossens, & Moens, , 2012). As with genotype, certain environmental factors must be present (e.g., highly palatable foods) in addition to genetic or biological components for a child to be overweight or obese.

Intrauterine Environment

The intrauterine environment continues to receive attention for the impact it has on the health and development of children, especially in regard to the early development of obesity. A number of maternal factors from pregnancy, including maternal obesity, gestational weight gain, gestational diabetes, and maternal glucose concentrations, are associated with excess fetal growth (Boney, Verma, Tucker, & Vohr, 2005; Hillier et al., 2007; Oken & Gillman, 2012; Oken, Rifas-Shiman, Field, Frazier, & Giliman, 2008; Pettitt, 2001). Infants born to obese mothers have greater relative birth weight and, in some studies, are also longer at birth (Chandler-Laney, Gower, & Fields, 2013; Knight et al., 2007; Sewell, Houston, Super, & Catalano, 2006), and epidemiological studies consistently demonstrate a relationship between birth weight and BMI in both childhood and adulthood (Rasmussen & Johansson, 1998; Reilly et al., 2005; Sorensen et al., 1997; Yu et al., 2011). There is also evidence that, aside from fetal overgrowth, an intrauterine environment complicated by pre-existing or gestational diabetes, or even moderately elevated maternal glucose, may predispose children to obesity in childhood (Chandler-Laney, Bush, Rouse, Mancuso, & Gower, 2011; Fraser et al., 2010; Hillier et al., 2007; Whitaker, 2004). This literature implies that maternal obesity and comorbid metabolic health conditions during pregnancy may pre-program children to be susceptible to excess weight gain in later life. For example, women who are obese tend to have higher circulating glucose concentrations during pregnancy, and because glucose crosses the placenta in proportion to the concentration in maternal circulation, it increases the risk for fetal overgrowth (Catalano et al., 2012; Chandler-Laney et al., 2011; The HAPO Study Cooperative Research Group, 2009). Furthermore, the excess glucose delivery from maternal circulation may program the fetal pancreas to hypersecrete insulin, and this effect appears to persist across childhood (Bush et al., 2011; Chandler-Laney et al., 2011; Metzger, 2007). Insulin itself promotes growth, and prospective studies among children have shown that hyperinsulinemia is associated with excess weight gain (Johnson, Figueroa-Colon, Huang, Dwyer, & Goran, 2001; Odeleye, de Courten, Pettitt, & Ravussin, 1997). An alternate explanation is that chronic inflammation caused by maternal obesity during pregnancy contributes to later obesity in children by impairing the formation of the placenta, which would interfere with blood supply to the fetus and potentially alter metabolism (King, 2006; Larsson et al., 1986). Consequently, in addition to a genetic predisposition toward excess weight gain, children of obese mothers may experience an intrauterine environment that alters metabolic programming in a manner that increases their susceptibility toward obesity.

Home Environment

Children born to obese parents are also often exposed to greater obesogenic conditions in the home environment. A review of the impact of environmental and genetic factors on obesity in twins revealed that common environmental factors had a significant impact on obesity through childhood until adolescence (Silventoinen, Rokholm, Kaprio, & Sorensen, 2010). Conditions in the home environment that may be related to obesity include quality of foods available as well as parental feeding practices.

With respect to the food environment, it is known that the majority of children do not meet recommended national health guidelines for fruit, juice, and vegetable intake (Domel et al., 1994; Patterson, Block, Rosenburger, Pee, & Kahle, 1990). Less than a quarter of youth consume 5 servings per day of fruits and vegetables and intakes typically average 1.5-2.5 servings per day (Domel et al., 1994; Murphy, Castillo, Martorell, & Mendoza, 1990). Low availability and access to fruits and vegetables in the home environment greatly reduces the number of opportunities for children to get recommended servings of these foods (Baranowski et al., 1993; Kirby, Baranowski, Reynolds, Taylor, & Binkley, 1995), and there is a strong association among parental and children's intake for fat, fruit, and vegetables (van der Horst et al., 2007). Consequently, parents play an important role in the quality of the child's diet, both in terms of providing access to healthy food options, and in terms of modeling a healthy diet.

Parental feeding practices have a major impact during childhood on a child's emerging food preferences (Birch, Wolfe-Marlin, & Rotter, 1984; Birch, Zimmerman, & Hind, 1980), as well as food intake and the development of self-regulation of food intake (Birch, McPhee, Shoba, Steinberg, & Krehbiel, 1987). Children of parents with controlling feeding practices, such as close monitoring or restriction of the types and amount of food their child can eat, are more likely to be overweight, as shown in a review by Hurley, Cross and Hughes (2011). It has been hypothesized that parental control impedes a child's opportunity to respond to internal hunger and satiety cues by refocusing his/her attention to aspects of the eating environment (Birch et al., 1987; Costanzo & Woody, 1985; Thompson, 2010). For example, parents may reward children with sweets and pressure them to eat fruits and vegetables – practices that would enhance the rewarding value of preferred foods and create greater dislike for foods children are pressured to eat (Birch & Fisher, 2000; Birch & Krahnstoever-Davison, 2001). In sum, parental feeding practices are an important component of a child's home environment which may impact eating habits and weight gain.

As shown by the brief review above, there is a large body of literature showing associations among environmental factors and childhood obesity. Ultimately though, how children respond to their environment will determine their risk for the development of obesity. In other words, despite the opportunity to overeat, a child may not do so if they have adequate ability to self-regulate their intake. The ability to self-regulate may be determined by the underlying genotype or by a programmed effect from the intrauterine environment, but irrespective of the origin, it would be of interest to examine the role of general self-regulation abilities in the eating behavior of young children before overt obesity develops.

The Role of Eating Behavior and Self-regulation in Childhood Obesity

Children's eating behavior likely contributes to obesity but remains relatively understudied among young children. A few studies have examined children's response to food cues, enjoyment of eating, speed of eating, and satiety responsiveness. In children aged 3-5 years and 8-11 years, BMI was inversely associated with satiety responsiveness and positively associated with food responsiveness (Carnell & Wardle, 2008). In another study, four and five year old children who were overweight showed greater food responsiveness and enjoyment of food and less satiety responsiveness, slowness in eating, and food fussiness (Spence, 2011). Similar results were also found in studies of older children (Carnell et al., 2008; Webber, Hill, Saxton, Van Jaarsveld, & Wardle, 2009). These studies suggest that children who are overweight or obese experience difficulties in regulating energy intake; however, it is not yet clear whether this deficit is specific to food or is a more global issue related to self-regulation.

As discussed earlier, many children who are overweight and obese have ADHD or ADHD-like symptoms. One of the central features of ADHD is difficulty with self-regulation. Self-regulation is a broad term used to define the ability to adequately regulate responses to environmental stimuli. Self-regulation can be thought of as an internal thermostat, sensing and measuring aspects of the environment and then communicating with other systems (i.e., language or motor) to select and carry out a response (Florez, 2011). Self-regulatory behaviors are evident very early in life, for example, when an infant stops feeding to indicate satiety (Birch & Deysher, 1985). By toddlerhood, self-regulatory abilities are used to control emotions and behavior (Graziano, Reavis, Keane, & Calkins, 2007; Rueda, Posner, & Rothbart, 2005). Self-regulation is associated with a variety of positive life outcomes including physical and mental health, academic achievement, healthy interpersonal relationships, and happiness (Duckworth & Seligman, 2005; Mischel, Shoda, & Peake, 1988; Moffitt et al., 2011; Shoda, Mischel, & Peake, 1990; Tangney, Baumeister, & Boone, 2004; Tsukayama, Toomey, Faith, & Duckworth, 2010). Deficits in self-regulatory abilities are associated with a vast range of personal and social issues as well as psychological disorders, including aggression, anxiety, criminal behavior, depression and impulse control problems (Avakame, 1998; Baumeister, Heatherton, & Tice, 1994; Moffitt et al., 2011; Tangney et al., 2004; Tremblay, Masse, Vitaro, & Dobkin, 1995).

Deficits in self-regulation skills of children have also been associated with greater BMI (Francis & Susman, 2009; Graziano, Kelleher, Calkins, Keane, & O'Brien, 2013; Graziano, Calkins, & Keane, 2010; Seeyave et al., 2009). Also conceptualized as temperament in young children, components of self-regulation have been suggested to play a role in obesogenic eating behaviors (Anzman-Frasca, Stifter, & Birch, 2012; Bergmeier, Skouteris, Horwood, Hooley, & Richardson, 2013; Haycraft, Farrow, Meyer, Powell, & Blissett, 2011), including what and how children eat as well as decisions about starting and stopping eating (Blundell & Cooling, 2000; Blundell et al., 2005).

There are a number of different components of self-regulation, including attention, inhibitory control of behavior, and the regulation of emotion. Although inter-related, it is useful to consider these components separately in discussions about their role in obesity, because they may exert different influences on feeding behavior. The impact of developmental level on self-regulatory abilities and eating behaviors will also be discussed.

Attention

Attention is an important component of self-regulation that refers to the ability to maintain focus on a certain stimulus. Inattention has been linked to obesity in many (Khalife et al., 2014; Lange, Thamotharan, Sferra, Ramos, & Fields, 2014; Pauli-Pott, Albayrak, Hebebrand, & Pott, 2010), but not all (Drukker, Wojciechowski, Feron, Mengelers, & Van Os, 2009) studies. For example, children who exhibit inattention and hyperactivity at 5 years of age are more likely to be obese in adulthood, and when these behaviors persist throughout childhood, the obesity risk increases even more (White, Nicholls, Christie, Cole, & Viner, 2012). In a Go/No-Go task in which children must press a button when a specific symbol appears on the screen and refrain from pressing the button when a different symbol appears on the screen, school-age children who are obese have more errors due to inattention than do normal weight children (Kamijo et al., 2012; Pauli-Pott et al., 2010).

A potential role for inattention in obesity is also supported by studies of television viewing and body weight or eating behaviors. Research has consistently shown that from preschool through high school, children who eat meals or snacks while watching television have greater weight than do those who do not eat while watching television (Francis, Lee, & Birch, 2003; Phillips et al., 2004; Utter, Neumark-Sztainer, Jeffery, & Story, 2003). On the other hand, reducing distractions during meals, such as turning off the television, has been shown to lead to better eating behaviors and shorter meal durations (Powers et al., 2005; Stark, Powers, Jelalian, Rape, & Miller, 1994). In an experimental study of adult women, Bellisle and Dalix (2001) showed that women ate more when listening to a recorded story during the meal as compared to a meal without the auditory stimulus, and the authors attributed this difference to impaired self-control of intake when attention was directed elsewhere. Although the exact mechanism by which inattention is related to obesity is not known, researchers have suggested that children with short attention spans may be less likely to recognize internal satiety cues and thus more likely to eat in response to external food cues or to engage in mindless eating (Faith & Hittner, 2010). Few studies have examined this association in young children.

Inhibitory Control

Inhibitory control is the ability to withhold responses that may be inappropriate, to end an ongoing response, and to resist attending to distracting stimuli (Barkley, 1997; Nigg, 2000). Impulsivity also refers to the inability to withhold inappropriate responses, and this term is often used interchangeably with inhibitory control even though it reflects just one of the characteristics of impaired inhibitory control. Research indicates that the impulsive component of inhibitory control may contribute to the onset as well as the maintenance of obesity (Fields, Sabet, Peal, & Reynolds, 2011), and school-age children who are overweight or obese consistently show weaker inhibitory control than children of normal weight (Nederkoorn, Braet, Van Eijs, Tanghe, & Jansen, 2006; Nederkoorn, Jansen, Mulkens, & Jansen, 2006; Wirt, Hundsdorfer, Schreiber, Kesztyus, & Steinacker, 2014). In performance-based tasks administered in the laboratory, children who are overweight show deficits in inhibitory control and engage in more reward-directed behavior (Verbeken, Braet, Claus, Nederkoorn, & Oosterlaan, 2009). Although there seem to be global deficits in inhibitory control in children who are overweight or obese (Braet, Claus, Verbeken, & Vlierberghe, 2007; Nederkoorn, Braet, et al., 2006;

Nederkoorn, Jansen, et al., 2006), younger children especially display deficits in the impulsive component of inhibitory control, with rapid and inaccurate responses to laboratory-based challenges, such as the Go/No-Go task (described previously, in *Attention* section) (Pauli-Pott et al., 2010). Although most studies show an association between inhibitory control and obesity, some do not (Geller, Keane, & Scheirer, 1981), and there is some suggestion that inhibitory control is more closely related to weight gain when children are young (Pauli-Pott et al., 2010).

One mechanism by which impaired inhibitory control, and impulsivity specifically, may contribute to obesity is via greater response to food cues. Overall food intake is greater in adult women who are impulsive, even if they are of normal weight (Guerrieri et al., 2007), and children with poor inhibitory control as measured by laboratory measures and parent-report are less able to regulate their energy intake (Pieper & Laugero, 2013; Tan & Holub, 2011). Obese children are at greater risk for loss of control eating (Kalarchian & Marcus, 2012) and have been shown to increase food intake after exposure to the smell or a small preload of a highly palatable food (Jansen et al., 2003). Impulsivity also plays a role in food choice, with impulsive individuals being more likely to eat highly palatable foods and to satisfy food cravings (Guerrieri et al., 2007; Hetherington, 2007; Ouwens, van Strien, & van Leeuwe, 2009).

Delay of gratification tasks have been used to assess inhibitory control in the laboratory. In one protocol, the child is given a small amount of a desired food, such as a marshmallow, and told that if he or she waits before eating it, more will be provided in a few minutes (Mischel, Ebbesen, & Raskoff Zeiss, 1972). School-age children who are overweight have more difficulty waiting in delay of gratification tasks, and more often choose the smaller immediate reward rather than waiting for the larger reward (Bonato & Boland, 1983; Geller et al., 1981). Conversely, preschoolers who are able to delay gratification subsequently have a lower BMI in childhood and into adulthood (Schlam, Wilson, Shoda, Mischel, & Ayduk, 2013; Seeyave et al., 2009). It is not clear, however, whether the inhibitory control displayed in these food-related protocols generalizes to non-food related protocols.

A comparable non-food related challenge is called the “gift delay” or “prize in a box test” for which children are asked to wait a few minutes before opening a box containing a gift or prize. Those who cannot wait or who touch or shake the box before it is time to open it are rated as having poorer inhibitory control than those who do not interact with the box until told it is time to open it. Only one previous study has examined whether performance on this task is related to obesity in children, and indeed, those with poor inhibitory control at 2-years had greater BMI at 5 years of age (Graziano et al., 2010). Together with the findings reported above, it seems likely that global deficits in inhibitory control, rather than deficits only with respect to food, may be related to children’s impulsive response to food cues, which in turn, could increase risk for obesity. To our knowledge, however, previous studies have not fully explored whether a global deficit in inhibitory control is related to potentially obesogenic eating behaviors in very young children.

Emotion Regulation

Emotion regulation refers to the ability to modulate emotions in response to environmental demands (Cole, Martin, & Dennis, 2004; Gross, 1998). A child without the ability to properly cope with stress in his/her environment may engage in emotional eating or other negative eating behaviors as a way to self-regulate emotion and behavior, and over time may become obese (Leung et al., 2014). Indeed, approximately 30 percent of school-age children who are obese engage in emotional eating, and there is a linear relationship between emotional eating and BMI (Braet & VanStrien, 1997; Webber et al., 2009). Emotional overeating has been reported in children as young as 5 years old (Carper, Fisher, & Birch, 2000) and is associated with greater energy intake (Braet & VanStrien, 1997), particularly of sweet or salty energy dense foods and drinks (Nguyen-Rodriguez, Unger, & Spriujt-Metz, 2009).

An association of poor emotion regulation and eating behavior is also implied by research showing that children who have temper tantrums when food is denied are more likely to be overweight (Agras, Hammer, McNicholas, & Kraemer, 2004). The authors speculated that this association may be consequent to the parents providing food in order to reduce or prevent tantrums. It is not clear from this study, however, whether children who tantrum over food have impaired emotion regulation in general, or whether it is specific to food. In a sample of low-income preschoolers, children who were easily upset, experienced intense emotions, and had difficulties with emotion regulation were more likely to tantrum over being denied food (Leung et al., 2014), suggesting that poor emotion regulation in general may contribute to food-related tantrums. To our knowledge, no previous studies have used an objective laboratory-based test of emotion regulation to examine whether a child's ability to regulate emotion in general is associated with emotional overeating during early childhood.

Developmental Level

Previous research has revealed an association between verbal ability and development of self-regulatory ability (Kaler & Kopp, 1990; Wolfe & Bell, 2004). In very young children, verbal ability has been shown to be a reliable predictor of developmental level (Childers, Durham, & Wilson, 2016; Vance, West, & Kutsick, 1989). Researchers posit that children begin learning how to regulate their own behavior through verbal instructions from adults and more developmentally advanced peers. As self-regulatory capacity increases, children engage in overt verbalizations and eventually develop internal self-talk, which allows them to formulate thoughts and behaviors and monitor other functions, such as attention (Fuhs & Day, 2011).

Eating behavior, such as response to satiety, develops over stages, similar to other behaviors, including verbal and motor ability (Gahagan, 2012). Regulation of food intake begins during infancy (Soussignan, Schaal, & Marlier, 1999), and children's cognitive development is one of the many factors that influence the continued refinement of eating behaviors (Gahagan, 2012). As such, a child's developmental level is an important factor to consider when assessing their eating behaviors.

In summary, research continues to reveal a relationship between components of self-regulation and childhood obesity. Coupled with a genetic risk for obesity and an obesogenic environment, deficits in self-regulatory abilities may create even higher risk for developing obesity in childhood. It is important to obtain objective assessments of children's overall ability to self-regulate and to examine how this is related to their eating behaviors in order to inform potential interventions that might prevent overeating and obesity. This study adds to the current research by assessing self-regulatory ability via behavioral measures as well as parent report. In addition, this study will extend the literature by exploring the relationships among eating behaviors and temperament in toddlers, whereas most of the research in this area is in school-age children, adolescents, and adults.

Hypotheses

The overall objective of the current study was to examine whether behavioral regulation was associated with eating behaviors during early childhood. Although the literature supports a role for impaired self-regulation in obesity, few studies have used objective measures to characterize children's ability to self-regulate and whether different types of self-regulation (i.e., emotion, attention, inhibitory control) are associated with potentially obesogenic eating behaviors. In addition, very few studies have examined these associations in young children, to determine if deficits in self-regulatory behaviors contribute to the susceptibility to overeat even before obesity develops. These objectives were addressed in a cohort of 30-month-old children with the following hypotheses and aims:

Hypothesis 1. Children who are relatively inattentive will be less responsive to satiety and more responsive to food cues as compared to those with better attention regulation.

Specific Aim 1: The association between attention to a video and a cards task, objectively assessed in the laboratory, and parental report of satiety responsiveness and response to food cues will be examined in two-and-a-half-year-old children.

Hypothesis 2. Children with poor inhibitory control will be more responsive to food cues than those with better inhibitory control.

Specific Aim 2: The association between children's ability to wait for a food or non-food reward and their reported responsiveness to food will be examined.

Hypothesis 3. Children with poor emotion regulation will be reported as more likely to engage in emotional overeating than those with better emotion regulation.

Specific Aim 3: The association between children's degree of distress during confinement and their reported emotional overeating will be examined.

Additionally, given that eating behaviors and performance on the self-regulatory tasks could be impacted by children's developmental level, each hypothesis was tested with and without consideration of children's verbal development. As a secondary goal, we also examined associations of children's self-regulatory behaviors and eating behaviors with indices of adiposity at 30 months of age.

METHODS

Participants

Mother-child pairs were recruited from cohorts enrolled in prior studies to examine prenatal metabolic health and early childhood growth and from the general population. Mothers were either informed about this study during a data collection visit for the prior study, or they learned of the study from a flyer or advertisement in the university clinical research classified advertisements. All mother-child dyads were screened to assess eligibility. Children were excluded from this study if they were 1) born prior to 30 weeks gestation; 2) previously diagnosed with any medical condition known to affect normal feeding and growth; 3) unable to feed from the breast or bottle during infancy; 4) hospitalized in infancy for more than two months; 5) diagnosed with developmental delays that would preclude their ability to perform the required tasks, or 6) if the child was reported by the parent as unwilling or unable to complete study procedures.

Protocol

Participants attended one study visit when the child was 27-36 months of age. The mother and child entered a room with two research assistants. The room contained a couch and chair and a mat with crates of toys. Upon arrival, the child was invited to play with toys with one of the research assistants, to facilitate acclimation of the child to the study environment and research study staff. During this time, the other research assistant worked with the child's mother to obtain informed consent, verbally administer the questionnaires, or review questionnaires for completeness if they had been completed prior to the study visit. The questionnaires assessed children's eating behavior and self-regulation and the mother's affect. After the questionnaires were complete and the child was comfortable interacting with the research assistant, the Peabody Picture Vocabulary Test, Fourth Edition (Dunn & Dunn, 2007) was administered to assess the child's receptive vocabulary. Following this, behavioral measures of attention (i.e., video and cards tasks), inhibitory control (i.e., food delay and non-food delay tasks), and emotion regulation (i.e., high chair task) were conducted with the children. These tasks are described more fully below and were selected to correspond with the questionnaire measures of children's attention, inhibitory control, and emotion regulation, so that both observed and parent-report measures for these primary outcomes were obtained. Finally, anthropometric measures were obtained for the child (i.e., height, weight, subscapular skinfolds, triceps skinfolds, and waist skinfolds). Parents received $50 in cash at the end of the visit. This protocol was approved by University of Alabama at Birmingham's Institutional Review Board (Appendix A).

Measures

Peabody Picture Vocabulary Test, Fourth Edition (PPVT™-4)

Prior to the behavioral assessments, children were administered the Peabody Picture Vocabulary Test, Fourth Edition (PPVT™-4; Dunn & Dunn, 2007) to evaluate their verbal development. The PPVT™-4 is a norm-referenced instrument which measures receptive (hearing) vocabulary of children. For each item, the research assistant shows the child a page with four pictures on it and says a word, and the child responds by pointing to the picture that best illustrates the word's meaning. Receptive vocabulary has been shown to be a reliable predictor of IQ or developmental level in young children (Childers, Durham, & Wilson, 2016; Vance, West, & Kutsick, 1989). We used this test in the current study to provide information about the child's global development as well as his/her ability to understand verbal instructions during behavioral tasks.

Questionnaires

For the majority of participants, parental questionnaires were verbally administered during the visit by an investigator to reduce the potential for any literacy concerns to confound the data. When verbally administered, the order of questionnaires was randomized across participants. Some mothers (N=8) requested the questionnaires be provided prior to the study visit to save time. In these cases, the investigator briefly reviewed the questionnaires during the visit to ensure completion.

Child Eating Behavior Questionnaire (CEBQ)

The CEBQ is a parent-rated measure which assesses eight dimensions of eating style in children (Wardle, Sanderson, Gibson, & Rapoport, 2001). The CEBQ asks parents to rate 35 statements on a five-point scale of never, rarely, sometimes, often or always. Items load onto seven subscales: satiety responsiveness (e.g., My child gets full before his/her meal is finished); slowness in eating (e.g., My child finishes his/her meal very quickly); food fussiness (e.g., My child enjoys tasting new foods); food responsiveness (e.g., My child's always asking for food); enjoyment of eating (e.g., My child is interested in food); desire to drink (e.g., If given the chance, my child would always be having a drink); emotional undereating (e.g., My child eats less when s/he is upset); and emotional overeating (e.g., My child eats more when worried). The questionnaire was originally developed through evaluation of the existing literature and by parent interview regarding their child's eating behavior. It is designed to focus on young children ages three to eight years (Wardle et. al, 2001). This measure is internally valid, has good test-retest reliability, and has been validated against objective behavioral measures (Carnell & Wardle, 2007). The CEBQ was validated in four- to five-year-olds by examining associations between the CEBQ and four aspects of eating behavior across up to five occasions – eating without hunger, caloric compensation, eating rate, and energy intake at meal. Multiple regression models showed that these four combined eating behavior measures accounted for 56% of the variance in satiety responsiveness, 33% of the variance in food responsiveness and 40% of the variance in enjoyment of food (Carnell & Wardle, 2007). A number of published studies have used the CEBQ to assess the eating behavior of children aged two and three years (Gregory, Paxton, & Brozovic, 2010; Quah et al, 2017; Viana, Sinde, & Saxton, 2008). For the purposes of this study, we were primarily interested in three specific subscales (i.e., satiety responsiveness, food responsiveness, and emotional overeating) to address the *a priori* hypotheses. Each subscale had moderate to high levels of internal consistency, as determined by Cronbach's alpha (i.e., satiety responsiveness $\alpha = .64$; food responsiveness $\alpha = .84$; and emotional overeating $\alpha = .68$).

Early Childhood Behavior Questionnaire – Short Form (ECBQ-SF)

The ECBQ-SF was designed to assess temperament in children aged 18-36 months and was used in this study to evaluate the children's ability to self-regulate. It originated from the Children's Behavior Questionnaire (CBQ; Rothbart, Ahadi, Hershey, & Fisher, 2001) and the Infant Behavior Questionnaire-Revised (IBQ-R; Gartstein & Rothbart, 2003). The IBQ-R was developed by using precise operational definitions of temperament established through previous research and theories of behavior and temperament as well as thorough and extensive parent interviews; temperament constructs were then analyzed across different age groups of infants (Rothbart, 1981; Gartstein & Rothbart, 2003). The CBQ was later developed based on items from the IBQ as well as contemporary theory of temperament (Rothbart et al., 2001) and has been utilized in numerous studies, for example studying genetic and environmental influences on child temperament (Murphy, Eisenberg, Fabes, Shepard, & Guthrie, 1999) and cross-cultural differences in temperament (Ahadi, Rothbart, & Ye 1993).

Authors of the ECBQ-SF created age-appropriate items from the CBQ and IBQ-R to develop the items on the ECBQ-SF.   This measure has satisfactory (i.e., $\alpha > .65$) internal consistency among caregivers, test-retest reliability, and criterion validity (Putnam & Rothbart, 2006). The ECBQ-SF has 107 items for which parents use an eight-point scale to report their child's behavior (never, very rarely, less than half the time, about half the time, more than half the time, almost always, always, does not apply). From these items, the following dimensions of temperament are derived: activity level/energy, attentional focusing, attentional shifting, cuddliness, discomfort, fear, frustration, high intensity pleasure, impulsivity, inhibitory control, low-intensity pleasure, motor activation, perceptual sensitivity, positive anticipation, sadness, shyness, sociability, and soothability. These dimensions were combined to form three composite subscales: surgency, effortful control, and negative affect. In this study, the entire instrument was administered but the dimensions used to address the a priori hypotheses were attentional focusing, attentional shifting, impulsivity, inhibitory control, soothability, and effortful control. Each subscale had moderate to high levels of internal consistency, as determined by Cronbach's alpha (i.e., attentional focusing $\alpha = .74$; attentional shifting $\alpha = .66$; impulsivity $\alpha = .64$; inhibitory control $\alpha = .78$; soothability $\alpha = .51$; and effortful control $\alpha = .84$).

Positive Affect Negative Affect Scale (PANAS)

The PANAS is a 20-item self-report measure completed by mothers to assess their own positive and negative affect. Mothers rate how much they have felt a specific emotion in the past week on a five-point scale (1: very slightly or not at all; 2: a little; 3: moderately; 4: quite a bit; 5: extremely). It is a reliable and valid measure of affect in adults and has strong validity with measures of general distress and depression (Watson, Clark, Tellegen 1988; Crawford & Henry, 2004). This measure was included in the current study to control for the potential confounding effect of negative affect in mothers because prior studies have shown that mothers with negative affect report their infants as having a more difficult temperament and delayed acquisition of effective self-regulation strategies (Goodman & Gotlib, 1999).

Confusion Hubbub & Order Scale (CHAOS)

The Confusion Hubbub & Order Scale (CHAOS) is a 15-item self-report measure completed by mothers to assess the amount of environmental confusion (i.e., high levels of noise, crowding, and home traffic pattern) present in the home. Mothers indicate how much each statement describes their home environment on a four-point scale (1: very much like your own home; 2: somewhat like your own home; 3: a little bit like your own home; 4: not at all like your own home). It has satisfactory internal consistency and test-retest stability when assessing households with infants and toddlers and also correlates with trained observer measures of household environment confusion (Matheny, Wachs, Ludwig, & Phillips, 1995). This measure was included in the current study to evaluate the child's home environment. High scores indicate more environmental confusion in the home, and in prior studies, the CHAOS score has been inversely related to a variety of developmental outcomes, including children's health and temperament (Evans, Kliewer, & Martin, 1991; Matheny, Wilson, & Thoben, 1987).

U.S. Household Food Security Survey Module

The U.S. Household Food Security Survey Module is a measure designed to assess food security, which is defined as access at all times to enough food for a healthy life (USDA, 2010). This measure contains screeners that determine the number of questions each respondent answers, with 18 maximum items. The measure provides four categories of food security: high food security (no reported indications of food-access problems or limitations), marginal food security (one or two reported indications), low food security (reports of reduced quality, variety, or desirability of diet), and very low food security (reports of multiple indications of disrupted eating patterns and reduced food intake). This measure was included in this study because low food security would directly impact eating behaviors in children (Ke & Ford-Jones, 2015), and a portion of the participants in this study are of a socioeconomic status that increases their risk for having low food security.

Observational Measures of Behavior

Once informed consent, questionnaires, and the PPVT™-4 were completed, children were brought to an adjoining room (Room B) in which the behavioral assessments were conducted. Room B was visible from the original room (Room A) through a one-way mirror. Room B contained a child-size table and chair, a chair for the research assistant, and stimuli necessary for the specific task being conducted. A white noise machine was also used to reduce the potential for the child to be distracted by any noise in the corridor outside the room. The video camera was placed in front of the one-way mirror in Room A after the research assistant and the child were in Room B. The research assistant operating the video in Room A adjusted the viewing angle or focus of the camera as necessary. A video camera recorded all behavioral tasks, and the videotape was later coded by trained observers to quantify the behaviors of interest.

Children participated in several behavioral measures designed to assess attention, inhibitory control, and emotion regulation. The tasks chosen for this study were selected from the *Laboratory Temperament Assessment Battery*, *Preschool Version*, which describes procedures developed by the authors or used previously in scientific articles on child socioemotional development (LABTAB; Goldsmith & Rothbart, 1993; Gagne, Van Hulle, Aksan, Essex, & Goldsmith, 2011). The manual was created as a standardized instrument to measure early childhood temperament in a laboratory setting. Each task was timed with a stopwatch. The order of the tasks was standardized to maintain the interest and cooperation of the child (Table 1).

Table 1

Order of Observed Behavioral Tasks

Order	Task	Observed Behavior
1	Video	Attention
2[a]	Food Delay	Inhibitory Control
3[a]	Non-food Delay	Inhibitory Control
4[b]	Food Cards	Attention
5[b]	Non-food Cards	Attention
6	High Chair	Emotion Regulation

a and b: Tasks alternated in sequence from participant to participant.

Two similar measures of inhibitory control (food delay and non-food delay), and attention (food cards and non-food cards) were administered to compare behavior with and without a food stimulus. Mothers remained in Room A and were able to observe their children via a one-way mirror. However, if the child was unable to separate and unwilling to complete tasks without his/her mother present, mothers were permitted to be in Room B. When mothers were present in Room B, they were instructed to not interact with their children during the task unless the child was unsafe (e.g., trying to escape the high chair). If the child became upset during any of the behavioral tasks (i.e., highly distressed/crying hard for more than 30 seconds), the task was terminated early. Each child was given small breaks (1-3 minutes) in between each task if needed, and the next task was started when the child was seated and calm (Graziano et al., 2010).

Attention Assessment

Evaluation of sustained attention requires a task that can provide information about the length of time the child is engaged in the task (Gaertner, Spinrad, & Eisenberg, 2008). Measuring sustained attention in young children is difficult due to the variable nature of attention at this developmental stage, as well as the requirement of some type of motor response for many tests, for which young children have yet to adequately develop control (Mahone, 2005). For children 3 years of age and younger, tests that utilize looking behaviors (e.g., eye fixation) are relied upon to examine sustained attention. For example, the length of time a child maintains attention while watching a television show (Goldman, Shapiro, & Nelson, 2004) can be used to assess attention, and this was the protocol used in the present study. Children's ability to attend was assessed with two behavioral tasks: attention to a video and attention to a card-sorting task (using food and non-food cards). Both of these tasks utilize looking behavior as well as minimal or no motor response.

Video task. Children were instructed to watch a 5-minute segment of a video of a cartoon (i.e., Curious George at The Fire Station). This cartoon was selected because it was age-appropriate, non-violent, not commonly watched, and appeals to boys and girls. This activity was recorded by video with the camera angle viewing both eyes. The activity was terminated prior to 5 minutes if the child was highly distressed for 30 seconds or more (Goldsmith & Rothbart, 1993).

Cards tasks. Children were instructed to play with a set of cards for three minutes (i.e., children were told they could match alike cards and make “perfect matches” or match cards that were not alike and make “silly matches”). Children participated in two separate cards tasks. The order of tasks (i.e., food cards or non-food cards) was randomized. One task consisted of 6 pairs of cards with non-food pictures (e.g., a gorilla, a hat, an umbrella) and the other task consisted of 6 pairs of cards with food pictures (e.g., ice cream, an apple, macaroni and cheese). Children’s behavior during these tasks were recorded by video with the camera angle trained on both of the children’s eyes. The activity was terminated if the child was not interacting with or looking at the cards for more than 30 seconds or if the child was highly distressed for 30 seconds or more. To our knowledge, this measure has not been used in prior studies of children who are younger than 30 months of age. However, these cards tasks were included to provide an additional measure of attention that did not require complex motor skills and could assess attention in the presence of both food and non-food stimuli.

Inhibitory Control

Children’s ability to inhibit their responses was assessed with two behavioral delay tasks: food delay and non-food delay.

Food task. Prior to this task, the child’s mother indicated whether the child preferred chocolate, gummies, or a fruit candy. To measure inhibitory control, a single candy was placed under a clear plastic cup and the child was instructed to wait to eat the candy until the research assistant rang a bell. Two to three practice trials were conducted to evaluate understanding of the task prior to beginning trials. Understanding of the task was indicated by the child waiting for the research assistant to ring the bell before obtaining the candy. Only two children were not successful in passing the practice trials and were therefore excluded from the analyses. Six trials were conducted, using delays of 5, 10, 0, 20, 0, and 30 seconds in that order, before the cup was removed to allow the child access to the candy. This task has previously been used in children 30 months of age and was found to be positively correlated with caregivers' reports of children's inhibitory control and attention shifting (Spinrad, Eisenberg, & Gaertner, 2007).

Non-food task. The same methodology used in the inhibitory control food delay task described above was repeated for a non-food item so that a comparison could be made between the children's inhibitory control with a food versus non-food stimulus. For this task, small circular stickers the same size as chocolate candy were placed underneath the cup instead of candy. Six trials were conducted, using delays of 5, 10, 0, 20, 0, and 30 seconds in that order.

Emotion Regulation

Previous research has shown a relationship between measures of emotion regulation and emotion reactivity. Reactivity is a component of the emotional response to environmental demands which requires regulatory strategies to adjust for changes in reactivity (Calkins & Johnson, 1998). Particular regulatory behaviors as well as the degree of distress are both considered indications of emotion regulation processes (Graziano et al., 2010), so it is necessary to use a task that elicits frustration and thereby provides an opportunity for children to use self-regulatory behaviors.

High chair task. For this task, the child was placed in a high chair and strapped into a 3-point harness without toys or any other stimuli for 5 minutes. The high chair (First Adventure Multi-Stage High Chair; Eddie Bauer, Bellevue, WA) had an attached tray table and foot rest; cushions were removed to eliminate additional stimuli available to the child. This measure has been shown to elicit frustration, and therefore regulatory strategies in children as young as 18 months (Calkins & Johnson, 1998; Goldsmith & Rothbart, 1993). This measure assessed the degree of distress (for example, whining, fussing, crying or tantruming) and emotion regulatory behaviors such as self-stimulation, self-soothing, and distraction. The research assistant or the child's mother was present in the room during this task for safety purposes, but she was seated behind the child and did not interact with the child unless he/she was distressed for more than 30 seconds.

Coding Toddler Behaviors

Data from the videotapes were coded by independent coders who were not involved with data collection. Each coder met with the PI individually for training. At the training sessions, video segments of behavioral measures were displayed while the PI pointed out discrete examples of behaviors which should be coded (e.g., looking away from the video screen) for each measure, and the PI and the coder coded a task together. Once the coder expressed understanding of the coding scheme, the PI and the coder viewed new video segments, each independently coding. The PI reviewed the coding sheets, discussing discrepancies if necessary. Coding values were examined and a criterion of 100% agreement with the PI was established for the coder to be considered reliable. For each behavioral task, one of the trained coders coded all of the videos, and the second coder coded 25% of the videos so that inter-coder reliability could be evaluated. Coders worked at separate times to obtain independent ratings for each video. Cohen's kappa (κ) was calculated to determine agreement between coders; overall there was moderate to good agreement between coders (see Table 2). The data generated by the primary coder for each task was used in the final analyses. Coding was performed in batches at the end of the study, so that the coding for one task was complete before the coders were trained to code the next task. See Appendix B for coding schemes for each behavioral task described below.

Table 2

Cohen's Kappa for Video Coding

Variable	κ*
Video: Attention	.78
Video: Fidgeting	.50
Cards: Gaze	.54
Cards: Gaze + Hands	.59
Delay: Trials Waited	.86
High Chair: Calm	.63
High Chair: Help-Seeking	.70
High Chair: Self-Comforting	.66
High Chair: Escape	.72
High Chair: Distress	.73

*All κ *p*-values were <.0005.

Attention assessment: video task. As described in the LAB-TAB manual, the video was divided into 10-second epochs and trained coders scored each epoch according to whether the child watched the video for the majority of an epoch (i.e., five or more seconds out of ten looking at the video, defined as child's eyes directed at the screen). Children received a score of one for attending the majority of the epoch and a score of zero for not attending. Overall duration (i.e., total attention) was determined by summing the number of epochs the child attended to the video most of the time. In addition, the length of time it took the child to first look away from the screen was recorded in seconds (i.e., latency to look away) (Graziano et al., 2010). Z-scores were created for overall attention duration and latency to look away, and these z-scores were summed to create a video composite score. In addition, fidgeting was included as an outward expression that infers inattention (Farley, Risko, & Kingstone, 2013). The overall fidgeting score (i.e., total fidgeting) was determined as the sum of children's activity during each epoch scored as: 0: no fidgeting; 1: low fidgeting defined as hand movement or feet movement such as tapping feet or drumming fingers; 2: high fidgeting defined as hand and feet movement including bouncing (body movement, dancing) and/or movements more rapid than for low fidgeting behaviors. In addition, the length of time it took the child to fidget initially was recorded in seconds (i.e., latency to fidget). Z-scores were created for overall fidgeting amount and latency to fidget, and these z-scores were summed to create a fidgeting composite score (Goldsmith & Rothbart, 1993). Each component score as well as composite variables were used to evaluate relationships with ECBQ-SF and CEBQ variables.

Attention assessment: cards tasks. The video was divided into 10-second epochs and trained coders scored each epoch according to whether the child was gazing at the cards for the majority of an epoch, exactly as coded in the video task (total gaze). For each epoch, video coders also indicated whether the child was gazing at the cards while touching the cards for the majority of an epoch (total gaze + hands). Overall duration was determined by summing the number of epochs the child attended to the cards most of the time (Goldsmith & Rothbart, 1993). Scores for the food and non-food cards task were compared, and results were not significantly different. The task scores for each variable (total gaze; total gaze + hands) were each summed separately to create sum scores for both tasks (i.e., food cards sum of total gaze, non-food cards sum of total gaze; food cards sum of total gaze + hands, non-food cards sum of total gaze + hands). The food cards task and the non-food cards task were highly correlated with one another and were combined by summing the number of epochs the child attended to the cards during each task (i.e., cards sum of total gaze, cards sum of total gaze + hands). Each component score as well as composite variables were used to evaluate relationships with ECBQ-SF and CEBQ variables.

Inhibitory control: food and non-food delay tasks. For each trial, the children were scored according to whether they waited for the bell to ring before lifting the cup to get the candy or sticker (score = 1) or did not wait (score = 0). These scores were summed across trials to obtain an overall score (i.e., sum of trials waited; Goldsmith & Rothbart, 1993). Additionally, a variable was created that summed the number of seconds for each successful wait (length of wait sum); for example, if a child received a score of 1 for the 5-second and 10-second trials only, he would receive a length of wait sum score of 15. Scores for the food and non-food delay task were compared, and results were not significantly different so the length of wait sum variables were added together to reflect overall inhibitory control (i.e., delay composite). Although to our knowledge, the use of a non-food stimulus in an inhibitory control task has not been used previously in young children, other studies investigating inhibitory control frequently use methodology including similar food and non-food tasks (Merz et al., 2016; Hughes, Power, O'Connor, & Fisher, 2015; Mulder et al 2014). Each component score as well as composite variables were used to evaluate relationships with ECBQ-SF and CEBQ variables.

Emotion regulation: high chair task. Videotapes were coded in 10-second epochs, and for each epoch, children received a score for their emotional response and a score for their emotion regulation. Emotional response was rated on a scale of 0 to 4 (0: no emotional response; 1: short-lived mild distress; 2: mild distress most of the time; 3: distressed but not consistently, may be able to briefly calm; 4: extreme distress, task should be ended), and were summed across all epochs to obtain an overall emotional response score (i.e., distress). In addition, the length of time it took the child to first exhibit distress was recorded in seconds (i.e., latency to be distressed). Emotion regulation refers to the type of behavior the child engaged in during each epoch (i.e., a) calm: sitting still, focusing or playing on object or event, looking or scanning the room; b) help-seeking: turning around in chair to look at the research assistant or mother, talking to the research assistant or mother or calling for mother; c) self-comforting: thumb-sucking, hair twirling, or singing; d) escape: attempt to get out of high chair or restraints). The behavior evident for the longest period of time within each epoch was scored, even if multiple behaviors were used during each epoch. Scores for the self-regulatory behaviors (i.e., calm and self-comforting) were summed across all epochs to generate an overall index of positive self-regulation; these variables were positively correlated with each other and negatively correlated with the distress variable during this task and are thought to represent effective self-regulatory behaviors (i.e., self-regulation composite; Goldsmith & Rothbart, 1993; Graziano et al., 2010). Each component score as well as composite variables were used to evaluate relationships with ECBQ-SF and CEBQ variables.

Anthropometrics

Children wore no shoes and light clothing to obtain height and weight measurements. Children's body weight was obtained using an electronic scale (BodPod®; Life Measurement Inc., Concord, CA). Child height was measured to the nearest one millimeter using a seca® 264 digital stationary stadiometer (seca ® gmbh & co. kg, Hamburg, Germany). Children's waist circumference was measured in triplicate to the nearest tenth of a centimeter using a flexible tape measure (Gulik II; Country Technology, Gays Mills, WI). Children's skinfolds (subscapular, waist, and triceps) were obtained in triplicate to the nearest one millimeter using skinfold calipers (Harpenden, Baty International, West Sussex, England). Children's body mass index (BMI) was calculated as weight in kilograms divided by height in centimeters squared, and z-scores were derived using World Health Organization Anthro software (World Health Organization, 2011).

Data Analysis

Analyses were conducted to assess whether data met the assumptions for parametric statistics prior to the main analyses being performed. In addition, associations between behavioral measures and parent-report measures were examined to assess whether the results of the behavioral tests were consistent with the child's usual behaviors. The relationships among demographic variables and measures of children's self-regulatory and eating behaviors were also examined to identify potential covariates to be included in regression models. See Table 3 for outline of analyses conducted. All analyses were conducted using SPSS 22.

Table 3

Primary Linear Regression Models for Each Hypothesis

Hypothesis	Outcome Variable	Predictor Variable
1	Food Responsiveness	Attention (video/cards)*
	Food Responsiveness	Attention (parent report)*
	Satiety Responsiveness	Attention (video/cards)*
	Satiety Responsiveness	Attention (parent report)*
2	Satiety Responsiveness	Inhibitory Control (food delay/non-food delay)*
	Satiety Responsiveness	Inhibitory Control (parent report)*
3	Emotional Overeating	Distress*
	Emotional Overeating	Self-soothing*

*Covariates were added to models if associated with outcome variable and potentially included child age, sex, race, BMI-for-age z-score, PPVT-4 raw score, Positive Affect Negative Affect Scale.

Hypothesis 1

Simple Pearson correlations were calculated to examine whether children with poorer attention during the video and card sorting tasks were less responsive to satiety and more responsive to food cues. Multiple linear regression was then used to examine associations after adjusting for other variables (i.e., children's age, sex, race, BMI-for-age z-score, or PPVT-4 raw score) as appropriate. In separate analyses, attention focusing and attention shifting from the ECBQ-SF replaced the behavioral attention score from the video and cards tasks to examine whether the association was similar for observed versus parent-report behavior. Additionally, an interaction variable was created for the PPVT-4 raw score and each attention variable, in order to investigate the impact of child verbal development on the relationship between attention and food responsiveness and satiety responsiveness. For the video task, the following interaction variables were created and tested in separate models: PPVT-4 raw score by (1) Total Attention; (2) Latency to Look Away; (3) Video Composite; (4) Total Fidgeting; (5) Latency to Fidget; (6) Fidgeting Composite. For the cards tasks, the following interaction variables were created and tested in separate models: PPVT-4 raw score by (1) Food: Total Gaze; (2) Food: Total Gaze + Hands; (3) Non-food: Total Gaze; (4) Non-food: Total Gaze + Hands; (5) Sum: Total Gaze; (6) Sum: Total Gaze + Hands. For the ECBQ-SF, the interaction of PPVT-4 raw score and attention focusing, and PPVT-4 raw score at attention shifting, were tested in separate models. If a statistically significant relationship was found between the interaction variable and food responsiveness or satiety responsiveness, simple slopes analyses were used to examine the direction of the association between the interaction of PPVT-4 raw score and the attention variable, and the outcomes of food responsiveness or satiety responsiveness.

Hypothesis 2

To test the hypothesis that children with poor inhibitory control are more responsive to food cues, simple Pearson correlations were used to examine the association between children's inhibitory control score during the food or non-food task and the food responsiveness score from the CEBQ. Multiple linear regression was then used to examine associations after adjusting for variables such as children's age, sex, race, BMI-for-age z-score, or PPVT-4 raw score as appropriate. In separate analyses, impulsivity and inhibitory control scores from the ECBQ-SF replaced the behavioral inhibitory control score to examine whether any association with food responsiveness was similar for parent-report versus observed measures. Additionally, an interaction term between the PPVT-4 raw score and each inhibitory control variable was generated and included in separate regression models in order to investigate the impact of child verbal development on the relationship between inhibitory control and food responsiveness. For the food and non-food behavioral tasks, the following interaction variables were created and tested in separate models: PPVT-4 raw score by 1) Food: Sum of Trials Waited; (2) Food: Length of Wait Sum; (3) Non-food: Sum of Trials Waited; (4) Non-food: Length of Wait Sum; (5) Delay Composite. For the ECBQ-SF, an interaction term for PPVT-4 raw score and impulsivity was created, and a second for PPVT-4 raw score and inhibitory control. If a statistically significant relationship was found between the interaction variable and FR, simple slopes analyses were conducted to examine the direction of the association between the interaction of PPVT-4 raw score and the inhibitory control variable, and the outcomes of FR.

Hypothesis 3

To test the hypothesis that children with poorer emotion regulation skills engage in more emotional overeating, simple Pearson correlations were calculated among the emotional distress and emotion regulation scores from the high chair task and the emotional overeating score from the CEBQ. Multiple linear regression modeling was then used to examine associations after adjusting for other variables. A subsequent model was also run to examine whether the association of emotional distress or regulation with emotional overeating was independent of maternal negative affect (i.e., PANAS score). Similar models were constructed to examine whether soothability and effortful control on the ECBQ-SF were associated with emotional overeating (CEBQ). Additionally, an interaction score between PPVT-4 raw score and each emotion regulation variable was created in order to investigate the impact of child verbal development on the relationship between emotion regulation and emotional overeating. For the highchair task, the following interaction variables were created and tested in separate models: PPVT-4 raw score by (1) Distress; (2) Latency to be Distressed; (3) Calm; (4) Help Seeking; (5) Self-Comforting; (6) Escape (7) Self-Regulation Composite. For the ECBQ-SF, PPVT-4 raw score interaction variables were created with soothability and effortful control. If a statistically significant relationship was found between the interaction variable and EO, simple slopes analyses were conducted to examine the direction of the association between the interaction of PPVT-4 raw score and the emotion regulation variable, and the outcome of EO.

RESULTS

Participants included 43 children (19 boys; mean age 30.84 months) and their mothers (mean age 29.09 years). Descriptive statistics for this cohort are displayed in Table 4. The majority of the sample was African American (67%); all other children were Caucasian. The majority of mothers were not married (55.8%) and ranged in education level, with 18.6% high school graduates, 32.6% having some college education, 20.9% college graduates, and 18.6% with graduate school degrees. Mother's PANAS scores were comparable to scores of individuals in the general population (Crawford & Henry, 2004; Anas & Akhouri, 2013). CHAOS scores were similar to those in other studies examining child behavior (Dumas et al., 2005; MacRae, Darlington, Haines, & Ma, 2017). Nearly one-third of the children in this sample (i.e., 32.6%) had BMIs greater than the 85th percentile, indicating overweight or obese status. The mean standard score for the PPVT™-4 was 95.83, which is in the average range.

Table 4

Demographics

	Mean (SD)	Minimum	Maximum
Child Age at Visit (months)	30.84 (2.07)	27	36
Child Body Weight (kg)	13.91 (1.55)	10.99	18.34
Child weight-for-age z-score[a]	0.38 (0.84)	-1.61	2.61
Child weight-for-height z-score[a]	0.66 (0.95)	-1.22	3.56
Child BMI-for-age z-score[a]	0.71 (0.96)	-1.01	3.69
Child PPVT™-4 Standard Score[b]	95.83 (14.2)	73	142
Child PPVT™-4 Raw Score[b]	30.28 (17.33)	19	95
Mother Age at Visit (Years)	29.09 (6.36)	19.83	44.00
CHAOS Total Score[b]	45.57 (6.39)	24	57
PANAS Positive Affect[b]	38.53 (9.80)	0	50
PANAS Negative Affect[b]	16.90 (6.75)	0	35

N = 43, unless otherwise noted. a. Based on World Health Organization (WHO) reference data. b. n = 40, due to measure being added after first three participants were run.

Descriptive statistics showing the children’s performance on the behavioral tasks, and the results of the ECBQ-SF and CEBQ parent-report surveys are provided in Appendices C, D, and E, respectively. On each of the behavioral tasks, at least one child was unable or refused to comply with the instructions, thereby precluding an evaluation of the behavior the task was designed to investigate. For example, several children refused to sit in front of the television, so attention to the video could not be evaluated. Participants excluded due to noncompliance were as follows: video task (5); non-food delay task (5); food delay task (6); food cards task (6); non-food cards task (3); high chair task (1). Scores on the ECBQ-SF and CEBQ subscales were similar to those of other cohorts with children of a similar age (Parkinson, Drewett, LeCouteur, & Adamson, 2010; Putnam & Rothbart, 2006; Wardle, Guthrie, Sanderson, & Rapoport, 2001).

Given limited prior research using behavioral tasks to assess self-regulation in children of this age, Pearson correlations were calculated to examine whether the children's scores on the behavioral measures of attention, inhibitory control, and emotion regulation were associated with the parent-report scores on the ECBQ-SF. As shown in Tables 5 and 6, observed measures of behavior during the video and cards tasks were not correlated with attention focusing and attention shifting on the ECBQ-SF. The only statistically significant correlation was between latency to fidget and attention shifting ($r = .44$, $p < .01$), such that children who started fidgeting sooner while watching the video were reported to be worse at attention shifting (i.e., the ability to effectively move or transfer the focus of attention from one activity to another). Children's performance on the food and non-food delay tasks was not associated with their impulsivity or inhibitory control on the ECBQ-SF (Table 7). Finally, only the distress score from the high chair task was related to effortful control and frustration on the ECBQ-SF (Table 8). Specifically, children who became very distressed while in the high chair were reported to have less effortful control ($r = -.33$, $p < .05$) and greater frustration in their daily lives ($r = .31$, $p < .05$). Given the lack of statistically significant correlations between the observed measures and the ECBQ-SF scores, and the fact that it is not clear which type of assessment would better reflect children's actual behavior, each of the primary hypotheses were tested using the behavioral and ECBQ-SF scores in separate models.

Table 5

Correlation Coefficients for Behavioral Observation of Video Task and ECBQ-SF

	ECBQ-SF Subscale		
Observed Measure: Video	Attn. Focusing	Attn. Shifting	Activity Level
Total Attention	.27	.04	-.00
Latency to Look Away	-.15	.01	.17
Video Composite	.06	.03	.11
Total Fidgeting	-.33*	-.14	-.03
Latency to Fidget	.02	.44**	-.08
Fidgeting Composite	-.20	.20	-.07

ECBQ-SF: Early Childhood Behavior Questionnaire, Short-Form; Attn.: Attention. *: Correlation significant at the .05 level; **Correlation significant at the .01 level.

Table 6

Correlation Coefficients for Behavioral Observation of Cards Tasks and ECBQ-SF

	ECBQ-SF Subscale	
Observed Measure: Cards	Attn. Focusing	Attn. Shifting
Food: Total Gaze	-.06	-.10
Food: Total Gaze + Hands	-.05	-.11
Non-food: Total Gaze	.07	-.24
Non-food: Total Gaze + Hands	.04	-.26
Cards Sum: Total Gaze	.01	-.20
Cards Sum: Total Gaze + Hands	-.01	-.22

ECBQ-SF: Early Childhood Behavior Questionnaire, Short-Form; Attn.: Attention.

Table 7

Correlation Coefficients for Behavioral Observation of Delay Tasks and ECBQ-SF

	ECBQ-SF Subscale	
Observed Measure: Delay	Impulsivity	Inhibitory Control
Non-food: Sum of Trials Waited	-.13	-.01
Non-food: Length of Wait Sum	-.14	.25
Food: Sum of Trials Waited	-.00	.12
Food: Length of Wait Sum	-.14	.09
Delay Composite	-.14	.05

ECBQ-SF: Early Childhood Behavior Questionnaire, Short-Form.

Table 8

Correlation Coefficients for Behavioral Observation of High Chair Task and ECBQ-SF

	ECBQ-SF Subscale		
Obs. Measure: High Chair	Soothability	Effortful Control	Frustration
Distress	-.14	-.33*	.31*
Latency to be Distressed	-.21	.15	-.14
Calm Sum	.16	.19	-.16
Help-Seeking Sum	.03	-.06	.28[†]
Self-Comfort Sum	-.06	.16	-.18
Escape Sum	-.06	.22	.06
Self-regulation Composite[a]	.10	.26[1]	-.25

ECBQ-SF: Early Childhood Behavior Questionnaire, Short-Form. Obs.: Observed. †. Correlation trending for significance (.05 < *P* < .1); *: Correlation significant at the .05 level; a. Self-regulation composite is combination of calm and self-comfort variables.

Preliminary analyses identified several descriptive characteristics of the children that were associated with the self-regulation and eating behaviors (Appendix F). No statistically significant associations were found among the CHAOS scores or the food security measure and variables of interest. There were no associations of children's BMI-for-age z-score or skinfolds and their eating behaviors, however several associations with self-regulatory behaviors were found. Specifically, children with higher BMI-for-age z-scores were rated as more difficult to soothe when they are distressed (r = -.32, $p < .05$), and children with a greater sum of skinfolds exhibited less distress when confined to a high chair (r = -.33, $p < .05$). Caucasian participants exhibited more calm and self-soothing behaviors in the high chair task than African American children (Caucasians: M = 23.00, SD = 7.62; African Americans: M = 17.59, SD = 11.35; $p < .01$). Finally, PPVT-4 raw score was associated with the majority of video attention variables, such that higher PPVT-4 raw score was associated with better attention (total attention: r = .45, $p < .01$; video composite: r = .37, $p < .05$) and less fidgeting (total fidgeting: r = -.62, $p < .01$; fidgeting composite: r = -.57, $p < .01$). PPVT-4 raw scores were also associated with several eating behavior variables. More specifically, children with higher PPVT-4 raw scores were rated by parents as having greater satiety responsiveness (r = .43, $p < .01$), greater slowness in eating (r = .38, $p < .05$), and less desire to drink (r = -.35, $p < .05$).

Hypothesis 1

Hypothesis 1 predicted that children who are relatively inattentive will be less responsive to satiety and more responsive to food cues as compared to those with better attention regulation. In unadjusted models, measures of attention, both behavioral and parent-reported, were not associated with children's food responsiveness or satiety responsiveness (Table 9). Given that verbal development of the child could have impacted children's performance on the task or the association of attention with food responsiveness or satiety responsiveness, additional models were constructed to examine whether the interaction terms for PPVT-4 raw score and measures of attention were associated with satiety responsiveness or food responsiveness. The interaction of PPVT-4 raw score and several of the attention measures were associated with satiety responsiveness, but not food responsiveness. In separate models, the PPVT-4 raw score interacted with total attention and the video composite scores to be positively associated with satiety responsiveness ($\beta = .60$, $p < .01$; $\beta = .54$, $p < .01$, respectively). After adjusting for BMI-for-age z-score, the association of the PPVT-4 raw score x total attention, and PPVT-4 raw score x the video composite score, remained significantly associated with satiety responsiveness.

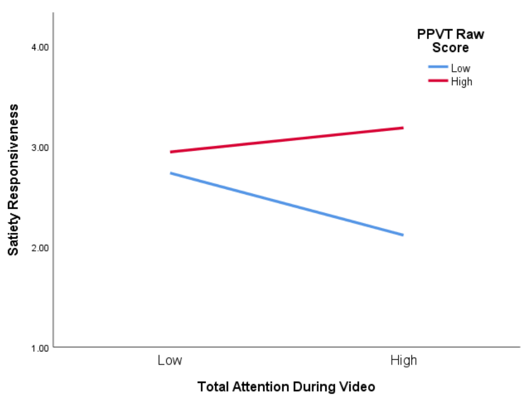
Table 9

Correlation Coefficients for Behavioral Observation Measures, ECBQ-SF, and CEBQ

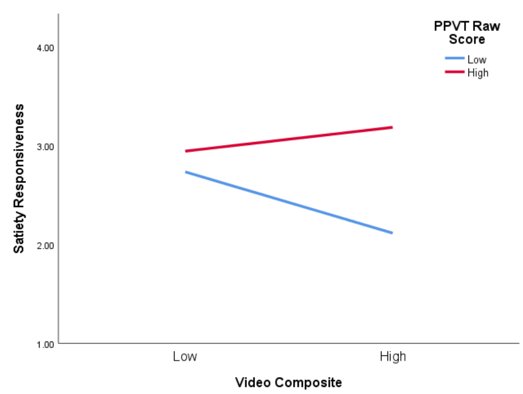
Measure	SR	FR	EO
Video			
Total Attention	.01	-.22	---
Latency to Look Away	.28†	-.13	---
Video Composite	.19	-.21	---
Total Fidgeting	-.14	.18	---
Latency to Fidget	-.10	-.16	---
Fidgeting Composite	-.15	.02	---
Cards			
Food: Total Gaze	-.26	.13	---
Food: Total Gaze + Hands	-.23	.12	---
Non-food: Total Gaze	-.16	.04	---
Non-food: Total Gaze + Hands	-.17	.06	---
Cards Sum: Total Gaze	-.28	.08	---
Cards Sum: Total Gaze + Hands	-.26	.09	---
Delay			
Non-food: Sum of Trials Waited	---	.03	---
Non-food: Length of Wait Sum	---	-.02	---
Food: Sum of Trials Waited	---	.02	---
Food: Length of Wait Sum	---	-.26	---
Delay Composite	---	-.20	---
High chair			
Distress	---	---	-.05
Latency to be Distressed	---	---	.35*
Calm Sum	---	---	.19
Help-Seeking Sum	---	---	-.01
Self-Comfort Sum	---	---	-.16
Escape Sum	---	---	-.38*
Self-reg. Composite	---		.06
ECBQ			
Attention Focusing	-.16	-.26	---
Attention Shifting	-.16	.04	---
Inhibitory Control	---	.03	---
Impulsivity	---	-.29†	---
Effortful Control	---	---	-.07
Soothability	---	---	-.01

Note. Dashes indicate the correlation was not reported because it is not relevant to hypotheses. ECBQ-SF: Early Childhood Behavior Questionnaire, Short-Form; CEBQ: Child Eating Behavior Questionnaire; SR: satiety responsiveness; FR: food responsiveness; EO: emotional overeating. †. Correlation trending for significance (.05 < P < .1); *: Correlation significant at the 0.05 level; **Correlation significant at the 0.01 level.

Simple slopes analysis revealed that there was a statistically significant inverse linear relationship between total attention to the video and satiety responsiveness when PPVT-4 raw score was low (*b* = -.04, *SE* = .02, $p < .05$), but not when PPVT-4 raw score was high (*b* =.01, *SE* = .02, $p > .05$); see Figure 1A. In other words, for children with low PPVT-4 raw score, low attention was associated with greater response to satiety cues as compared to children with high attention. Similar trending results were found with the video composite variable (low PPVT-4 raw score x video composite variable: -.19 ± .10, $.05 < p < .10$; high PPVT-4 raw score x video composite variable: .08 ± .07, $p > .05$; Figure 1B).



A.



B.

Figure 1. Interaction Effect of Video Attention Variables and PPVT-4 raw Score on Satiety Responsiveness

No associations between attention during the cards tasks and food responsiveness or satiety responsiveness were found (Table 9). In addition, the interaction of PPVT-4 raw score and card attention measures were not associated with satiety responsiveness or food responsiveness.

The parent-report measures of attention (i.e., attention shifting and attention focusing) were not associated with food or satiety responsiveness (Table 9). Similarly, the interaction terms for PPVT-4 raw score x attention shifting or attention focusing were not associated with food or satiety responsiveness.

Hypothesis 2

Hypothesis 2 predicted children with poor inhibitory control will be more responsive to food cues than those with better inhibitory control. There were no associations among the behaviors scored from the non-food and food delay tasks and food responsiveness (Table 9). There was also no association of the PPVT-4 raw score x inhibitory control measure interaction terms and food responsiveness. Furthermore, neither inhibitory control nor impulsivity from the ECBQ-SF were associated with food responsiveness. In addition, investigation of parent-report relationships of inhibitory control and impulsivity with interaction variables of PPVT-4 raw score and parent-report inhibitory control measures revealed no association with food responsiveness.

Hypothesis 3

Hypothesis 3 predicted that children with poor emotion regulation will be reported as more likely to engage in emotional overeating than those with better emotion regulation. In contrast to the *a priori* hypothesis, children who had more escape attempts during the high chair task were reported to have less emotional overeating (Table 9). After adjusting for BMI-for-age z-score which was associated with distress in the high chair, the escape attempts variable was no longer associated with emotional overeating.

Soothability and effortful control from the ECBQ-SF were not associated with emotional overeating in the total cohort (Table 9). The interaction variables of PPVT-4 raw score and emotion regulation measures were also not associated with emotional overeating. Given that negative affect in mothers can influence how they report their children's affect, we examined whether any association emerged after adjusting for maternal negative affect from the PANAS, but this was not the case.

Exploratory Analyses

In addition to testing the *a priori* hypotheses, exploratory analyses revealed several other associations between children's temperament and their eating behaviors. Analyses were only run with ECBQ-SF variables (Appendix H).

Attention shifting was significantly correlated with food fussiness ($r = -.33$, $p < .05$) and enjoyment of food ($r = .44$, $p < .01$). In other words, children who were less able to shift attention were fussier about food and were reported to have less enjoyment of food than those with better attention shifting. Attention focusing was significantly correlated with desire to drink ($r = -.45$, $p < .01$), suggesting that children with less ability to focus their attention had more desire to drink.

Children who were more impulsive had less food fussiness ($r = -.34$, $p < .05$), and those with poorer inhibitory control had less emotional overeating ($r = .43$, $p < .02$).

Children who were difficult to soothe also had less enjoyment of food ($r = .38$, $p < .05$). Effortful control was significantly correlated with enjoyment of food ($r = .35$, $p < .05$), indicating that children with better control had more enjoyment of food.

DISCUSSION

Results of this study do not support the hypothesis that the ability of young children to self-regulate is associated with their eating behavior. The only association related to the *a priori* hypotheses that obtained statistical significance was between attention to the video and satiety responsiveness, but the association was only found for children with low verbal development and was in the opposite direction to that hypothesized. Specifically, among children with low PPVT-4 raw scores, those with high attention were reported to have low satiety responsiveness, whereas those with poor attention were rated as more responsive to satiety. Furthermore, there were no associations among inhibitory control and response to food cues, or among emotion regulation and emotional overeating. Overall, these findings demonstrate little evidence for an association of self-regulatory ability and eating behavior in very young children.

Attention

To our knowledge, this is the first study to report an association of attention focusing with responsiveness to satiety. However, in this cohort, the association was only evident among children with lower PPVT-4 raw scores, and it was in the opposite direction than that hypothesized. Specifically, children with low PPVT-4 raw scores and low total attention were reported by parents as having greater responsiveness to satiety cues; whereas children with low PPVT-4 raw scores and high total attention were rated by parents as having less responsiveness to satiety cues. In contrast, for children with more developed verbal skills, attention was unrelated to parent-reported satiety responsiveness. Although the mechanisms underlying the association of the PPVT-4 raw score x total attention interaction with satiety responsiveness are not known, it is possible that parents of children with more versus less developed verbal skills rely on different cues to interpret their child's satiety responsiveness. Prior research has shown that young children use increasingly intentional hunger and fullness cues as they develop, including the emergence of verbal expressions of hunger and fullness (Hodges, Wasser, Colgan, & Bentley, 2016). Consequently, parents of children with more developed verbal skills may accept their child's verbal indication of hunger and fullness, rather than attempting to interpret non-verbal cues. For parents of children with less developed verbal skills, however, results of this study suggest that they may interpret their children's lack of attention as a sign of satiety, whereas better attention is interpreted as poorer satiety responsiveness. An alternate possibility is that differences in the association between attention and satiety responsiveness among children with high versus low PPVT-4 raw scores are attributable to differences in children's ability to understand and comply with investigator instructions during testing. In this cohort, children with low PPVT scores were less attentive to the video as compared to children with higher PPVT-4 raw scores.

Notably, no associations were found among attention measures and food responsiveness, even when including PPVT-4 raw score interaction variables in models. This is contrary to several prior studies which reported that poor attention focusing was related to greater response to food cues in children aged 4 years and older (Leventakou et al., 2016; Faith & Hitner, 2010). This is also in contrast to the finding in this cohort that children with poor attention focusing had greater desire to drink. It is not clear why there was an association between poor attention and desire to drink but not for food responsiveness, as these two constructs are typically related to each other (Jansen et al., 2012; Webber, Hill, Saxton, Jaarsveld, & Wardle, 2008). It is possible that questionnaire items within the desire to drink subscale are more objective and more clearly defined as compared to food responsiveness items, or that parents are better able to evaluate their children's desire to drink as compared to responsiveness to food cues because children have greater frequency of drinking than eating. Since the invention of sippy cups, toddlers have more access to drinks than they did previously (Ben-Avraham, Hyden, Fletcher, & Bonuck, 2015). Desire to drink, rather than response to food cues, may have a stronger association with attention because drinks consumed by toddlers are typically sweet and palatable, whereas many foods are not so rewarding. Prior research has shown that the majority of toddlers are consuming 100% fruit juice, fruit drinks, and soda (O'Connor, Yang, & Nicklas, 2006). Children's desire to drink has been associated with a preference for and consumption of sugar sweetened beverages (Sweetman, Wardle, & Cooke, 2008), which in turn, is associated with weight gain in both children and adults (Malik, Schulze, & Hu, 2006). Consequently, it is possible that at this young age, desire to drink may provide a better index of children's response to food cues than the items on the response to food cues subscale. It would be of interest to re-examine the factor structure of the CEBQ in a larger cohort of children of this age, to explore whether items desire to drink and responsiveness to food load still load on separate subscales as they do for older children in whom the CEBQ was originally validated (Carnell & Wardle, 2007). It will also be important in future research to include an assessment of the children's food environment and their access to food and drinks because this could potentially modify the associations among children's self-regulatory behaviors, eating behaviors, and weight gain.

The results of this study also revealed associations among parent-reported attention shifting and food fussiness and enjoyment of food. Specifically, children with less ability to shift their attention were reported as being fussier about food and having less enjoyment of food. These results suggest that children with poor attention shifting are less able to remove their attention from a disliked food, which could result in fussiness and distress around mealtimes. Prior research has shown that children with attention difficulties are more likely to be picky eaters (Zucker et al., 2015), and picky eaters have greater risk for obesity (Finistrella et al., 2012). Additionally, there tends to be greater stress and conflict during mealtimes between parents and children who are picky eaters (Zucker et al., 2015), so fussiness and lack of enjoyment during mealtimes may also be a reflection of the dynamic created around eating/feeding a child with attention difficulties. Parents of picky eaters are more likely to offer food rewards as encouragement to eat which, over time, will increase the value of the preferred or rewarded food and decrease the value of the disliked food (Harris, Fildes, Mallan, & Llewellyn, 2016). Consequently, unless they are allowed their favorite foods for each meal, toddlers will have less enjoyment of eating (Kuhl, Clifford, & Stark, 2012). Together, these findings suggest that children who are less able to shift their attention away from the stimulus in front of them (e.g., less desired food) may be at risk for obesity because of the way in which their parents use food to appease the child's distress or as a reward.

In sum, results of this study suggest that there is an association between children's overall ability to attend and their eating behaviors, even though the specific *a priori* hypotheses were not supported. More research is needed to evaluate whether the change in the association of attention with satiety responsiveness across verbal development is due to a direct effect of verbal development on children's behavior, or whether it simply reflects parental use of different cues to interpret children's satiety response when children are more versus less verbal. Further, the association of attention with desire to drink is consistent with the *a priori* hypothesis of an association between attention and response to food cues, but more work is needed to evaluate whether desire to drink reflects response to food cues at this young age. Finally, the associations of attention shifting with food fussiness and enjoyment of eating are consistent with literature showing an association of attention and picky eating. Although there was no association between attention variables and measures of adiposity in this cohort, it would be of interest in the future to evaluate whether the ability to focus and shift attention have a lagged effect on weight gain. Together, these findings suggest that interventions to improve attention focusing and facilitate attention shifting might also yield benefit for reducing some of the eating behaviors that increase the risk for obesity.

Inhibitory Control

Data from this study did not support the hypothesis that children with poorer inhibitory control or greater impulsivity are more responsive to food cues. Although several studies in the literature report that individuals with more impulsivity are more responsive to food, and thereby eat in response to external signals rather than internal signals of hunger (Leventakou et al., 2016; Bartholdy, Dalton, Daly, Campbell, & Schmidt, 2016), other research has demonstrated negative or no relationships among these variables (Liang, Matheson, Kaye, & Boutelle, 2014). Inconsistencies in findings may be due to the manner in which impulsivity is measured and whether or not the questions or tasks used to measure impulsivity were specific to food. Additionally, impulsivity and inhibitory control are often terms used interchangeably, although impulsivity reflects just one of the characteristics of impaired inhibitory control, and differences in the use of these terms may impact how findings are represented in the literature. It is also possible that the relatively young age of children in this cohort precluded the ability to detect an association between inhibitory control or impulsivity and response to food cues.

Emotion Regulation

Results of this study do not support the hypothesis that children with poor emotion regulation have greater emotional overeating. This finding is in contrast to previous research in older children, which showed that emotional reactivity was related to emotional eating (Harrist, Hubbs-Tait, Topham, Shriver, & Page, 2013). It is possible that the relatively young age of children in this cohort precluded the ability to detect an association between emotion regulation and emotional overeating because prior research suggests parents are less likely to report emotional overeating, as compared to emotional undereating, in their children aged 2-5 years (Farrow, Haycraft, & Blissett, 2015). Research suggests that children may naturally lose their appetite when stressed, and eating in response to emotions may be a learned behavior (Farrow, Haycraft, & Blissett, 2015; Savage, Fisher, & Birch, 2007). Although it was not examined in this study, parent eating behaviors and parent feeding practices play a major role in eating behavior of young children. Children whose mothers use food for emotion regulation have greater consumption of sweet palatable foods in the absence of hunger, and while in a negative mood state, than children whose mothers do not eat for emotional reasons (Farrow, Haycraft, & Blissett, 2015; Blissett, Haycraft, & Farrow, 2010). Additionally, previous research has shown an association of parent self-report of disinhibited eating with a child's diminished ability to self-regulate food intake (Johnson & Birch, 1994). It is also possible that, because children's access to food is limited by their caregivers, they may not have had the opportunity to eat when they are experiencing negative emotions. It would be useful in future studies to measure parental use of food to soothe an upset child as well as parental emotional eating because this may contribute to the child using food for mood regulation (Stifter, Anzman-Frasca, Birch, & Voegtline, 2011). Although research has not shown that using food to soothe has long-term effects on weight (Carnell & Wardle, 2007; Wardle & Carnell, 2007), studies have shown that parental use of food to soothe young children is associated with the child's weight gain (Stifter, Anzman-Frasca, Birch, & Voegtline, 2011).

It must be acknowledged that the use of a high chair to create distress may have confounded this study. Children who were more content in the high chair (i.e., took longer to become distressed and had fewer escape attempts) were reported to have more emotional overeating. It is possible that children who are susceptible to eating in order to improve their mood are calmed by the high chair because of its association with food. Unfortunately, no information was obtained about children's regular use of high chairs during meals at home or in a childcare setting. In future studies of this nature, however, it will be important to use another type of restraint that has not been previously associated with food.

Influence of Development and Adiposity

Some of the statistically significant findings in this study were present only when the PPVT-4 raw score was included in analyses. This is likely due to more sophisticated development of self-regulatory abilities, which begin to rapidly advance and integrate around three years of age (Montroy, Bowles, Skibbe, McClelland, & Morrison, 2016). Prior to the assimilation of self-regulatory abilities, which involves the recruitment of additional skills (i.e., language and motor skills), children typically respond to their environment with reactionary behaviors, primarily relying on an assessment of the environment to determine responses (Montroy et al., 2016). In other words, over time, children develop the ability to use reflective thought, to consider social norms, and to engage in task-oriented behavior in response to environmental stimuli, rather than just reacting to the environment around them (Kopp, 1982). Moreover, attention has been shown to serve as a foundation for further development of self-regulation, with the hypothesis that children's increased ability to control emotions and behavior is derived from separate attention systems that increase in complexity as development progresses and evolves (Frick, et al., 2017; Posner, Rothbart, Sheese, & Voelker, 2012). Consequently, this could explain why measures of attention, but not measures of inhibitory control and emotion regulation, were associated with eating behaviors.

Additionally, there were few associations of adiposity with eating behavior and self-regulatory ability in this study. There is limited research among children of this age investigating measures of adiposity and self-regulatory ability. One study has shown that the overall self-regulation ability of two-year-olds was not associated with their BMI at the same age, but it was predictive of BMI at five years of age (Graziano, Calkins, & Keane, 2010). This suggests that deficits in these skills may take time to have an effect on BMI in childhood. A study conducted in four-year-olds showed that eating behaviors at this age were associated with child BMI z-score, but self-regulatory behaviors were not (Hughes, Power, O'Connor, & Fisher, 2015). Consequently more research is needed to fully elucidate how the development of self-regulatory behaviors and eating behaviors impact the risk for obesity in the future. Although our study included a representative proportion of children in the overweight/obese BMI category compared to the overall population, the sample size was too small to compare average weight children to those who were overweight or obese.

Limitations and Future Directions

Limitations inherent to this study include the small sample size, which may have prevented us from having enough power to find statistical significance within several of our proposed hypotheses. Another limitation is the cross-sectional design of the study, which prevents the ability to infer causality. The use of questionnaire data to assess eating behaviors is also a limitation as it reflects parental perception of children's behavior rather than objectively measured behavior. In addition, the CEBQ was based on a survey developed for infants and older children, and it is not clear whether it is a valid and sensitive measure of eating behaviors in toddlers. Another limitation is the lack of validated behavioral measures of self-regulation in children of this age.

As noted previously, observed measures of behavior did not correlate with parent-reported temperament. This is consistent with prior research which also found poor agreement between observed behavioral tasks and parent report of behavior in the home (Gagne, Van Hulle, Aksan, Essex, & Goldsmith, 2011; Mangelsdorf, Schoppe, & Buur, 2000; Saudino, 2003). Parent reports of child behavior are often biased for a variety of reasons such as comparisons to siblings or inaccurate expectations of typical behavior for a given developmental level. Moreover, assessment of the same behavior with observational measures and parent report questionnaires may be tapping into different aspects of the same behavior. For example, in Saudino's (2009) study of child activity level, parent-reported measures of activity were more closely associated with genetic factors, whereas laboratory observations of activity were more closely related to environmental factors. Consequently, incorporating both parent-report and direct observation of the behaviors of interest in the same study will provide a richer assessment of child temperament and self-regulatory ability, but investigators should be careful to consider how the method of data collection could impact the operational definition of each construct.

Future studies examining self-regulatory abilities and eating behavior in very young children should include observational measures of eating behaviors under standardized conditions, as they may provide more accurate and objective data. Repeated assessments of these behaviors will be important to establish reliability of the measures. In addition, it is important to gather more information about the child and family, such as parental feeding practices and eating behaviors, accessibility of food, and diet (e.g., through a food record), etc., because these could be important mediators or modifiers of the associations among children's self-regulatory ability and their eating behaviors and risk for obesity. Finally, consideration of children's genetic potential for obesity, or the risk for obesity that was programmed by early life exposures (i.e., during pregnancy or infancy), will further enhance understanding of which children are susceptible to obesity and the mechanisms that contribute to their weight gain.

Conclusions

In conclusion, this study provided limited information about the relationship of self-regulatory behaviors and eating behaviors in young children. Moreover, significant results were contrary to proposed hypothesis (i.e., a subset of children with poorer attention were rated as having less satiety responsiveness), and this study found no support for an association of inhibitory control with eating behavior or for a role of emotion regulation in eating behavior. Given the minimal effectiveness of interventions for weight-loss or weight-loss maintenance in obese adolescents and adults (Nguyen, Komman, & Baur, 2011; Douketis, Macie, Thabane, & Williamson, 2005), it is important to develop interventions to prevent obesity from ever developing. Despite the lack of support for the *a priori* hypotheses in this study, there was some evidence that attention regulation may be an important developmental skill that influences some eating behaviors. Future research should continue to investigate the role of attention in eating behaviors, particularly as children's ability to focus and shift attention matures, and as they gain more independence in terms of opportunities to eat. Finally, it will be very important in future studies to investigate whether there is a lagged effect of attention regulation on children's weight gain and obesity risk.

REFERENCES

Agranat-Meged, A. N., Deitcher, C., Goldzweig, G. , Leibenson, L., Stein, M., & Galili-Weisstub, E. (2005). Childhood obesity and attention deficit/hyperactivity disorder: a newly described comorbidity in obese hospitalized children. *International Journal of Eating Disorders, 37*(4), 357-359.

Agras, W., Hammer, L., McNicholas, F., & Kraemer, H. (2004). Risk factors for childhood overweight. A prospective study from birth to 9.5 years. *Journal of Pediatrics*, *145*(1), 20-25.

Ahadi, S. A., Rothbart, M. K., & Ye, R. (1993). Children's temperament in the US and China: similarities and differences. *Personality, 7*(5), 359-378. doi: 10.1002/per.2410070506

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.

Anas, M., & Akhouri, D. (2013). Positive and negative affect in depressed and normal adults. *Journal of Indian Health Psychology, 8*(1), 61-68.

Anderson, S. E., & Whitaker, R. C. (2009). Prevalence of obesity among US preschool children in different racial and ethnic groups. *Archives of Pediatric Adolescent Medicine, 163*(4), 344-348.

Anzman-Frasca, S. S., Stifter, C. A., & Birch, L. L. (2012). Temperament and childhood obesity risk: A review of the literature. *Journal of Developmental and Behavioral Pediatrics, 33*(9), 732-745.

Avakame, E.F. (1998). Intergenerational transmission of violence, self-control, and conjugal violence: A comparative analysis of physical violence and psychological aggression. *Violence and Victims, 13*, 301-316.

Baranowski, T., Domel, S., Gould, R., Baranowski, J., Leonard, S., Treiber, F., & Mullis, R. (1993). Increasing fruit and vegetable consumption among 4th and 5th grade students: Results from focus groups using reciprocal determinism. *Journal of Nutrition Education, 25*, 114-120.

Barkley, R. A. (1997). Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. *Psychological Bulletin, 121*, 65-94.

Bartholdy, S., Dalton, B., O'Daly, O. G., Campbell, I. C., & Schmidt, U. (2016). A systematic review of the relationship between eating, weight and inhibitory control using the stop signal task. *Neuroscience and Biobehavioral Reviews, 64*, 35-62. doi: 10.1016/j.neubiorev.2016.02.010

Baumeister, R. F., Heatherton, T. F., & Tice, D. M. (1994). *Losing control: How and why people fail at self-regulation*. San Diego, CA: Academic Press.

Bellisle, F., & Dalix, A. M. (2001). Cognitive restraint can be offset by distraction, leading to increased meal intake in women. *American Journal of Clinical Nutrition, 74*, 197-200.

Ben-Avraham, S., Hyden, C. J., Fletcher, J., & Bonuck, K. A. (2015). Bottle and sippy cup use is associated with diet and energy intake in toddlers. *Maternal & Child Nutrition, 11*(4), 845-858. doi: 10.1111/mcn.12114

Bergmeier, H., Skouteris, H., Horwood, S., Hooley, M., & Richardson, B. (2013). Associations between child temperament, maternal feeding practices and child body mass index during the preschool years: A systematic reviewof the literature. *Obesity Reviews, 15*(1), 1-10.

Birch, L. L., & Deysher, M. (1985). Conditioned and unconditioned caloric compensation: evidence for self-regulation of food intake by young children. *Learn and Motivation, 16*, 341-355.

Birch, L. L., & Fisher, J. O. (2000). Mothers' child-feeding practices influence daughters' eating and weight. *American Journal of Clinical Nutrition, 71*, 1054-1061.

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

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

Birch, L. L., McPhee, L., Shoba, B. C., Steinberg, L., & Krehbiel, R. (1987). "Clean up your plate":Effects of child feeding practices on the conditioning of meal size. *Learning & Motivation, 18*(3), 301-317.

Birch, L. L., Zimmerman, S. I., & Hind, H. (1980). The influence of social-affective context on the formation of children's food preferences. *Child Development, 51*(3), 856-861.

Biro, F.M., & Wien, M. (2010). Childhood obesity and adult morbidities. *American Journal of Clinical Nutrition, 91*(5), 1499S-1505S.

Blissett, J., Haycraft, E., & Farrow, C. (2010). Inducing preschool children's emotional eating: relations with parental feeding practices. *The American Journal of Clinical Nutrition, 92*, 359-365.

Blum, K., Cull, J. G., Braverman, E. R., & Comings, D. E. (1996). Reward Deficiency Syndrome. *American Scientist, 84*(2), 132-145.

Blum, K., Sheridan, P. J., Wood, R. G., Braverman, E. R., Chen, T. J. H., Cull, J. G., & Comings, D. E. (1996). The D2 dopamine receptor gene as a predictor of reward deficiency syndrome: Bayes theorem. *Journal of the Royal Society of Medicine, 89*(7), 396-400.

Blum, K., Thanos, P.K., & Gold, M.S. (2014). Dopamine and glucose, obesity, and reward deficiency syndrome. *Front Psychol, 5*, 919. doi: 10.3389/fpsyg.2014.00919

Blundell, J. E., & Cooling, J. (2000). Routes to obesity: Phenotypes, food choices and activity. *British Journal of Nutrition, 83*, S33-S38.

Blundell, J. E., Stubbs, R. J., Golding, C., Croden, F., Alam, R., Whybrow, S., . . . Lawton, C.L. (2005). Resistance and susceptibility to weight gain: Individual variability in response to a high-fat diet. *Physiology & Behavior, 86*, 614-622.

Bonato, D.P., & Boland, F.J. (1983). Delay of gratification in obese children. *Addictive Behavior*, *8*(1), 71-74.

Boney, C., Verma, A., Tucker, R., & Vohr, B. (2005). Metabolic syndrome in childhood: Association with birth weight, maternal obesity, and gestational diabetes mellitus. *Pediatrics, 115*, 290-296.

Braet, C., Claus, L., Verbeken, S., & Vlierberghe, L.V. (2007). Impulsivity in overweight children. *European Child & Adolescent Psychiatry, 16*, 473-483. doi: 10.1007/s00787-007-0623-2

Braet, C., & Crombez, G. (2003). Cognitive interference due to food cues in childhood obesity. *Journal of Clinical Child and Adolescent Psychology, 32*, 32-39. doi: 10.1207/S15374424JCCP3201_04

Braet, C., & Van Strien, T. (1997). Assessment of emotional, externally induced and restrained eating behavior in nine to twelve-year-old obese and non-obese children. *Behavior Research and Therapy*, *35*, 863-873.

Brotman, L. M., Dawson-McClure, S., Huang, K.-Y., Theise, R., Kamboukos, D., Wang, J., et al. (2012). Early childhood family intervention and long-term obesity prevention among high-risk minority youth. *Pediatrics, 129*(3), e621-e628. doi: 10.1542/peds.2011-1568.

Bush, N. C., Chandler-Laney, P. C., Rouse, D. J., Granger, W. M., Oster, R. A., & Gower, B. A. (2011). Higher gestational glucose concentration is associated with lower offspring insulin sensitivity and altered β-cell function. *Journal of Clinical Endocrinology and Metabolism, 96*(5), 803-809.

Calitri, R., Pothos, E. M., Tapper, K., Brunstrom, J. M., & Rogers, P. J. (2010). Cognitive biases to healthy and unhealthy food words predict change in BMI. *Obesity, 18*, 2282-2287. doi: 10.1038/oby.2010.78

Calkins, S., & Johnson, M. (1998). Toddler regulation of distress to frustrating events: Temperamental and maternal correlates. *Infant Behavior Development, 21*, 379-395.

Carnell, S., Gibson, C., Benson, L., Ochner, C. N., & Geliebter, A. (2012). Neuroimaging and obesity: current knowledge and future directions. *Obesity Reviews*, *13*(1), 43-56. doi: 10.1111/j.1467-789X.2011.00927.x

Carnell, S., Haworth, C. M. A., Plomin, R., & Wardle, J. (2008). Genetic influence on appetite in children. *International Journal of Obesity, 32*(10), 1468-1473.

Carnell, S., & Wardle, J. (2007). Measuring behavioural susceptibility to obesity: Validation of the child eating behaviour questionnaire. *Appetite, 48*(1), 104-113. doi: 10.1016/j.appet.2006.07.075

Carnell, S., & Wardle, J. (2008). Appetite and adiposity in children: Evidence for a behavioral susceptibility theory of obesity. *American Journal of Clinical Nutrition, 88*, 22-229.

Carper, J. L., Fisher, J. O., & Birch, L. L. (2000). Young girls' emerging dietary restraint and disinhibition are related to parental control in child feeding *Appetite, 35*, 121-129.

Castellanos, E. H., Charboneau, E., Dietrich, M. S., Park, S., Bradley, B. P., Mogg, K., & Cowan, R.L. (2009). Obese adults have visual attention bias for food cue images:

Evidence for altered reward system function. *International Journal of Obesity, 33*, 1063-1073. doi: 10.1038/ijo.2009.138

Catalano, P. M., McIntyre, H. D., Cruickshank, J. K., McCance, D. R., Dyer, A. R., Metzger, B. E., . . . Oats, J. J. (2012). The hyperglycemia and adverse pregnancy outcome study: Associations of GDM and obesity with pregnancy outcomes. *Diabetes Care, 35*(4).

Chandler-Laney, P. C., Bush, N. C., Rouse, D. J., Mancuso, M. S., & Gower, B. A. (2011). Maternal glucose concentration during pregnancy predicts fat and lean mass of prepubertal offspring. *Diabetes Care, 34*, 741-745.

Chandler-Laney, P. C., Gower, B. A., & Fields, D. A. (2013). Gestational and early life influences on infant body composition at 1 year. *Obesity (Silver Spring), 21*(1), 144-148. doi: 10.1002/oby.20236.

Chen, P. S., Yang, Y. K., Yeh, T. L., Lee, I. H., Yao W. J., Chiu, N. T., et al. (2008). Correlation between body mass index and striatal dopamine transporter availability in healthy volunteers–a SPECT study. *Neuroimage, 40*, 275-279. doi: 10.1016/j.neuroimage.2007.11.007

Childers, J. S., Durham, T. W., & Wilson, S. (2016). Relation of performance on the Kaufman Brief Intelligence Test with the Peabody Picture Vocabulary Test—Revised among preschool children *Perceptual and Motor Skills, 79*(3), 1195-1199.

Cole, P., Martin, S., & Dennis, T. (2004). Emotion regulation as a scientific construct: Methodological challenges and directions for child development research. *Child Development, 75*(2), 317-333. doi: 10.1111/j.1467-8624.2004.00673.x.

Cortese, S., Angriman, M., Maffeis, C., Isnard, P., Konofal, E., Lecendreux, M., et al. (2008). Attention-Deficit/Hyperactivity Disorder (ADHD) and obesity: A systematic review of the literature. *Critical Reviews in Food Science and Nutrition, 48,* 524-537.

Cortese, S., Ramos Olazagasti, M. A., Klein, R. G., Castellanos, F. X., Proal, E., & Mannuzza, S. (2013). Obesity in men with childhood ADHD: A 33-year controlled, prospective, follow-up study. *Pediatrics, 31*(6), e1731-e1738.

Costanzo, P., & Woody, E. (1985). Domain-specific parenting styles and their impact on the child's development of particular deviance: The example of obesity proneness. *Journal of Social and Clinical Psychology, 3*(4), 425-445.

Crawford, J. R., & Henry, J. D. (2004). The Positive and Negative Affect Schedule (PANAS): Construct validity, measurement properties and normative data in a large non-clinical sample. *British Journal of Clinical Psychology, 43,* 245-265.

Daniels, S. R. (2006). The consequences of childhood overweight and obesity. *The Future of Children, 16*(1), 47-67.

Davids, S., Lauffer, H., Thoms, K., Jagdhuhn, M., Hirschfeld, H., Domin, M., Hamm, A., & Lotze, M. (2010). Increased dorsolateral prefrontal cortex activation in obese children during observation of food stimuli. *International Journal of Obesity & Related Metabolic Disorders, 34,* 94-104.

Davis, C. (2010). Attention-Deficit/Hyperactivity Disorder: Associations with overeating and obesity. *Current Psychiatry Reports, 12*(5), 389-395.

Davison, K. K., & Birch, L. L. . (2004). Predictors of fat stereotypes among 9-year-old girls and their parents. *Obesity Research, 12*(1), 86-94.

DelParigi, A. , Pa, D.N., & Tataranni, P.A. (2005). In pursuit of neural risk factors for weight gain in humans. *Neurobiol Aging, Suppl 1*(50-55).

Domel, S. B., Baranowski, T., Leonard, S. B., Davis, H., Riley, P., & Baranowski, J. (1994). Accuracy of fourth and fifth grade students' food records compared to school lunch observation. *American Journal of Clinical Nutrition, 59*, S218-S220.

Douketis, J. D., Macie, C., Thabane, L., & Williamson, D. F. (2005). Systematic review of long-term weight loss studies in obese adults: Clinical significance and applicability to clinical practice. *International Journal Of Obesity, 29*(10), 1153-1167. doi: doi:10.1038/sj.ijo.0802982

Drukker, M., Wojciechowski, F., Feron, F. J., Mengelers, R., & Van Os, J. (2009). A community study of psychosocial functioning and weight in young children and adolescents. *International Journal of Pediatric Obesity, 4*, 91-97.

Duckworth, A. L., & Seligman, M. E. P. (2005). Self-discipline outdoes IQ in predicting academic performance of adolescents. *Psychological Science, 16*(12), 939-944. doi: 10.1111/j.1467-9280.2005.01641.x.

Dumas, J. E., Nissley, J., Nordstrom, A., Smith, E. P., Prinz, R. J., & Levine, D. W. (2005). Home chaos: sociodemographic, parenting, interactional, and child correlates. *Journal of Clinical Child and Adolescent Psychology, 34*(1), 93-104.

Dunn, L. M. , & Dunn, D. M. (2007). Peabody Picture Vocabulary Test: Fourth Edition (PPVT-4). Minneapolis, MN: Pearson.

Erhart, M., Herpertz-Dahlmann, B., Wille, N., Sawitzky-Rose, B., Holling, H., & Ravens-Sieberer, U. (2012). Examining the relationship between Attention-

Deficit/Hyperactivity Disorder and overweight in children and adolescents. *European Child & Adolescent Psychiatry, 21*, 39-49.

Evans, G., Kliewer, W., & Martin, J. (1991). *New direction in health psychology assessment*. New York: Hemisphere.

Faith, M., & Hittner, J. (2010). Infant temperament and eating style predict change in standardized weight status and obesity risk at 6 years of age. *International Journal of Obesity 34*(10), 1515-1523. doi: 10.1038/ijo.2010.156.

Farley, J., Risko, E. F., & Kingstone, A. (2013). Everyday attention and lecture retention: the effects of time, fidgeting, and mind wandering. *Frontiers in Psychology, 4*(619), 1-9. doi: 10.3389/fpsyg.2013.00619

Farrow, C., Haycraft, E., & Blissett, J. (2015). Teaching our children when to eat: how parental feeding practices inform the development of emotional eating - a longitudinal experimental design. *Am J Clin Nutr, 101*(5), 908-913. doi: 10.3945/ajcn.114.103713

Fields, S., Sabet, M., Peal, A., & Reynolds, B. (2011). Relationship between weight status and delay discounting in a sample of adolescent cigarette smokers. *Behavioral Pharmacology, 22*(3), 266-268. doi: 10.1097/FBP.0b013e328345c855.

Finistrella, V. , Manco, M., Ferrara, A., Rustico, C., Presaghi, F., & Morino, G. (2012). Cross-sectional exploration of maternal reports of food neophobia and pickiness in preschooler-mother dyads. *Journal of the American College of Nutrition, 31*, 152-159.

Florez, I.R. (2011). Developing young children's self-regulation through everyday experiences. *Young Children, 66*, 46-51.

Fortuna, J. L. (2012). The obesity epidemic and food addiction: clinical similarities to drug dependence. *Journal of Psychoactive Drugs, 44*(1), 56-63.

Francis, L., & Susman, E.J. (2009). Self-regulation failure and rapid weight gain in children from age 3 to 12 years. *Archives of Disease in Children and Adolescents, 163*, 297-302.

Francis, L. A., Lee, Y., & Birch, L. L. (2003). Parental weight status and girls' television viewing, snacking, and body mass indexes. *Obesity Research, 11*, 143-151.

Fraser, A., Tilling, K., Macdonald-Wallis, C., Sattar, N., Brion, M.J., Benfield, L., . . . Lawlor, D.A. (2010). Association of maternal weight gain in pregnancy with offspring obesity and metabolic and vascular traits in childhood. *Circulation, 121*, 2557-2564.

Frick, M.A., Forslund, T., Fransson, M., Johansson, M., Bohlin, G., & Brocki, K.C. (2017). The role of sustained attention, maternal sensitivity, and infant temperament in the development of early self-regulation. *British Journal of Psychology*. doi: 10.1111/bjop.12266

Fuemmeler, B. F., Ostbye, T., Yang, C., McClernon, F. J., & Kollins, S. H. (2011). Association between Attention-Deficit/Hyperactivity Disorder (ADHD) symptoms and obesity and hypertension in early adulthood: A population-based study. *International Journal of Obesity, 35*(6), 852-862.

Fuhs, M. W., & Day, J. D. (2011). Verbal ability and executive functioning development in preschoolers at Head Start. *Developmental Psychology*, *47*(2), 404-416.

Gaertner, B. M., Spinrad, T. L., & Eisenberg, N. (2008). Focused attention in toddlers: measurement, stability, and relations to negative emotion and parenting. *Infant and Child Development, 17*(4), 339-363. doi: 10.1002/ICD.580

Gagne, J. R., Van Hulle, C. A., Aksan, N., Essex, M. J., & Goldsmith, H. H. (2011). Deriving childhood temperament measures from emotion-eliciting behavioral episodes: scale construction and initial validation. *Psychological Assessment, 23*(2), 337-353. doi: 10.1037/a0021746

Gahagan, S. (2012). The development of eating behavior – biology and context. *J Dev Behav Pediatr, 33*(3), 261-271, doi:10.1097/DBP.0b013e31824a7baa

Gartstein, M. A., & Rothbart, M. K. (2003). Studying infant temperament via the Revised Infant Behavior Questionnaire. *Infant Behav Dev, 26*, 64-86.

Gearhardt, A. N., Yokum, S., Orr, P. T., Stice, E., Corbin, W. R., & Brownell, K. D. (2011). Neural correlates of food addiction. *Arch Gen Psychiatry, 68*, 808-816.

Geller, S. E., Keane, T.M., & Scheirer, C. J. (1981). Delay of gratification, locus of control, and eating patterns in obese and nonobese children. *Addictive Behaviors, 6*, 9-14.

Goldman, D. Z., Shapiro, E. G., & Nelson, C. A. (2004). Measurement of vigilance in 2-year-old children. *Developmental Neuropsychology 25*, 227-250.

Goldsmith, H. H., & Rothbart, M. K. (1993). *The laboratory temperament assessment battery (LAB-TAB)*. University of Wisconsin.

Goldstein, M., Brendel, G., Tuescher, O., Pan, H., Levy, K. N., Epstein, J., & Silbersweig, D. (2007). Neural substrates of the interaction of emotional stimulus processing and motor inhibitory control: An emotional linguistic Go/no-go fMRI study. *NeuroImage, 36*, 1026-1040.

Goodman, S. H., & Gotlib, I. H. (1999). Risk for psychopathology in the children of depressed mothers: A developmental model for understanding mechanisms of transmission. *Psychological Review, 106*(3). doi: http://dx.doi.org/10.1037/0033-295X.106.3.458

Graziano, P., Kelleher, R., Calkins, S., Keane, S., & O'Brien, M. (2013). Predicting weight outcomes in preadolescence: The role of toddlers' self-regulation skills and the temperament dimension of pleasure. *International Journal of Obesity, 37*, 937-942.

Graziano, P. A., Calkins, S. D., & Keane, S. P. (2010). Toddler self-regulation skills predict risk for pediatric obesity. *International Journal of Obesity, 34*, 633-641.

Graziano, P. A., Reavis, R. D., Keane, S. P., & Calkins, S. D. (2007). The role of emotion regulation and children's early academic success. *Journal of School Psychology, 45*(1), 3-19.

Gregory, J. E., Paxton, S. J., & Brozovic, A. M. (2010). Maternal feeding practices, child eating behaviour and body mass index in preschool-aged children: a prospective analysis. *International Journal of Behavioral Nutrition and Physical Activity, 7*(1), 55. doi: 10.1186/1479-5868-7-55

Gross, J. J. (1998). The emerging field of emotion regulation: An integrative review. *Review of General Psychology, 2*(3), 271.

Guerrieri, R., Nederkoorn, C., & Jansen, A. (2008). The interaction between impulsivity and a varied food environment: its influence on food intake and overweight *Int. J. Obes., 32*, 708-714. doi: http://dx.doi.org/10.1038/sj.ijo.0803770

Guerrieri, R., Nederkoorn, C., Stankiewicz, K., Alberts, H., Geschwind, N., Martijn, C., & Jansen, A. (2007). The influence of trait and induced state impulsivity on food intake in normal-weight healthy women. *Appetite*, *49*(1), 66-73.

Haworth, C. M., Carnell, S., Meaburn, E. L., Davis, O. S., Plomin, R., & Wardle, J. (2008). Increasing heritability of BMI and stronger associations with the FTO gene over childhood. *Obesity, 16*, 2663-2668. doi: 10.038/oby.2008.434.

Harris, H. A., Fildes, A., Mallan, K. M., & Llewellyn, C. H. (2016). Maternal feeding practices and fussy eating in toddlerhood: A discordant twin analysis. *The International Journal Of Behavioral Nutrition And Physical Activity, 13*(81). doi: 10.1186/s12966-016-0408-4

Harrist, A. W., Hubbs-Tait, L., Topham, G. L., Shriver, L. H., & Page, M. C. (2013). Emotion regulation is related to children's emotional and external eating. *Journal Of Developmental And Behavioral Pediatrics, 34*(8), 557-565. doi: doi:10.1097/DBP.0b013e3182a5095f

Haycraft, E., Farrow, C., Meyer, C., Powell, F., & Blissett, J. (2011). Relationships between temperament and eating behaviours in young children. *Appetite*, *56*, 689-692.

Heinrichs, S. C. (2003). Nonexercise muscle tension and behavioral fidgeting are positively correlated with food availability/palatability and body weight in rats. *Physiology & Behavior, 79*(2), 199-207. doi: 10.1016/S0031-9384(03)00086-6

Hetherington, M. M. (2007). Individual differences in the drive to overeat. *Nutrition Bulletin*, *32*(suppl 1), 14-21.

Hewitt, J. K. (1997). The genetics of obesity: What have genetic studies told us about the environment? *Behavior Genetics, 27*, 353-358.

Hill, J. O., Wyatt, H. R., Reed, G. W., & Peters, J. C. (2003). Obesity and the environment: Where do we go from here? *Science*, *299*, 853-855.

Hillier, T. A., Pedula, K. L., Schmidt, M. M., Mullen, J. A., Charles, M. A., & Pettitt, D. J. (2007). Childhood obesity and metabolic imprinting: The ongoing effects of maternal hyperglycemia. *Diabetes Care*, *30*, 2287-2292.

Hodges, E. A., Wasser, H.M., Colgan, B.K., & Bentley, M.E. (2016). Development of feeding cues during infancy and toddlerhood. *MCN Am J Matern Child Nurs, 41*(4), 244-251. doi: 10.1097/NMC.0000000000000251

Hughes, S. O., Power, T. G., O'Connor, T. M., & Fisher, J. O. (2015). Executive functioning, emotion regulation, eating self-regulation, and weight status in low-income preschool children: How do they relate? *Appetite, 89*(1-9). doi: http://dx.doi.org/10.1016/j.appet.2015.01.009

Hurley, K. M., Cross, M. B., & Hughes, S. O. (2011). A systematic review of responsive feeding and child obesity in high-income countries. *The Journal of Nutrition, 141*(3), 495-501.

Life Measurement Instruments. Concord, CA, USA: COSMED.

Jansen, P. W., Roza, S. J., Jaddoe, V. W., Mackenbach, J. D., Raat, H., Hofman, A., … Tiemeier, H. (2012). Children's eating behavior, feeding practices of parents and weight problems in early childhood: results from the population-based Generation

R Study. *The International Journal of Behavioral Nutrition and Physical Activity, 9*, 130. doi: 10.1186/1479-5868-9-130

Jansen, A., Theunissen, N., Slechten, K., Nederkoorn, C., Boon, B., Mulkens, S., & Roefs, A. (2003). Overweight children overeat after exposure to food cues. *Eating Behaviors, 4*(2), 197-209.

Janssen, L. K., Duif, I., van Loon, I., Wegman, J., de Vries, J. H., Cools, R., & Aarts, E. (2017). Loss of lateral prefrontal cortex control in food-directed attention and goal-directed food choice in obesity. *Neuroimage, 146*, 148-156. doi: 10.1016/j.neuroimage.2016.11.015

Johnson, M. S., Figueroa-Colon, R., Huang, T. T.-K., Dwyer, J. H., & Goran, M. I. (2001). Longitudinal changes in body fat in African American and Caucasian children: Influence of fasting insulin and insulin sensitivity. *Journal of Clinical Endocrinology and Metabolism, 86*(7), 3182-3187.

Johnson, S.L., & Birch, L. L. (1994). Parents' and children's adiposity and eating style. *Pediatrics, 94*(5), 653-661.

Kalarchian, M., & Marcus, M. (2012). Psychiatric comorbidity of childhood obesity. *International Review of Psychiatry (Abingdon, England), 24*(3), 241-246. doi: 10.3109/09540261.2012.678818

Kaler, S. R. & Kopp, C. B. (1990). Compliance and comprehension in very young toddlers. *Child Development, 61* (6), 1997-2003. doi: 10.1111/j.1467-8624.1990.tb03581.x

Kamijo, K., Pontifex, M. B., Khan, N. A., Raine, L. B., Scudder, M. R., Drollette, E. S., . . . Hillman, C. H. (2012). The impact of poverty on the mental health and development of very young children. *Psychophysiology, 49*, 1361-1371.

Ke, J., & Ford-Jones, E. L. (2015). Food insecurity and hunger: A review of the effects on children's health and behaviour. *Paediatrics & Child Health*, *20*(2), 89-91.

Khalife, N., Kantomaa, M., Glover, V., Tammelin, T., Laitinen, J., Ebeling, H., . . . Rodriguez, A. (2014). Childhood attention deficit-hyperactivity disorder symptoms are risk factors for obesity and physical inactivity in adolescence. *Journal of the American Academy of Child & Adolescent Psychiatry*, *53*(4), 425-436.

King, J. C. (2006). Maternal obesity, metabolism, and pregnancy outcomes. *Annual Review of Nutrition*, *26*, 271-291.

Kirby, S. D., Baranowski, T., Reynolds, K. D., Taylor, G., & Binkley, D. (1995). Children's fruit and vegetable intake: Socioeconomic, adult-child, regional, and urban-rural influences. *Journal of Nutrition Education*, *27*(5), 261-271.

Knight, B., Shields, B. M., Hill, A., Powell, R. J., Wright, D., & Hattersley, A. T. (2007). The impact of maternal glycemia and obesity on early postnatal growth in a nondiabetic Caucasian population. *Diabetes Care, 30*, 777- 783.

Kopp, C. B. (1982). Antecedents of self-regulation: A developmental perspective. *Developmental Psychology*, *19*, 199-214. doi: http://dx.doi.org/10.1037/0012-1649.18.2.199

Kuhl, E. S., Clifford, L. M., & Stark, L. J. (2012). Obesity in preschoolers: Behavioral correlates and directions for treatment. *Obesity, 20*(1), 3-29. doi: 10.1038/oby.2011.201

Lange, K., Thamotharan, S., Sferra, M., Ramos, A., & Fields, S. (2014). Effects of weight and gender on a task of inattention. *Eating Behaviors, 15*(4), 574-577.

Larsson, G., Spjuth, J., Ranstam, J., Vikbladh, I., Saxtrup, O., & Astedt, B. (1986). Prognostic significance of birth of large infant for subsequent development of maternal non-insulin-dependent diabetes mellitus: a prospective study over 20-27 years. *Diabetes Care, 9*, 359-364.

Lattimore, P., & Mead, B. R. (2015). See it, grab it, or STOP! Relationships between trait impulsivity, attentional bias for pictorial food cues and associated response inhibition following in-vivo food cue exposure. *Appetite, 90*, 248-253. doi: 10.1016/j.appet.2015.02.020

Leung, C. Y., Lumeng, J. C., Kaciroti, N., Chen, Y. P., Rosenblum, K., & Miller, A. L. (2014). Surgency and negative affectivity, but not effortful control, are uniquely associated with obesogenic eating behaviors among low-income preschoolers. *Appetite, 78*, 139-146.

Leventakou, V., Micali, N., Georgiou, V., Sarri, K., Koutra, K., Koinaki, S., et al. (2016). Is there an association between eating behaviour and attention-deficit/hyperactivity disorder symptoms in preschool children? *Journal of Child Psychology and Psychiatry, 57*(6), 676-684.

Levine, J. A., Lanningham-Foster, L. M., McCrady, S. K., Krizan, A. C., Olson, L. R., Kane, P. H., & Clark, M. M. (2005). Interindividual Variation in Posture Allocation: Possible Role In Human Obesity. *Science, 307*(5709), 584.

Levine, J., Schleusner, S., & Jensen, M. (2000). Energy expenditure of nonexercise activity...fidgeting-like activities. *American Journal of Clinical Nutrition, 72*(6), 1451-1454.

Li, S., Zhao, J. H., Luan, J., Luben, R. N., Rodwell, S. A., Khaw, K. T., . . . Loos, R. J. (2010). Cumulative effects and predictive value of common obesity-susceptibility variants identified by genome-wide association studies. *American Journal of Clinical Nutrition, 91*(1), 184-190.

Liang, J., Matheson, B. E., Kaye, W. H., & Boutelle, K. N. (2014). Neurocognitive correlates of obesity and obesity-related behaviors in children and adolescents. *International Journal of Obesity & Related Metabolic Disorders, 38*(4), 494-506. doi: 10.1038/ijo.2013.142

Lumeng, J.C., Miller, A.M., Horodynski, M.A., Brophy-Herb, H.E., Contreras, D., Lee, H., et al. (2017). Improving self-regulation for obesity prevention in Head Start: a randomized controlled trial. *Pediatrics 139*(5). doi: 10.1542/peds.2016-2047

MacRae, L. M., Darlington, G., Haines, J., & Ma, D. W. (2017). Examination of associations between chaos in the home environment, serum cortisol level, and dietary fat intake among parents of preschool-age children. *Applied Physiology, Nutrition & Metabolism, 42*(7), 788-791.

Mahone, E. M. (2005). Measurement of attention and related functions in the preschool child. *Mental Retardation and Developmental Disabilities, 11*, 216-225.

Malik, V.S., Schulze, M.B., & Hu, F.B. (2006). Intake of sugar-sweetened beverages and weight gain: a systematic review. *The American Journal of Clinical Nutrition, 84*(2), 274-288.Mangelsdorf, S.C., Schoppe, S.J., & Buur, H. (2000). The meaning of parental reports: A contextual approach to the study of temperament and behavior problems in childhood. In: Molfese VJ, Molfese DL, editors. Temperament and personality development across the life span. Mahwah, NJ: Lawrence Erlbaum Associates. pp. 121–140.

Matheny, A. P., Wachs, T. D., Ludwig, J. L., & Phillips, K. (1995). Bringing order out of chaos: Psychometric characteristics of the Confusion, Hubbub, And Order Scale. *Journal of Applied Developmental Psychology, 16*(3), 429-444. doi: 10.1016/0193-3973(95)90028-4

Matheny, A. P., Wilson, R. S, & Thoben, A. S. (1987). Home and mother: Relations with infant temperament. *Developmental Psychology, 23*(3), 323-331.

Merz, E. C., Landry, S. H., Zucker, T. A., Barnes, M. A., Assel, M., Taylor, H. B., et al. (2016). Parenting predictors of delay inhibition in socioeconomically disadvantaged preschoolers. *Infant and Child Development 25*(5), 371-390. doi: http://dx.doi.org/10.1002/icd.1946

Metzger, B. E. (2007). Long-term outcomes in mothers diagnosed with gestational diabetes mellitus and their offspring. *Clinical Obstetrics and Gynecology, 50*(4), 972-979.

Micali, N., Simonoff, E., Elberling, H., Rask, C.U., Olsen, E.M., & Skovgaard, A.M. (2011). Eating patterns in a population based sample of children aged 5 to 7 years:

Association with psychopathology and parentally perceived impairment. *Journal of Developmental and Behavioral Pediatrics, 32*, 572-580.

Michaelides, M., Thanos, P. K., Kim, R., Cho, J.,Ananth,M.,Wang, G. J., et al. (2012). PET imaging predicts future body weight and cocaine preference. *Neuroimage, 59*, 1508-1513. doi: 10.1016/j.neuroimage.2011.08.028

Mischel, W., Ebbesen, E. B., & Raskoff Zeiss, A. (1972). Cognitive and attentional mechanisms in delay of gratification. *Journal of Personality and Social Psychology*, *21*(2), 204-218.

Mischel, W., Shoda, Y., & Peake, P. K. (1988). The nature of adolescent competencies predicted by preschool delay of gratification. *Journal of Personality and Social Psychology*, *54*, 687-696.

Moffitt, T. E., Arseneault, L., Belsky, D., Dickson, N., Hancox, R.J., Harrington, H., . . . Caspi, A. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Sciences, 108*(7), 2693-2698. doi: 10.1073/pnas.1010076108.

Montroy, J. J., Bowles, R. P., Skibbe, L. E., McClelland, M. M., & Morrison, F. J. (2016). The development of self-regulation across early childhood. *Developmental Psychology, 52*(11), 1744-1762. doi: doi:10.1037/DEV0000159

Murphy, B. C., Eisenberg, N., Fabes, R. A., Shepard, S., & Guthrie, I. (1999). Consistency and change in children's emotionality and regulation: A longitudinal study. *Merrill-Palmer Quarterly, 45*(3), 413-444.

Murphy, S. P., Castillo, R. O., Martorell, R., & Mendoza, F. S. (1990). An evaluation of food group intakes by Hispanic-American children. *Journal of the American Dietetic Association, 90*, 388-393.

Nederkoorn, C., Braet, C., Van Eijs, Y., Tanghe, A., & Jansen, A. (2006). Why obese children cannot resist food: the role of impulsivity. *Eating Behaviors, 7*, 315-322.

Nederkoorn, C., Jansen, E., Mulkens, S., & Jansen, A. (2006). Impulsivity predicts treatment outcome in obese children. *Behaviour Research and Therapy, 45*, 1071-1075.

Nederkoorn, C., Smulders, F.T., Havermans, R.C., Roefs, A., & Jansen, A. (2006). Impulsivity in obese women. *Appetite, 47*, 253-256. doi: http://dx.doi.org/10.1016/ j.appet.2006.05.008

Neel, J. V. (1962). Diabetes mellitus: A ‘‘thrifty’’ genotype rendered detrimental by ‘‘progress’’? *American Journal of Human Genetics, 14*, 353-362.

Nguyen, B., Kornman, K. P., & Baur, L. A. (2011). A review of electronic interventions for prevention and treatment of overweight and obesity in young people. *Obesity Reviews, 12*, e298-e314.

Nguyen-Rodriguez, S. T., Unger, J. B., & Spriujt-Metz, D. (2009). Psychological determinants of emotional eating in adolescence. *Eating Disorders: The Journal of Treatment & Prevention, 17*(3), 211-224.

Nigg, J. T. (2000). On inhibition/disinhibition in developmental psychopathology: Views from cognitive and personality psychology and a working inhibition taxonomy. *Psychological Bulletin, 126*, 220-246.

Nijs, I. M. T., Muris, P., Euser, A. S., & Franken, I. H. A. (2010). Differences in attention to food and food intake between overweight/obese and normal-weight females under conditions of hunger and satiety. *Appetite, 54,* 243-254. doi: 10.1016/j.appet.2009.11.004

O'Connor, T. M., Yang, S., & Nicklas, T. A. (2006). Beverage intake among preschool children and its effect on weight status. *Pediatrics, 118*(4), e1010-e1018; doi: 10.1542/peds.2005-2348

Odeleye, O. E., de Courten, M., Pettitt, D. J., & Ravussin, E. (1997). Fasting hyperinsulinemia is a predictor of increased body weight gain and obesity in Pima Indian children. *Diabetes, 46*(8), 1341-1345. doi: 10.2337/diab.46.8.1341.

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. *JAMA, 311*(8), 806-814. doi: doi: 10.1001/jama.2014.732.

Oken, E., & Gillman, M. W. (2012). Fetal origins of obesity. *Obesity, 11*(4), 496-506.

Oken, E., Rifas-Shiman, S. L., Field, A. E., Frazier, A. L., & Giliman, M. W. (2008). Maternal gestational weight gain and offspring weight in adolescence. *Obstetrics & Gynecology, 112*(5), 999-1006.

Ouwens, M., van Strien, T., & van Leeuwe, J. F. J. (2009). Possible pathways between depression, emotion and external eating: A structural equation model. *Appetite, 53*, 245-248.

Pagoto, S. L., Curtin, C., Lemon, S. C., Bandini, L. G., Schneider, K. L., Bodenlos, J. S., & Ma, Y. (2009). Association between adult attention deficit/hyperactivity disorder and obesity in the US population. *Obesity, 17*(3), 539-544.

Parkinson, K., Drewett, R., Le Couteur, A., & Adamson, A. (2010). Do maternal ratings of appetite in infants predict later Child Eating Behaviour Questionnaire scores and body mass index? *Appetite, 54*(1), 186-190. doi: 10.1016/j.appet.2009.10.007

Patterson, B. H., Block, G., Rosenburger, W. F., Pee, D., & Kahle, L. L. (1990). Fruits and vegetables in the American diet: Data from the NHANES II survey. *American Journal of Public Health, 80*, 1443-1449.

Pauli-Pott, U., Albayrak, O., Hebebrand, J., & Pott, W. (2010). Association between inhibitory control capacity and body weight in overweight and obese children and adolescents: Dependence on age and inhibitory control component. *Child Neuropsychology, 16*, 592-603.

Pettitt, D. D. (2001). Intrauterine diabetic environment confers risks for type 2 diabetes mellitus and obesity in the offspring, in addition to genetic susceptibility. *Journal of Pediatric Endocrinology & Metabolism, 14*(8), 1085-1091.

Phillips, S. M., Bandini, L. G., Naumova, E. N., Cyr, H., Colclough, S., Dietz, W. H., & Must, A. (2004). Energy-dense snack food intake in Adolescence: Longitudinal relationship to weight and fatness. *Obesity Research, 12*, 461-472.

Pieper, J. R., & Laugero, K. D. (2013). Preschool children with lower executive function may be more vulnerable to emotional-based eating in the absence of hunger. *Appetite, 62*, 103-109.

Pietilainen, K. H., Kaprio, J., Rissanen, A., Winter, T., Rimpela, A., Viken, R. J., & Rose, R. J. (1999). Distribution and heritability of BMI in Finnish adolescents aged 16y and 17y: A study of 4884 twins and 2509 singletons. *International Journal of Obesity, 23*, 107-115.

Posner, M. I., Rothbart, M. K., Sheese, B. E., & Voelker, P. (2012). Control networks and neuromodulators of early development. *Developmental Psychology, 48*(3), 827-835. doi: https://doi-org.ezproxy3.lhl.uab.edu/10.1037/a0025530

Powers, S. W., Jones, J. S., Ferguson, K. S., Piazza-Waggoner, C., Daines, C., & Acton, J. D. (2005). Randomized clinical trial of behavioral and nutrition treatment to improve energy intake and growth in toddlers and preschoolers with cystic fibrosis. *Pediatrics, 116*(6), 1442-1450.

Ptacek, R., Kuzelova, H., Paclt, I., Zukov, I., & Fischer, S. (2009). ADHD and growth: Anthropometric changes in medicated and non-medicated ADHD boys. *Medical Science Monitor: International Medical Journal of Experimental and Clinical Research in African Literatures, 15*, CR595-599.

Pulgarón, E. R. (2013). Childhood obesity: A review of increased risk for physical and psychological comorbidities. *Clinical Therapeutics, 35*(1), A18-A32. doi: 10.1016/j.clinthera.2012.12.014.

Putnam, S. P., & Rothbart, M. K. (2006). Development of short and very short forms of the Children's Behavior Questionnaire. *Journal of Personality Assessment, 87*(1), 103-113.

Quah, P. L., Cheung, Y. B., Pang, W. W., Toh, J. Y., Saw, S. M., Godfrey, K. M., et al. (2017). Validation of the Children's Eating Behavior Questionnaire in 3 year old children of a multi-ethnic Asian population: The GUSTO cohort study. *Appetite, 113*, 100-105. doi: 10.1016/j.appet.2017.02.024

Rasmussen, F., & Johansson, M. (1998). The relation of weight, length and ponderal index at birth to body mass index and overweight among 18-year-old males in Sweden. *European Journal of Epidemioligy, 14*(4), 373-380.

Reilly, J. J., Armstrong, J., Dorosty, A. R., Emmett, P. M., Ness, A., Rogers, I., . . . Sherriff, A. (2005). Avon Longitudinal Study of Parents and Children Study Team: Early life risk factors for obesity in childhood: cohort study. *BMJ, 330,* 1357.

Rothbart, M. K., Ahadi, S. A., Hershey, K. L., & Fisher, P. (2001). Investigations of temperament at three to seven years: The Children's Behavior Questionnaire. *Child Development, 72*(5), 1394-1408.

Rothbart, M.K. (1981). Measurement of temperament in infancy. *Child Development, 52*, 569-578.

Rueda, M. R., Posner, M. I., & Rothbart, M. K. (2005). The development of executive attention: Contributions to the emergence of selfregulation. *Developmental Neuropsychology, 28*, 573-594.

Saudino, K.J. (2003). Parent ratings of infant temperament lessons from twin studies. *Infant Behavior & Development, 26*, 100–107.

Saudino, K.J. (2009). Do different measures tap the same genetic influences? A multi-method study of activity level in twins. *Dev Sci, 12*(4), 626-633. doi: 10.1111/j.1467-7687.2008.00801.x

Savage, J. S., Fisher, J. O., & Birch, L. L. (2007). Parental influence on eating behavior: conception to adolescence. *The Journal Of Law, Medicine & Ethics: A Journal Of The American Society Of Law, Medicine & Ethics, 35*(1), 22-34.

Schlam, T. R., Wilson, N. L., Shoda, Y., Mischel, W., & Ayduk, O. (2013). Preschoolers' delay of gratification predicts their body mass 30 years later. *Journal of Pediatrics, 162*(1), 90-93.

Seeyave, D. M., Coleman, S., Appugliese, D., Corwyn, R. F., Bradley, R. H., Davidson, N. S., . . . & Lumeng, J. C. (2009). Ability to delay gratification at age 4 years and risk of overweight at age 11 years. *Archives of Pediatrics & Adolescent Medicine, 163*, 303-308.

Serdula, M. K., Ivery, D., Coates, R. J., Freedman, D. S., Williamson, D. F., & Byers, T. (1993). Do obese children become obese adults? A review of the literature. *Preventive Medicine, 22*, 167-177.

Sewell, M. F., Houston, P. L., Super, D. M., & Catalano, P. (2006). Increased neonatal fat mass, not lean body mass, is associated with maternal obesity. *American Journal of Obstetrics & Gynecology, 195*, 1100-1103.

Shoda, Y., Mischel, W., & Peake, P. K. (1990). Predicting adolescent cognitive and self-regulatory competencies from preschool delay of gratification: Identifying diagnostic conditions. *Developmental Psychology, 26*, 978-986.

Silventoinen, K., Rokholm, B., Kaprio, J., & Sorensen, T. I. (2010). The genetic and environmental influences on childhood obesity: a systematic review of twin and adoption studies. *International Journal of Obesity (London), 34*(1), 29-40. doi: 10.1038/ijo.2009.177

Soussignan, R., Schaal, B., & Marlier, L. (1999). Olfactory alliesthesia in human neonates: prandial state and stimulus familiarity modulate facial and autonomic responses to milk odors. *Dev Psychobiol, 35*, 3–14.-83. doi: 10.1002/dev.10152

Sorensen, H. T., Sabroe, S., Rothman, K. J., Gillman, M., Fischer, P., & Sorensen, T. I. (1997). Relation between weight and length at birth and body mass index in young adulthood: cohort study. *BMJ 315*(7116), 1137.

Spence, J. C. (2011). Examining behavioural susceptibility to obesity among Canadian pre-school children: The role of eating behaviours. *International Journal of Pediatric Obesity, 6*(2), e501-e507.

Spinrad, T.L., Eisenberg, N., & Gaertner, B. M. (2007). Measures of effortful regulation for young children. *Infant Ment Health J, 28*(6), 606-262.

Spruijt-Metz, D. (2011). Etiology, treatment and prevention of obesity in childhood and adolescence: A decade in review. *Journal of Research on Adolescence, 21*(1), 129-152. doi: 10.1111/j.1532-7795.2010.00719.x

Stark, L. J., Powers, S. W., Jelalian, E., Rape, R. N., & Miller, D. L. (1994). Modifying problematic mealtime interactions of children with cystic fibrosis and their parents via behavioral parent training. *Journal of Pediatric Psychology, 19*(6), 751-768.

Steinsbekk, S., Bonneville-Roussy, A., Fildes, A., Llewellyn, C. H., & Wichstrøm, L. (2017). Child and parent predictors of picky eating from preschool to school age. *The International Journal Of Behavioral Nutrition And Physical Activity*, *14*(87). doi: doi:10.1186/s12966-017-0542-7

Stice, E., Spoor, S., Bohan, C., & Small, D. M. (2008). Relation between obesity and blunted striatal response to food is moderated by TaqIA A1 allele. *Science, 322*, 449-452.

Stifter, C.A., Anzman-Frasca, S., Birch, L.L., & Voegtline, K. (2011). Parent use of food to soothe infant/toddler distress and child weight status: An exploratory study. *Appetite, 57*(3), 693-699.

Sweetman, C., Wardle, J., & Cooke, L. (2008). Soft drinks and 'desire to drink' in preschoolers. *The International Journal of Behavioral Nutrition and Physical Activity, 5*(60).

Tamayo, T., Christian, H., & Rathmann, W. (2010). Impact of early psychosocial factors (childhood socioeconomic factors and adversities) on future risk of type 2 diabetes, metabolic disturbances and obesity: A systematic review. *BMC Public Health, 10*, 525. doi: 10.1186/1471-2458-10-525

Tan, C. C., & Holub, S. C. (2011). Children's self-regulation in eating. Associations with inhibitory control and parents' feeding behavior. *Journal of Pediatric Psychology, 36*(3), 340-345.

Tangney, J. P., Baumeister, R. F., & Boone, A. L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *Journal of Personality, 72*, 271-322.

The HAPO Study Cooperative Research Group. (2009). Hyperglycemia and adverse pregnancy outcome (HAPO) study: Associations with neonatal anthropometrics. *Diabetes, 58*(2), 453-459.

Thompson, M. E. (2010). Parental feeding and childhood obesity in preschool-age children: Recent findings from the literature. *Issues in Comprehensive Pediatric Nursing, 33*, 205-267.

Tremblay, R. E., Masse, L. C., Vitaro, F., & Dobkin, P. L. (1995). The impact of friends' deviant behaviour on early onset of delinquency: Longitudinal data from six to thirteen years of age. *Development and Psychopathology, 7*, 649-668.

Tsukayama, E., Toomey, S. L., Faith, M. S., & Duckworth, A. L. (2010). Self-control protects against overweight status in the transition from childhood to adolescences. *Archives of Pediatrics and Adolescent Medicine, 164*, 631-635.

United States Department of Agriculture. (2012). Survey Tools. *Food Security in the U.S.*, from https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/survey-tools/#household

Utter, J., Neumark-Sztainer, D., Jeffery, R., & Story, M. (2003). Couch potatoes or french fries: Are sedentary behaviors associated with body mass index, physical activity, and dietary behaviors among adolescents? *Journal of the American Dietetic Association, 103*, 1298-1305.

Vance, B., West, R., & Kutsick, K. (1989). Prediction of Wechsler Preschool and Primary Scale of Intelligence IQ scores for preschool children using the Peabody Picture Vocabulary Test-R and the Expressive One Word Picture Vocabulary Test. *Journal of Clinical Psychology, 45*, 642-644. doi: 10.1002/1097-4679(198907)45:4<642::AID-JCLP2270450421>3.0.CO;2-Q

van der Horst, K., Oenema, A., Ferreira, I., Wndel-Vos, W., Giskes, K., van Lenthe, F., & Brug, J. (2007). A systematic review of environmental correlates of obesity-related dietary behaviors in youth. *Health Education Research, 22*(2), 203-226.

Verbeken, S., Braet, C., Claus, L., Nederkoorn, C., & Oosterlaan, J. (2009). Childhood obesity and impulsivity: An investigation with performance-based measures. *Behavior Change, 26*, 153-167.

Verbeken, S., Braet, C., Lammertyn, J., Goossens, L., & Moens, E. (2012). How is reward sensitivity related to bodyweight in children? *Appetite, 58*(2), 478-483. doi: 10.1016/J.APPET.2011.11.018

Viana, V., Sinde, S., & C Saxton, J. (2008). Children's Eating Behaviour Questionnaire: Associations with BMI in Portuguese children. *British Journal of Nutrition, 100*, 445-450. doi: 10.1017/S0007114508894391

Volkow, N. D., Fowler, J. S., Wang, G. J., & Swanson, J. M. (2004). Dopamine in drug abuse and addiction: results from imaging studies and treatment implications. *Mol Psychiatry, 9*, 557-569.

Volkow, N. D., Wang, G.-J., & Baler, R. D. (2011). Reward, dopamine and the control of food intake: implications for obesity. *Trends in Cognitive Sciences, 15*(1), 37-46. doi: http://doi.org/10.1016/j.tics.2010.11.001

Wang, G. J., Volkow, N. D., Logan, J., Pappas, N. R., Wong, C. T., & Zhu, W. (2001). Brain dopamine and obesity. *Lancet, 357*, 354-357. doi: 10.1016/S0140-6736(00)03643-6

Wardle, J., Carnell, S., Haworth, C. M., & Plomin, R. (2008). Evidence for strong genetic influence on childhood adiposity despite the force of the obesogenic environment. *American Journal of Clinical Nutrition, 87*, 398-404.

Wardle, J., Guthrie, C. A., Sanderson, S., & Rapoport, L. (2001). Development of the Children's Eating Behaviour Questionnaire. *J Child Psychol Psychiatry*, *42*. doi: 10.1111/1469-7610.00792

Wardle, J., Sanderson, S., Gibson, E. L., & Rapoport, L. (2001). Factor-analytic structure of food preferences in four-year-old children in the UK. *Appetite, 37*, 217-223.

Waring, M. E., & Lapane, K. L. (2008). Overweight in children and adolescents in relation to attention-deficit/hyperactivity disorder: Results from a national sample. *Pediatrics, 122*(e1), e1-e6.

Watson, D., Clark, L.A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS Scales. *Journal of Personality and Social Psychology, 54*(6), 1063-1070.

Webber, L., Hill, C., Saxton, J., Van Jaarsveld, C., & Wardle, J. (2009). Eating behaviour and weight in children. *International Journal of Obesity (2005), 33*(1), 21-28. doi: 10.1038/ijo.2008.219.

Weiss, R., & Kaufman, F. R. (2008). Metabolic complications of childhood obesity. *Diabetes Care, 31*(Suppl 2), S310-S316.

Werthmann, J., Roefs, A., Nederkoorn, C., Mogg, K., Bradley, B. P., & Jansen, A. (2011). Can(not) take my eyes off it: attention bias for food in overweight participants. *Health Psychology, 30*(5), 561-569. doi: 10.1037/a0024291

Whitaker, R. C. (2004). Predicting preschooler obesity at birth: The role of maternal obesity in early pregnancy. *Pediatrics, 114*, e29-36.

Whitaker, R. C., Wright, J. A., Pepe, M. S., Seidel, K. D., & Dietz, W. H. (1997). Predicting obesity in young adulthood from childhood and parental obesity. *New England Journal of Medicine, 337*(13), 869-873.

White, B., Nicholls, D., Christie, D., Cole, T. J., & Viner, R. M. (2012). Childhood psychological function and obesity risk across the lifecourse: Findings from the 1970 British Cohort Study. *International Journal of Obesity (London), 36*(4), 511-516. doi: 10.1038/ijo.2011.253

Wirt, T., Hundsdorfer, V., Schreiber, A., Kesztyus, D., & Steinacker, J. M. (2014). Associations between inhibitory control and body weight in German primary school children. *Eating Behaviors, 15*(1), 9-12. doi: 10.1016/j.eatbeh.2013.10.015

Wolfe, C.D. & Bell, M.A. (2004). Working memory and inhibitory control in early childhood: contributions from physiology, temperament, and language. *Dev Psychobiol*, *44*(1), doi: 10.1002/dev.10152

World Health Organization. (2011). WHO Anthro (Version 3.2.2). Geneva, Switzerland: World Health Organization.

Yu, Z. B. et al. (2011). Birth weight and subsequent risk of obesity: A systematic review and meta-analysis. *Obesity Reviews, 12*(7), 525-542.

Zucker, N., Copeland, W., Franz, L., Carpenter, K., Keeling, L., Angold, A., & Egger, H. (2015). Psychological and psychosocial impairment in preschoolers with selective eating. *Pediatrics*, *136*(3), e582-e590.

APPENDIX A

UAB INSTITUTIONAL REVIEW BOARD APPROVAL LETTER

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM
Office of the Institutional Review Board for Human Use

470 Administration Building
701 20th Street South
Birmingham, AL 35294-0104
205.934.3789 | Fax 205.934.1301 | irb@uab.edu

APPROVAL LETTER

TO: Shepard, Desti

FROM: University of Alabama at Birmingham Institutional Review Board
Federalwide Assurance # FWA00005960
IORG Registration # IRB00000196 (IRB 01)
IORG Registration # IRB00000726 (IRB 02)

DATE: 28-Jun-2018

RE: IRB-140425008
Early Childhood Temperament and Body Weight ("The Toddler Temperament Study")

The IRB reviewed and approved the Continuing Review submitted on 22-May-2018 for the above referenced project. The review was conducted in accordance with UAB's Assurance of Compliance approved by the Department of Health and Human Services.

Type of Review: Expedited
Expedited Categories: 4, 6, 7
Determination: Approved
Approval Date: 28-Jun-2018
Approval Period: One Year
Expiration Date: 27-Jun-2019

The following populations are approved for inclusion in this project:

- Children – CRL 1

APPENDIX B

CODING SHEETS

Video

Subject # ____________________ Scorer ____________________ Date Scored ____________________

- ❖ Code attending first, then fidgeting.

Latency to fidget _______ seconds Latency to look away: _______ seconds

<u>Interval 1</u>

10 sec epochs	1	2	3	4	5	6	<u>Average</u>
Begin/End Time	0:00/0:10	0:11/0:20	0:21/0:30	0:31/0:40	0:41/0:50	0:51/1:00	
Attends to monitor for entire epoch (No=0; Yes=1)							_______
Fidgeting (0 – 2)							_______

<u>Interval 2</u>

10 sec epochs	1	2	3	4	5	6	<u>Average</u>
Begin/End Time	1:01/1:10	1:11/1:20	1:21/1:30	1:31/1:40	1:41/1:50	1:51/2:00	
Attends to monitor for entire epoch (No=0; Yes=1)							_______
Fidgeting (0 – 2)							_______

<u>Interval 3</u>

10 sec epochs	1	2	3	4	5	6	<u>Average</u>
Begin/End Time	2:01/2:10	2:11/2:20	2:21/2:30	2:31/2:40	2:41/2:50	2:51/3:00	
Attends to monitor for entire epoch (No=0; Yes=1)							_______
Fidgeting (0 – 2)							_______

<u>Interval 4</u>

10 sec epochs	1	2	3	4	5	6	<u>Average</u>
Begin/End Time	3:01/3:10	3:11/3:20	3:21/3:30	3:31/3:40	3:41/3:50	3:51/4:00	
Attends to monitor for entire epoch (No=0; Yes=1)							_______
Fidgeting (0 – 2)							_______

<u>Interval 5</u>

10 sec epochs	1	2	3	4	5	6	<u>Average</u>
Begin/End Time	4:01/4:10	4:11/4:20	4:21/4:30	4:31/4:40	4:41/4:50	4:51/5:00	
Attends to monitor for entire epoch (No=0; Yes=1)							_______
Fidgeting (0 – 2)							_______

Fidgeting

0 = No fidgeting
1 = Low fidgeting: Hand movement or feet movement; tapping feet or drumming fingers
2 = High fidgeting: Hand and feet movement, bouncing (body movement, dancing); movements more rapid than for low fidgeting behaviors.

Matching Cards (circle one: Food/Non-Food)

Subject # ___________________ Scorer ___________________ Date Scored ___________________

- ❖ How long child remains engaged in activity & if diff. in duration for the food vs. non-food cards.
- ❖ Code gaze alone first, then gaze plus hand.
- ❖ Task can be ended after 30 seconds (3 epochs) of disengagement; code as "0" for remaining intervals.

Evaluator Mother No one (circle one) present in room.

Interval 1

10 sec epochs	1	2	3	4	5	6	Sum
Begin/End Time	0:00/0:10	0:11/0:20	0:21/0:30	0:31/0:40	0:41/0:50	0:51/1:00	
Gaze directed at stimuli at least 5 secs (0: No; 1: Yes)							_______
Gaze directed at + hand moving stimuli at least 5 secs (0: No; 1: Yes)							_______

Interval 2

10 sec epochs	1	2	3	4	5	6	Sum
Begin/End Time	1:01/1:10	1:11/1:20	1:21/1:30	1:31/1:40	1:41/1:50	1:51/2:00	
Gaze directed at stimuli at least 5 secs (0: No; 1: Yes)							_______
Gaze directed at + hand moving stimuli at least 5 seconds (0: No; 1: Yes)							_______

Interval 3

10 sec epochs	1	2	3	4	5	6	Sum
Begin/End Time	2:01/2:10	2:11/2:20	2:21/2:30	2:31/2:40	2:41/2:50	2:51/3:00	
Gaze directed at stimuli at least 5 secs (0: No; 1: Yes)							_______
Gaze directed at + hand moving stimuli at least 5 secs (0: No; 1: Yes)							_______

Total Gaze: __________ Total Gaze+Hands: __________ Total # of epochs coded (max 18): ___________

Global negative affective response (0 – 4): _______

Global Affective Response: What description best characterizes the child's affect:

0: No emotional response or positive response; no distress
1: Some mild distress, but short-lived, return to neutral or positive.
2: Mild distress most of the time (or some moderate distress), but doesn't escalate to extreme distress, or if it does, it is very brief.
3: Distressed, but not consistently, may be able to briefly distract & calm. Although a child may not calm back to neutral from extreme distress, there may be some reduction to a lower level of distress.
4: Task should end with child in extreme distress. A child at this level should show a constant level of distress (no reduction) or continued escalation. A child may start at a low level of distress, but build-up with no reduction. This child should be consumed with distress or the source of distress.

(Circle one) Snack/Sticker Delay

Subject # ___________________ Scorer ___________________ Date Scored ___________________

Does child pass initial practice trials (waiting until bell is rung) (No=0; Yes=1)? ____________

- ❖ measure how well the child is able to refrain from taking a treat or sticker during a short delay

<u>Intervals</u>

	5 secs	10 secs	0 secs	20 secs	0 secs	30 secs	<u>Average</u>
Begin Time: when cup is placed over stimuli							
Latency to touch cup (01: no wait; # of sec; if C waits full time, put #)							_______
Wait for signal (No=0; Yes=1)							_______
If did not wait (above), list what C did (e.g., touched obj, lifted cup, ate candy, etc.)							
No. times C prompts E							_______
C requires 2^{nd} prompt (No=0; Yes=1)							

Global Cooperation Score: ______

Global Cooperation Score

Ability of child to engage and complete the task

0: child is unwilling or unable to engage in task
1: child is unwilling or unable to complete the task because of feeling tired, angry, irritable or sick or does not have the capacity to understand the instructions
2: child does all the trials but has comprehensional or motivational difficulties, is passive or inhibited
3: child understands the task well and participates

Highchair

Subject # ______________ Scorer ______________ Date Scored _______________ (Circle one) Eval/Mom in room

Latency to become distressed ________ seconds OR If no distress, circle this sentence.

- ❖ Code type of behavior first, then re-watch video and code affect.
- ❖ Coding for Grayed rows: Each epoch should have 3 codes of '0' and a single '1.' Child should engage in behavior for at least 5 seconds.
- ❖ If child is removed before all intervals complete, code Global Affective Response as 4 for remaining epochs and continue with last behavior code.

Interval 1

10 sec epochs	1	2	3	4	5	6	Average
Begin/End Time	0:00/0:10	0:11/0:20	0:21/0:30	0:31/0:40	0:41/0:50	0:51/1:00	
Calm/Distraction (Sitting still, focus/play on obj/event; looking/scanning)							________
Help-seeking (looking to E to get attention, talking to E, calling for mother)							________
Self-comforting (thumb-sucking, hair twirling, singing/talking)							________
Escape (attempt to get out of high chair or remove restraints)							________
Global affective response (0-4)							________

Interval 2

10 sec epochs	1	2	3	4	5	6	Average
Begin/End Time	1:01/1:10	1:11/1:20	1:21/1:30	1:31/1:40	1:41/1:50	1:51/2:00	
Calm/Distraction (Sitting still, focus/play on obj/event; looking/scanning)							________
Help-seeking (looking to E to get attention, talking to E, calling for mother)							________
Self-comforting (thumb-sucking, hair twirling, singing/talking)							________
Escape (attempt to get out of high chair or remove restraints)							________
Global affective response (0-4)							________

Interval 3

10 sec epochs	1	2	3	4	5	6	Average
Begin/End Time	2:01/2:10	2:11/2:20	2:21/2:30	2:31/2:40	2:41/2:50	2:51/3:00	
Calm/Distraction (Sitting still, focus/play on obj/event; looking/scanning)							_______
Help-seeking (looking to E to get attention, talking to E, calling for mother)							_______
Self-comforting (thumb-sucking, hair twirling, singing/talking)							_______
Escape (attempt to get out of high chair or remove restraints)							_______
Global affective response (0-4)							_______

Interval 4

10 sec epochs	1	2	3	4	5	6	Average
Begin/End Time	3:01/3:10	3:11/3:20	3:21/3:30	3:31/3:40	3:41/3:50	3:51/4:00	
Calm/Distraction (Sitting still, focus/play on obj/event; looking/scanning)							_______
Help-seeking (looking to E to get attention, talking to E, calling for mother)							_______
Self-comforting (thumb-sucking, hair twirling, singing/talking)							_______
Escape (attempt to get out of high chair or remove restraints)							_______
Global affective response (0-4)							_______

Interval 5

10 sec epochs	1	2	3	4	5	6	Average
Begin/End Time	4:01/4:10	4:11/4:20	4:21/4:30	4:31/4:40	4:41/4:50	4:51/5:00	
Calm/Distraction (Sitting still, focus/play on obj/event; looking/scanning)							_______
Help-seeking (looking to E to get attention, talking to E, calling for mother)							_______
Self-comforting (thumb-sucking, hair twirling, singing/talking)							_______
Escape (attempt to get out of high chair or remove restraints)							_______
Global affective response (0-4)							_______

Affect Lability: _______ Global regulation: ______ → to code after based on above codes

Global Affective Response: What description best characterizes the child's affect:

0: No emotional response or positive response; no distress
1: Some mild distress, but short-lived, return to neutral or positive.
2: Mild distress most of the time (or some moderate distress), but doesn't escalate to extreme distress, or if it does, it is very brief.
3: Distressed, but not consistently, may be able to briefly distract & calm. Although a child may not calm back to neutral from extreme distress, there may be some reduction to a lower level of distress.
4: Task should end with child in extreme distress. A child at this level should show a constant level of distress (no reduction) or continued escalation. A child may start at a low level of distress, but build-up with no reduction. This child should be consumed with distress or the source of distress.

Affect Lability: During the episode when the child in high chair, the child's affective responses are:

0: Stable: Child's affect does not change throughout the task.
1: Mostly Stable: Child's affect only changes once or twice in any extreme way, or some small changes between two levels (ex: neutral to mild joy, or moderate to mild distress).
2: Somewhat Stable: The child makes a few extreme changes in affect, or several small changes between two levels, or modulates a great deal from -1 to 1.
3: Mostly Unstable: There are several extreme changes in affect (at least two level changes, but often 3-level changes).
4: Unstable: Child affect changes many times throughout the task from positive to negative (moderate levels) or from extreme distress or joy to neutral.

APPENDIX C

Table C: Descriptive Statistics for Behavioral Observation Measures

Table C

Descriptive Statistics for Behavioral Observation Measures

Behavioral Variable	n[a]	Unit of Measure	M (SD)	Min.	Max.
Video					
Total Attention	38	epochs	18.95 (8.57)	0	30
Latency to Look Away	38	seconds	15.37 (53.59)	0	300
Video Composite	38	z-scores	0.04 (1.64)	-2.40	6.96
Total Fidgeting	38	coding score[b]	24.84 (15.87)	0	60
Latency to Fidget	38	seconds	6.08 (7.38)	0	40
Fidgeting Composite	38	z-scores	1.0 (1.56)	-2.31	4.99
Cards					
Food: Total Gaze	34	epochs	6.38 (5.62)	0	17
Food: Total Gaze + Hands	34	epochs	6.06 (5.44)	0	17
Non-food: Total Gaze	37	epochs	6.68 (6.36)	0	18
Non-food: Total Gaze + Hands	37	epochs	6.22 (6.17)	0	18
Cards Sum: Total Gaze	33	epochs	13.52 (10.75)	0	35
Cards Sum: Total Gaze + Hands	33	epochs	12.67 (10.58)	0	35
Delay					
Non-food: Sum of Trials Waited	33	trials	5.18 (3.30)	0	21
Non-food: Length of Wait Sum	33	seconds	48.46 (19.50)	5.5	65
Food: Sum of Trials Waited	34	trials	4.73 (2.46)	0	14
Food: Length of Wait Sum	34	seconds	45.25 (24.14)	2.3	65
Delay Composite	30	seconds	39.83 (22.95)	0	60
High chair					
Distress	42	coding score[c]	27.26 (34.90)	0	108
Latency to be Distressed	42	seconds	116.74 (113.18)	1	300
Calm Sum	42	epochs	12.76 (8.78)	0	29
Help-Seeking Sum	42	epochs	3.86 (4.94)	0	19
Self-Comfort Sum	42	epochs	6.50 (6.79)	0	26
Escape Sum	42	epochs	3.31 (3.87)	0	16
Self-reg. Composite	42	epochs	19.26 (10.56)	0	30

Min.: minimum; Max.: Maximum; Self-reg.: self-regulation.
a. Sample size varies for tasks due to noncompliance, lack of understanding of task (i.e., failure of practice trials), or later added measure; see text for detailed information. b. Behavior was coded as 0-2 for each epoch, which was summed to determine overall score. c. Behavior was coded as 0-4 for each epoch, which was summed to determine overall score.

APPENDIX D

Table D: Descriptive Statistics for Early Childhood Behavior Questionnaire

Table D

Descriptive Statistics for Early Childhood Behavior Questionnaire[a]

ECBQ Variable	Mean (SD)	Minimum	Maximum
Effortful Control	4.64 (0.63)	2.88	5.84
Attn. Focusing	4.52 (0.95)	2.50	6.50
Attn. Shifting	5.04 (0.92)	2.38	7.00
Cuddliness	5.25 (0.91)	3.00	7.00
Inhibitory Control	3.50 (1.05)	1.00	6.50
Low Intensity Pleasure	4.87 (1.22)	1.33	7.00
Negative Affect	3.75 (0.85)	1.98	5.34
Discomfort	3.43 (1.43)	1.00	6.86
Fear	3.21 (1.26)	1.00	5.88
Frustration	4.61 (1.31)	2.33	7.00
Motor Activation	3.30 (1.50)	1.00	6.50
Perceptual Sensitivity	4.81 (1.31)	1.20	7.00
Sadness	3.54 (1.09)	1.17	5.50
Shyness	3.71 (1.43)	1.00	6.20
Soothability	4.62 (0.84)	2.60	6.40
Surgency	5.38 (0.73)	2.91	6.76
Activity Level/Energy	5.32 (0.88)	3.38	7.00
High Intensity Pleasure	5.57 (1.21)	2.67	7.00
Impulsivity	4.60 (1.26)	1.50	7.00
Positive Anticipation	5.78 (0.89)	2.60	7.00
Sociability	5.64 (1.19)	2.25	7.00

Note. N = 43. Bolded titles indicate composites consisting of not-bolded subscales below them. Attn.: Attention. a. For each subscale and composite, the minimum score is 1, and the maximum score is 7.

APPENDIX E

Table E: Descriptive Statistics for Child Eating Behavior Questionnaire

Table E

Descriptive Statistics for Child Eating Behavior Questionnaire (CEBQ)[a]

CEBQ Subscale	Mean (SD)	Minimum	Maximum
Satiety Responsiveness	2.83 (0.66)	1	4.4
Food Responsiveness	2.63 (1.01)	1	5
Emotional Overeating	1.85 (0.65)	1	3.5
Slowness in Eating	2.73 (0.85)	1	5
Food Fussiness	2.69 (0.94)	1	5
Enjoyment of Food	3.98 (0.78)	2.25	5
Desire to Drink	3.88 (1.17)	1	5
Emotional Undereating	2.98 (0.93)	1	5

Note. N = 43. a. For each subscale, the minimum score is 1, and the maximum score is 5.

APPENDIX F

Table F: Correlation Coefficients for Outcome Variables and Measures of Adiposity and PPVT-4 Raw Score

Table F

Correlation Coefficients for Outcome Variables and Measures of Adiposity and PPVT-4 Raw Score

Measure	BMI-for-age z-score	Sum of Skinfolds	PPVT Raw Score
Video			
Total Attention	.01	.23	.45**
Latency to Look Away	-.29†	-.28†	.14
Video Composite	-.18	-.04	.37*
Total Fidgeting	-.19	-.32†	-.62**
Latency to Fidget	-.26	-.16	-.28†
Fidgeting Composite	-.29†	-.30†	-.57**
Cards			
Food: Total Gaze	.14	.07	-.21
Food: Total Gaze + Hands	.16	.07	-.24
Non-food: Total Gaze	.08	.09	-.08
Non-food: Total Gaze + Hands	.09	.05	-.15
Cards Sum: Total Gaze	.10	.04	-.16
Cards Sum: Total Gaze + Hands	.11	.01	-.22
Delay			
Non-food: Sum of Trials Waited	-.10	-.01	.30†
Non-food: Length of Wait Sum	.11	.04	.22
Food: Sum of Trials Waited	.17	.29†	.17
Food: Length of Wait Sum	.07	.14	.25*
Delay Composite	-.01	.03	.24
High chair			
Distress	-.29†	-.33*	-.10
Latency to be Distressed	.30*	.19	-.05
Calm Sum	-.23	.19	.04
Help-Seeking Sum	-.02	.01	-.02
Self-Comfort Sum	.13	.16	.07
Escape Sum	-.24	-.15	-.04
Self-reg. Composite	.27†	.26	.08
ECBQ			
Attention Focusing	.10	.14	
Attention Shifting	-.04	.26†	
Inhibitory Control	.00	.07	
Impulsivity	.03	.05	
Effortful Control	-.06	.18	
Soothability	-.32*	-.04	

†. Correlation trending for significance (.05 < *P* < .1); *: Correlation significant at the 0.05 level.

APPENDIX G

Table G: Correlation Coefficients for Behavioral Observation Measures, Early Childhood Behavior Questionnaire, and Child Eating Behavior Questionnaire

Table G

Correlation Coefficients for Behavioral Observation Measures, Early Childhood Behavior Questionnaire, and Child Eating Behavior Questionnaire

Measure	SR	FR	EO
Video			
Total Attention	.01	-.22	---
Latency to Look Away	.28†	-.13	---
Video Composite	.19	-.21	---
Total Fidgeting	-.14	.18	---
Latency to Fidget	-.10	-.16	---
Fidgeting Composite	-.15	.02	---
Cards			
Food: Total Gaze	-.26	.13	---
Food: Total Gaze + Hands	-.23	.12	---
Non-food: Total Gaze	-.16	.04	---
Non-food: Total Gaze + Hands	-.17	.06	---
Cards Sum: Total Gaze	-.28	.08	---
Cards Sum: Total Gaze + Hands	-.26	.09	---
Delay			
Non-food: Sum of Trials Waited	---	.03	---
Non-food: Length of Wait Sum	---	-.02	---
Food: Sum of Trials Waited	---	.02	---
Food: Length of Wait Sum	---	-.26	---
Delay Composite	---	-.20	---
High chair			
Distress	---	---	-.05
Latency to be Distressed	---	---	.35*
Calm Sum	---	---	.19
Help-Seeking Sum	---	---	-.01
Self-Comfort Sum	---	---	-.16
Escape Sum	---	---	-.38*
Self-reg. Composite	---		.06
ECBQ			
Attention Focusing	-.16	-.26	---
Attention Shifting	-.16	.04	---
Inhibitory Control	---	.03	---
Impulsivity	---	-.29†	---
Effortful Control	---	---	-.07
Soothability	---	---	-.01

Note. Dashes indicate the correlation was not reported because it is not relevant to hypotheses. SR: satiety responsiveness; FR: food responsiveness; EO: emotional overeating. †. Correlation trending for significance (.05 < *P* < .1); *: Correlation significant at the 0.05 level; **Correlation significant at the 0.01 level.

APPENDIX H

Table H: Correlation Coefficients for Early Childhood Behavior Questionnaire and Child Eating Behavior Questionnaire

Table H

Correlation Coefficients for Early Childhood Behavior Questionnaire and Child Eating Behavior Questionnaire

ECBQ Variable	SR	SE	FF	FR	EF	DD	EU	EO
Attn. Focusing	-0.16	0.04	-0.23	-0.26	0.20	-0.45	-0.18	-0.19
Attn. Shifting	-0.16	-0.16	-0.33*	-0.05	0.44**	-0.00	-0.14	0.01
Impulsivity	-0.03	-0.14	-0.34*	-0.29	0.17	0.10	-0.21	-0.10
Inh. Control	-0.06	-0.08	-0.11	0.03	0.14	-0.04	0.14	0.06
Soothability	-0.16	-0.20	-0.14	-0.04	0.38*	-0.16	-0.10	-0.01
Effortful Control	-0.04	-0.11	-0.25	-0.07	0.35	-0.05	0.10	-0.07

Note. N = 43. Abbreviations. Attn.: attention. DD: desire to drink; EF: enjoyment of food; EO: emotional overeating; EU: emotional undereating; FF: food fussiness; FR: food responsiveness; Inh.: inhibitory; SE: slowness in eating; SR: satiety responsiveness. *: Significant at the .05 level; **: Significant at the .01 level.