Stress Reactivity as a Predictor of Emotional Eating

by

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ABSTRACT

Childhood obesity is associated with many well established health risks as well as high annual public health costs. Because of this, the childhood obesity literature has highlighted the need to detect at-risk groups in order to implement targeted preventions. Emotional eating has been identified as an unhealthy behavior and a risk factor for overweight status among children though very little is known about what predisposes children to emotionally eat. Stress has often been found to elicit emotional eating but most studies looking at this relationship have relied on self-reports in adult and clinical samples. Thus, the current study seeks to investigate the relationship between stress reactivity (measured using heart rate variability) and emotional eating in a sample of 247 children between the ages of 4-6. Furthermore, levels of control may moderate the relationship between stress reactivity (HRV) and emotional eating. Linear regression analysis was used to explore these relationships. It was expected that higher levels of reactivity to stress would predict an increased likelihood of emotional eating. This association was expected to be attenuated among children with higher levels of inhibitory control and attentional focusing as well as lower levels of impulsivity. However, the hypothesized findings were not supported by the data. Despite these null findings, and in light of several limitations, it is still hypothesized that emotional eating involves physiological and impulsivity/effortful control processes. Implications of future research are discussed.

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Approximately 23% of children in the United States between the ages of two and five are classified as overweight or obese; among school-age children this figure increases to almost 35% (Ogden, Carroll, Kit, & Flegal, 2014). The health risks associated with pediatric obesity, like hypertension, hyperlipidemia, hyperinsulinemia, sleep apnea, increased risk of type 2 diabetes, social exclusion and increased depression, are well established (Lobstein, Baur, & Uauy, 2004) and contribute to high annual public health costs (Finkelstein, Fiebelkorn, & Wang, 2004). A wide variety of obesity prevention programs have been developed for different settings that focus on one or two direct risk factors (Schmitz & Jeffery, 2000). However, child weight status may be better explained by assessing an interactive relationship that includes other proximal risk factors. Little research has been done in this area, but if supported could suggest what risk factors to focus on in future prevention efforts. This is important because the childhood obesity literature has highlighted the need to detect at-risk groups in order to implement targeted preventions.

Emotional Eating

Within the obesity literature, emotional eating (most often defined as overeating in the absence of hunger in response to negative affect; Thayer, 2001) has been proposed as a risk factor that may contribute to the development and maintenance of overweight status among children, adolescents, and adults (Blissett, Haycraft, & Farrow, 2010). Models of emotional eating, like the individual differences model, indicate that stress is often a precursor to overeating (Greeno & Wing, 1994) which suggests that eating behavior can have a functional value in coping with stress. In fact, research suggests that increased stress and poorer coping abilities leads to more disturbed eating attitudes (Fryer, Waller, & Kroese, 1997; Thayer, 2001). More specifically, Mayhew and Edelman (1989) showed that higher use of avoidance-focused coping and lower use of active cognitive and behavioral coping was associated with disordered eating in a small nonclinical sample. Shatford and Evans (1986) found that women with bulimic symptoms were more likely to use emotion-focused and avoidance-focused coping and less likely to use problem-focused coping to deal with stress. Emotion focused coping aims to decrease the experience of negative emotions; this has been supported by reports that women who ate in response to negative feelings found these feelings to improve after consumption (Popkess-Vawter, Brandau, & Straub, 1998). Avoidance style of coping involves actively avoiding confrontation with the problem (Billings & Moos, 1981). Because using food as an attempt to reduce the negative feelings associated with stress does not actually address the issues themselves, this type of behavior could be conceptualized as a maladaptive coping response. Unlike other maladaptive, addictive substances used for coping, however, food is readily available, used by all, and must be consumed to live. Because of this, it may be easier for food to be used as a reliable source of comfort, satisfaction and consolation.

It is evident that research supports emotional eating as a coping strategy; however, there have been several studies that attempt to expand the proposals within the individual differences model in an effort to explain who may be predisposed to stress-induced emotional eating. Eating behaviors in general, have been shown to be influenced by intrapersonal, interpersonal, community settings and societal factors (Story, Neumark-Sztainer, & French, 2002) and may become established at a young age (O'Connor et al., 2006; Story et al., 2002; Xie, Gilliland, Li, & Rockett, 2003). With the formation of maladaptive coping skills, emotional eating in children and adolescents has been found to relate to increased food consumption (Braet & van Strien, 1997), higher intake of energy dense foods (de Lauzon et al., 2004; Wardle et al., 1992), and negatively associated with fruit and vegetable consumption (de Lauzon et al., 2004) which means children's overall food consumption is not compatible with the Food Guide Pyramid (Xie et al., 2003).

Looking at individual differences in weight, research found that perceived stress explained a higher proportion of the variance in emotional eating in a sub-sample of overweight and obese participants compared to the overall sample (Sims et al., 2008). Similarly, high stress levels and maladaptive coping skills were found in obese binge eating groups compared to controls (Hansel & Wittrock, 1997). Apparent here is the notion that when individuals are stressed they will display less healthy eating patterns, but if they are overweight or obese, this effect will be stronger.

Cross-cultural differences have also been found in the prevalence of emotional eating, with Hispanics reporting higher frequencies of emotional eating followed by African American and Caucasian children (Jenkins et al., 2005). Large amounts of time and resources have been dedicated to identifying individual differences in child, cultural and environmental risk factors for emotional eating, while few individual differences of emotional eating within the biological realm have been explored. Dallman and colleagues (2003) found that glucocorticoids increase the intensity of pleasurable or compulsive activities which may increase the motivation to consume satisfying foods. Furthermore, Gibson (2006) reported that consumption of these satisfying foods can improve mood and decrease the effects of stress through changes in certain pathways of the brain. Adaptations in the opioidergic, dopaminergic, and/or serotonergic neurotransmission pathways, along with potential sensitivity and chronic exposure, could lead to overeating and obesity status.

Despite all this research, there are still missing pieces of the individual differences model, specifically in the area of psychophysiology. Physiological reactivity, measured using heart rate variability, has been clearly implicated in emotion and stress response. This line of research could introduce a physiological predictor into the obesity literature, opening the door to understanding obesity through a dual-process theory lens (i.e., behavior is determined by the interplay of automatic and controlled processes; Sherman & Gawronski, 2014). If physiological reactivity is supported as a predictor of emotional eating, it could become an important point of understanding obesity through a dual-process theory lens and lead to potential biological interventions for obesity.

Heart Rate Variability

Each emotion that is experienced when dealing with environmental challenges is associated with varying degrees of physiological arousal; the autonomic nervous system (ANS) is key to understanding this physiological arousal (Levenson, 2003). The autonomic nervous system uses two antagonistic systems to regulate heart rate: the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS). During times of stress, the SNS has an excitatory influence on heart rate set by the heart's pacemaker, the sinoatrial node causing an increase in heart rate. During times of stability, the PNS works via the vagus nerve to inhibit the pacemaking activity, resulting in a decreased heart rate. The ability to transition between high and low arousal states demonstrates the ease with which the ANS can rapidly vary heart rate. These fluctuations in heart rate are referred to as heart rate variability (HRV; Appelhans & Luecken, 2006).

There are two common ways to measure HRV: when resting or reacting to events. Measures of resting HRV occur over a period when conditions remain stable and the individual is inactive (Sandercock, Bromley, & Brodie, 2005). High levels of consistency among resting HRV has been found in healthy adult individuals over time intervals of a year or more (Burleson et al., 2003; Sandercock et al., 2005) and is generally associated with overall health. For example, frequent exercise positively influences HRV while unhealthy behaviors like alcohol consumption or smoking decrease HRV. HRV is also linked with several physical conditions (Meule, Freund, Skirde, Vögele, & Kübler, 2012).

Specifically, low resting HRV predicts adverse cardiovascular events (Hillebrand et al., 2013), and correlates inversely with risk for hypertension among adults (Liao et al., 1996). Reductions of HRV are also seen in non-cardiac pathologies, like stress-induced conditions (Michels et al., 2013). Furthermore, individuals with lower resting HRV report more anxiety symptoms than those with higher resting HRV (Piccirillo et al., 1997), and depressed individuals have lower resting HRV than healthy controls (Rottenberg, Clift, Bolden, & Salomon, 2007). Body weight is also inversely related to resting HRV, meaning obese individuals have lower HRV compared to normal/underweight counterparts (Meule et al., 2012). This attenuation of HRV is generally thought of as an indicator of poor autonomic function (Mehta, 2015) which may contribute to the stabilization of obesity and the associated cardiovascular mortality (Baum et al., 2013; Friederich et al., 2006). This effect is not specific to adult obesity; pediatric obesity is also associated with a sympathovagal imbalance characterized by a decrease in parasympathetic activity (Cote, Harris, Panagiotopoulos, Sandor, & Devlin, 2013; Martini et al., 2001)

There is little research investigating the relationship between resting HRV and emotional eating. What little there is focuses on cravings or overeating at clinical levels (bingeing). For example, Rodríguez-Ruiz and colleagues (2009) found that low HRV was associated with increased food craving and uncontrolled eating behaviors. Similarly, it has been found that frequent experiences of food cravings were strongly linked with low HRV, while high HRV was correlated with dieting success (Muele et al., 2012). Together, these results may suggest a positive relationship between HRV and self-regulation of eating behavior.

Along these lines, resting HRV also predicts the use of effective coping strategies when dealing with stress. Higher resting HRV levels correlate significantly with reports of using engagement strategies, like social support seeking (Geisler, Kubiak, Siewert, & Weber, 2013), in the face of everyday demands rated as moderately or highly stressful (Fabes & Eisenberg, 1997).

The other common measure of HRV is when reacting to the environment. Reactive HRV refers to measurements of heart rate variability over a time period in which an individual responds to a challenging or stressful stimulus and is typically assessed by comparing baseline rates to the levels attained during deliberate exposure to stress (Eisenberg et al., 1996; Sandercock et al., 2005; Wu, Snieder, & de Geus, 2010). When compared over multiple stressors, psychometric studies have shown satisfactory temporal stability of the commonly used reactivity measures; furthermore, HRV results from laboratory stress measures have been shown to translate well to real-world settings (Wu et al., 2010).

Following a stress-inducing event, individuals who respond well to stress, show reductions in HRV when compared to baseline. It is thought that this allows the brain to attend and respond to the environmental challenges (Beauchaine, Gatzke-Kopp, & Mead, 2007). This means that HRV suppression (a decrease in HRV compared to resting rate) represents the ability to cope with the environment; it also appears to reflect levels of effortful control (Calkins, Graziano, & Keane, 2007) which has been supported in infants, children, and adults (Beauchaine, 2001). On the other hand, elevation of HRV (an increase in HRV compared to resting rate) represents emotional reactivity or stress.

Few studies have investigated the relationship of HRV reactivity and stress in children; those that have suggest children who have greater HRV suppression during stressful tasks have higher levels of positive affect, increased social skills, and fewer behavior problems (Calkins & Keane, 2004). Several studies in adults have also demonstrated strong associations of stress to changes in HRV. Individuals with a high resting HRV, showed HRV suppression when faced with different stress tasks (Egizio et al., 2008; Souza et al., 2013; Weber et al., 2010). Similarly, in an obese adult sample, HRV increased after a physically stressful condition (Mehta, 2015). Furthermore, patients with bulimia nervosa and binge eating disorder exhibited no change in HRV during a mental stress task, indicating poor autonomic stress reactivity, while the non-bingeing group showed HRV reduction. Increased hunger and desire to binge was also shown to follow stress tasks (Messerli-Bürgy et al., 2010). Taken together, this evidence suggests that HRV may be a good indicator of stress reactivity.

While HRV provides important information when measured as resting or reactive, the current study will focus on reactive HRV. This was selected because the models of emotional eating suggest that stress is often a precursor (Greeno & Wing, 1994); it is important to measure emotional eating as a response to stress—however, most studies rely on self-reported stress. Using HRV as a measure of a physiological response to stress in models of emotional eating would add valuable information to the individual differences and dual-process models of emotional eating.

Current Study and Hypotheses

The current study seeks to investigate the relationship between stress reactivity (as measured by HRV) and emotional eating in a sample of 4-6 year old children (see Figure 1). Specifically, higher reactivity to stress (increased elevation) will predict an increased likelihood of emotional overeating, lower levels of emotional undereating, and higher amounts of food consumed during the laboratory task. In an attempt to explain weight status with an interactive model, and consistent with previous research, several variables may impact the relationship between stress reactivity and emotional eating.

First, there are several variables that may influence the relationship between reactivity to stress and emotional eating and should be controlled for; these include weight status, ethnicity, gender, and food security. Because emotional eating is generally higher in overweight samples (Ganley, 1989; Sims et al., 2008), it is hypothesized that there will be more emotional eating in kids with larger BMIs. Furthermore, because cross cultural differences have been found in the prevalence of emotional eating (Jenkins et al., 2005) and Hispanic parents are more likely to use food as a reward and encourage their children to eat more throughout the day (Hughes et al., 2006), it is hypothesized that rates of emotional overeating will be higher in Hispanic children compared to non-Hispanics. Eating pathology is seen more often in females (White, Haycraft, Wallis, Arcelus, Leung, & Meyer, 2015), and some research suggests that women use emotion-regulation strategies and show more emotional eating (Larsen, van Strien, Eisinga, & Engels, 2006) than men. Therefore, it is hypothesized that the female children will have higher rates of emotional eating.

Finally, food security may affect the relationship between stress reactivity and emotional eating. Food security exists when every member of a household has access to enough food for an active, healthy life. Individuals who are food insecure may live in hunger or fear of starvation; it is a situation of uncertain availability of nutritionally adequate and safe foods or limited ability to acquire acceptable foods in socially acceptable ways (Kaiser et al., 2002). Research has shown that feeding patterns differ based on food security and the availability of food (Bronte-Tinkew, Zaslow, Capps, Horowitz, & McNamara, 2007; Kaiser et al., 2002) and it seems logical that children who do not have regular access to foods will consume more food when it is present regardless of hunger cues. It is expected that stress reactivity will explain the variance in emotional eating over-and-above these factors.

Furthermore, levels of control (whether voluntary or involuntary) may moderate the relationship between stress reactivity and emotional eating. These levels of control include effortful control and impulsivity. Effortful control is a temperamentally based, stable set of characteristics that are voluntarily influenced and are involved in the regulation of emotional and behavioral reactivity (Eisenberg et al., 2007). Effortful control includes both attentional regulation (the ability to shift and focus attention as needed) and inhibitory control (the ability to inhibit a dominant response in order to activate a subdominant response; Rothbart & Bates, 2006; Murray & Kochanska, 2002). Impulsivity is an aspect of involuntary control that involves rushing into or through an activity without giving it much thought (Eisenberg et al., 2007).

Research from Eisenberg and colleagues (2009) has suggested that children with externalizing problems tend to be lower in effortful control and higher in impulsivity—this relationship is expected in emotional eating. For example, impulsive children give into their desires and are pulled into an activity without thinking based on the potential rewards. This could be how children high in impulsivity are responding to food. Furthermore, the ability to shift attention away from stressors in order to focus on more positive thoughts may reduce reactivity to stress and allow children to inhibit their impulse to eat (Compas, Connor-Smith, & Jaser, 2004; Eisenberg et al., 2004). It is expected that this relationship will interact with stress reactivity. Specifically, across the sample higher levels of HRV elevation following a stressful task is expected to predict elevated emotional eating levels. However, this association is expected to be attenuated among children with higher reported effortful control and lower reported impulsivity.

In summary, emotional eating is an unhealthy behavior and a risk factor for obesity that is often a reaction to stress. The current emotional eating literature has mainly focused on single psychological or social risk factors using adult or clinical samples with self-report measures. While this research has provided great insight into emotional eating, there is still more to be explored. The nuanced level of investigation in the proposed study aims to explore other proximal risk factors using a physiological measure of stress reactivity in children. If successful, this research will help identify potential targets and may support the use of a stress reactivity task in future prevention and intervention work.

Methods

Participants

Participants included 247 children (mean age = 4.8, *SD* = 0.84; 47.9% female), along with their primary caregiver (see Table 1 for further demographic information). The racial and ethnic composition of the sample was 70.8% Caucasian, 21.3% African American, 5.8% Asian, and 2.1% Native American; 33.2% identified as Hispanic. The mother-child dyads were recruited to participate in this study via flyers placed at day care and preschools, gas stations, pediatrician's offices, restaurants, and grocery stores. Primary caregivers that called and expressed interest in the study were asked several eligibility questions pertaining to the child. Those who met inclusion criteria (fluent in English, no traumatic brain injury, no significant disability that would prevent them from completing lab tasks, no food allergies related to the food groups provided in this study) were invited to the laboratory.

Procedure

The present study is part of a larger project investigating a theoretical model consisting of temperamental negative affectivity, reactivity to stress, effortful control, emotional eating, and weight status. As part of this larger study, primary caregivers were instructed not to allow their child to eat two hours before the scheduled laboratory visit. Twenty-four hours before the lab visit, caregivers were called to remind them of their visit and the no food policy. When parents first arrived to the lab, informed consent was reviewed and obtained. Following the consent process, the child's height, weight and percent body fat was assessed. Buccal cells from the child's mouth were obtained for genetic analysis and the child was given a standard snack consisting of dry cereal (i.e., Cheerios), bottled water, and a fruit cup (these foods were selected based on FDA approved guidelines). After the snack the child conducted an effortful control battery. To keep children engaged, children watched 5 minute cartoons approximately every 15 minutes, in-between experimental activities. Following the effortful control battery, they then performed an executive attention task, consisting of a Stroop with shapes task, and a mild challenge/stress task consisting of a puzzle task. In this stress-inducing task, children were asked to assemble a puzzle consisting of shapes within five minutes without being able to see the puzzle and while alone in a room (adapted from Eisenberg et al., 1996). To heighten the likelihood that children felt motivated to perform well on the task, children were told that they would earn stickers toward a prize for completing the tasks. A timer was placed on the table that vocally announced how much time children had to complete the task. Following the mild stressor, children moved to the laboratory eating task. Children earned stickers and silly bands throughout the 2 hour lab visit and a toy from the treasure chest at the end. Children were videotaped during the entire visit to the lab.

While the children completed the tasks, their primary caregivers completed several questionnaires related to the child's temperamental negative affectivity, inhibitory control, attentional control, eating behaviors and parent's feeding strategies. For Hispanic primary caregivers that needed assistance completing the questionnaires, a bilingual research assistant provided support. Families were then thanked for their participation, paid, and debriefed. Parents were compensated $50 for the lab visit. In addition, to help improve their child's self-regulation skills, primary caregivers received information on effective parenting strategies in this area (adapted from the PATHS manual and modules; Greenberg, Kusché, & Mihalic, 1998).

Measures

Emotional eating. As the construct of interest, emotional eating will be measured using both parent-report on the Children's Eating Behaviour Questionnaire (CEBQ; Wardle, Guthrie, Sanderson, & Rapoport, 2001) and an objective free access procedure.

Parent report of child's eating behaviors. The CEBQ assesses parents' perceptions on child's responsiveness to food, enjoyment of food, satiety responsiveness, slowness in eating, fussiness, emotional overeating, emotional undereating, and desire for drinks. Each subscale can range in score from 4 to 20 with higher scores indicating increased levels of the construct. Internal reliability coefficients ranged from .74 to .91 (Wardle et al., 2001). The present study will use the subscales for *emotional overeating* and *undereating* for analyses as they are most relevant for the focus on emotional eating behaviors; the alpha coefficients for this sample are .86 and .73 respectively.

Eating Laboratory Task. Prior to the puzzle task, children's hunger level (or how full they felt) was assessed (1 = not hungry at all, 2 = a little bit hungry, 3 = hungry, 4 = very hungry). After the puzzle task was completed, children were asked to sit in a room in front of a table that had a bowl of thirty M&Ms and a bowl of twenty grapes, with each bowl being exactly the same size, shape, and color. Children were instructed to rest there and that they were allowed to eat the food; they were left alone in the room for five minutes. The children were videotaped while they are in the room. During the eating laboratory task, the type of food chosen, the amount of food eaten, and the pace at which they ate was recorded. Amount of food eaten was computed as total caloric consumption as well as the rate of total caloric intake and rate of total fat caloric intake based on the total number of M&Ms and grapes eaten. M&Ms and grapes were selected because research investigating preferred foods of binge eaters among children, adolescents and adults have found that sweet foods are preferred (Allison & Timmerman, 2007; Theim et al., 2007). In addition, a study of the likeability of ninety-two different foods among a sample of 1,232 children from one to eleven years of age revealed that chocolate and grapes were among the ten foods preferred; no gender differences in terms of likeability existed among these foods (Cooke & Wardle, 2005).

Reactivity to stress. Children's resting heart rate was measured for two minutes at the very beginning of the research day, before any laboratory tasks had been completed. After other emotion regulation tasks, children rested for one minute and thirty seconds before the stress-inducing puzzle task while they viewed a relatively neutral but pleasant film. Children's physiological reactivity was also recorded during the puzzle task. Physiological data was collected, edited, and analyzed using software/hardware developed by the James Long Co. This equipment samples physiological data at 1000Hz and allows for viewing of physiological samples on- and off-line. The equipment also allows for semi-automated as well as manual editing and analysis of physiological data that avoids confounds in heart rate data. Electrodes were placed on participants' lower left and right rib cage and lower neck in a standard three-lead configuration.

Raw interbeat interval (IBI) values were also inspected for values outside normal physiological levels (i.e., < 200 or > 2000 ms). Values outside this range were removed from twenty-six participants and then HRV measures were calculated; past research has suggested that there are no significant differences in HRV parameters calculated by "tossing" these outliers versus "interpolating" them (Kemper, Hamilton, & Atkinson, 2007).

The standard deviation of NN intervals (SDNN, a measure of overall HRV; Appelhans & Luecken, 2006) is the most widely used measure of HRV (Kemper, Hamilton, & Atkinson, 2007); therefore, *resting heart rate variability* will be computed as the mean SDNN during the two minutes prior to the completion of any tasks, the initial baseline when children were in relatively neutral states. *Reactive heart rate variability* will be computed as the mean SDNN during completion of the stressful puzzle task. *Stress reactivity*, measured as *HRV suppression* or *HRV elevation*, will be computed as the difference between HRV during the puzzle task and HRV during the initial baseline; a positive value will indicate HRV elevation (increased levels of stress) and a negative value will indicate HRV suppression (ability to cope with the environment).

Moderators and Covariates. Effortful control, impulsivity, weight status, ethnicity, and food security are all variables that are hypothesized to influence the relationship between reactivity to stress and emotional eating.

Parent report of child's effortful control and impulsivity. Child effortful control and impulsivity were measured using the Child Behavior Questionnaire (CBQ; Rothbart, Abadi, Hershey, & Fisher, 2001). This is a widely used measure that assesses a wide range of child behaviors including activity level, anger/frustration, approach/positive anticipation, attentional focusing, discomfort, soothability, fear, high intensity pleasure, impulsivity, inhibitory control, low intensity pleasure, sadness, shyness, and smiling/laughter. Subscale scores can range from 6 to 42 with higher scores indicating higher levels of each construct. Because *attentional focusing* and *inhibitory control* are components of effortful control and *impulsivity* is part of reactive control, these subscales will be the focus of the present study. The alpha reliability for the CBQ on a nationally representative sample was .68 for attentional focusing, .77 for inhibitory control, and .76 for impulsivity in samples of 4 to 7 year olds (Rothbart, Ahadi, Hersey, & Fisher, 2001), and within this sample are .75, .67 and .66 respectively. The alpha reliability for inhibitory control increases to .69 when one of the items was removed.

Weight status. Body mass index (BMI) is believed to be a measure of excess weight. BMI was calculated using weight and height. Body weight was assessed to the nearest .1kg using an electronic scale (Weight Tronix), while height was assessed to the nearest .5cm using a stadiometer (Holtain). For children, BMI will be calculated using gender and age relevant charts from the Center for Disease Control and Prevention, Department of Health and Human Services. For children, healthy weight is defined as a BMI that falls below the 85^{th} percentile for their age and sex group (Barlow & Expert Committee, 2007).

Cultural component. Race and ethnicity were obtained through a demographic questionnaire. Based on this questionnaire, the sample was divided into two groups: Hispanic and non-Hispanic.

Food security. The US Department of Agriculture Household Food Security questionnaire was used to assess food security. This is an 18 item questionnaire that categorizes families into food secure, food insecure without hunger, and food insecure with hunger (Nord, Andrews, & Winicki, 2002). This measure has been used with different ethnic groups (Rose & Bodor, 2006).

Results

Data cleaning

Data were inspected for potential outliers using the outlier labeling rule (Hoaglin & Iglewicz, 1987); one extreme value (0.75) from rate of total calorie consumptions, one extreme value (1.1667) from impulsivity, three extreme values (24.20, 25.10, 27.60) from child BMI, two extreme values (5.68, 449.19) from baseline SDNN, and six extreme values (0.37, 196.80, 243.75, 340.19, 411.12, 474.70) from puzzle task SDNN were removed from analyses.

Missing data

For missing data, t-tests were computed for all the variables comparing two groups (those with missing data within the variable vs. those with data on the variable). For food security, 33 individuals were missing data for household food security (13%). There were no significant differences found for impulsivity, attentional control, inhibitory control, stress reactivity, or any of the dependent variables. Significant differences were found for ethnicity ($t(43.19) = 2.461$, $p = .018$) and BMI ($t(224) = 2.236$, $p = .026$), where children with missing food security scores were more likely to be non-Hispanic and have higher BMIs (M = 17.10) than those with food security scores (M = 16.31). For stress reactivity, 45 individuals were missing data necessary to compute a reactivity stress score (18%). Of those, 17 were due to technical issues. When comparing group differences, the two groups significantly differed in levels of inhibitory control ($t(241) = -2.701$, $p = .007$); children with missing reactivity to stress scores showed lower levels of inhibitory control (M = -0.41) than those children with reactivity to stress scores (M = 0.08). For total calorie consumption, there were 27 individuals with missing data due to technical issues (11%). The only significant difference was with level of impulsivity ($t(240) = -2.170$, $p = .031$); children with missing total calorie consumption scores showed lower levels of impulsivity (M = -0.43) than those children with complete scores (M = 0.05).

Preliminary analyses

Sample statistics (means, standard deviations, range, skew, and kurtosis) and correlations were obtained for all study variables (see Tables 2 and 3 respectively). Due to issues of non-normality (as indicated by kurtosis scores > 3), emotional overeating, baseline HRV scores (SDNN), and puzzle task HRV scores (SDNN) were square root transformed for use in analyses.

Covariates. Possible covariates for analyses concerning reactivity to stress included child's BMI, child's ethnicity, child's gender, and household food security. Child BMI was significantly correlated with ethnicity (Hispanic children were more likely to have higher BMIs), household income (children with higher BMIs were more likely to come from higher household incomes), emotional overeating (children with higher BMIs were more likely to emotionally overeat), impulsivity (children with higher BMIs had higher impulsivity scores), and attentional control (children with higher BMIs had decreased attentional focusing). Child ethnicity was significantly correlated with food security (Hispanic children were more likely to be food insecure) and household income (Hispanic children were more likely to come from households with lower income). Child gender was significantly correlated with total calorie consumption (males were more likely to have increased calorie consumption), rate of total calorie consumption (males were more likely to have increased rate of calorie consumption), rate of fat calorie consumption (males were more likely to have increased rate of fat calorie consumption), impulsivity (males were more likely to be impulsive), inhibitory control (males had lower inhibitory control), attentional control (males had lower attentional focusing), and puzzle task HRV (males were more likely to have higher HRV during that puzzle task). Food security was significantly correlated with household income (food secure individuals were more likely to come from households with higher income), emotional overeating (food insecurity was most likely associated with increase emotional overeating), and attentional control (food insecurity was most likely associated with decreased attentional focusing). All four covariates were included in all analyses.

Manipulation Check. A t-test was used to compare HRV values at initial baseline and during the puzzle stress task. Results revealed that HRV was significantly lower during the puzzle task ($t(201) = 4.328$, $p < 0.001$); this suggests that the puzzle task was stressful enough to elicit a change in these physiological measures.

Primary Results

Hypothesis 1: Stress reactivity predicts emotional eating. A hierarchical regression equation was constructed. In Step 1, the covariates (BMI, ethnicity, gender, food security) were entered into the equation; in Step 2, stress reactivity (SDNN difference scores) was added. A separate regression equation was constructed for each dependent variable (parent reported emotional overeating, parent reported emotional undereating, rate of total calorie consumption, rate of fat calorie consumption, total calorie consumption). As Table 4 displays, stress reactivity did not predict any forms of emotional eating above and beyond the covariates.

Hypothesis 2: Impulsivity and effortful control moderate the relationship between stress reactivity and emotional eating. In Step 3 of the hierarchical regression equation, impulsivity and effortful control were explored. However, inhibitory control was significantly and strongly correlated with attentional control. Multicollinearity leads to unreliable regression coefficients and large standard errors because there is very little unique information available to base the value on (Cohen, Cohen, West, & Aiken, 2003). To avoid these issues inhibitory control and attentional control were explored in separate equations. When HRV and the covariates (gender, ethnicity, BMI, food security) were controlled for, impulsivity and inhibitory control did not predict any forms of emotional eating (see Table 5). However, attentional control significantly predicted emotional overeating even when controlling for HRV and the covariates (see Table 6). Specifically, a parent's report of a child having lower levels of attentional control predicted higher parent-reported emotional overeating.

In Step 4 of the hierarchical regression equation, the interaction terms (between stress reactivity and impulsivity/inhibitory control/attentional control) were added. None of the interaction terms were significant.

Discussion

In today's society, it is extremely difficult to have a healthy relationship with food. This is evident by the high rates of obesity in the United States (Ogden et al., 2014). Extensive literature has examined the relationship between stress and emotional eating finding that emotional eating is a common coping strategy for stress (Greeno & Wing, 1994) that contributes to overweight status among children and adults (Blissett et al., 2010). Research has also suggested that HRV is deeply related to emotion and stress response, such that greater levels of HRV suppression during a stressful task have been associated with more positive outcomes (Beauchaine et al., 2007). However, few studies have sought to explain emotional eating using HRV as a measure of stress reactivity. The current study examined the relationship between stress reactivity and emotional eating (parent-reported overeating, parent-reported undereating, total caloric consumption, rate of total caloric intake, and rate of total fat caloric intake) as well as whether effortful control and/or impulsivity might moderate the impact of HRV on emotional eating. This was done in order to add valuable psychophysiological data to the individual differences model of emotional eating. Furthermore, this line of research examined emotional eating and weight status through a dual-process theory lens (i.e., behavior is determined by the interplay of automatic and controlled processes) which may better explain the decisions that lead to emotional eating.

Sherman and Gawronski (2014) highlighted that even in light of the dual-process theory, behaviors still occur in animals that do not contain the same level of conscious control as humans; this suggests that controlled processes/cognitions are not necessarily needed to originate behavior. Based on this theory, the first hypothesis was that stress reactivity would predict the different emotional eating variables. However, after controlling for gender, BMI, ethnicity, and food security, the hypothesized relationship between reactivity to stress and emotional overeating, emotional undereating, total caloric consumption, rate of total caloric intake, and rate of total fat caloric intake was not supported by the data. Not only was this unexpected based on the dual-process theory, but it also does not fit with previous research findings that suggest HRV is a good indicator of stress reactivity (Calkins & Keane, 2004; Egizio et al., 2008; Mehta, 2015;

Messerli-Bürgy et al., 2010; Souza et al., 2013; Weber et al., 2010) and emotional eating occurs following stress (Greeno & Wing, 1994).

There are several possible explanations for these unanticipated results. First may be the selection of SDNN as the measure of HRV over other valid options. While SDNN is a measure of overall HRV, the square root of the mean squared difference of successive interbeat intervals (RMSSD) is thought to be a measure of parasympathetically mediated HRV (Appelhans & Luecken, 2006). While the SNS does increase heart rate in response to the environment, it works slowly. The PNS works more quickly to increase or decrease heart rate in response to environmental demands via the vagus nerve (Appelhans & Luecken, 2006) and may be a better measure of physiological reactivity following a stressful task. Another potential measure of HRV is a residualized change score which is a standard statistical technique that may be preferred to a simple "task minus baseline" difference score (Prochaska, Velicer, Nigg, & Prochaska, 2008).

A second explanation for the results might be that resting HRV is a better indicator of emotional eating than reactive HRV. Reactive HRV, a common measure of heart rate during a stressful stimulus, was selected for this study because the individual differences model of emotional eating suggests that this eating behavior is a common reaction to stress. Furthermore, reactive HRV research has shown an association between greater HRV suppression during stressful tasks and favorable outcomes in children (Calkins & Keane, 2004); conversely, obese samples, as well as eating disordered populations, have shown elevations in HRV following a stressful task as well as increased hunger and food cravings (Messerli-Bürgy et al., 2010; Mehta, 2015). However, resting HRV has demonstrated high levels of consistency over long periods of time (Burleson et al., 2003; Sandercock et al., 2005) which may indicate that it is more of a trait-like measure of an individual's capacity to regulate their heart rate in response to different environmental demands (Bertsch, Hagemann, Naumann, Schächinger, & Schulz, 2012; Thayer, Hansen, Saus-Rose, & Helge Johnsen, 2009), including stressful ones. In addition to this, research has associated higher resting HRV with the use of more effective coping strategies in the face of overwhelming daily stressors (Fabes & Eisenberg, 1997; Geisler et al., 2013) as well as fewer food cravings and dieting success (Meule et al., 2012). Since emotional eating is a maladaptive coping strategy for daily stressors, resting HRV could be a better predictor of this behavior.

Finally, it may be the case that the covariates accounted for the rates of emotional eating seen in this study in several ways. Since emotional eating has been directly linked to weight status (Blissett, Haycraft, & Farrow, 2010), a more complete model of emotional eating includes BMI as an outcome variable; BMI as an outcome was not included in this study, but should be assumed to fit the model due to past research. By controlling for BMI, this study may have inadvertently masked the outcome effects. Gender significantly predicted all three of the free access procedure emotional eating lab tasks; it is possible that gender impacts emotional eating in young children more strongly than does HRV. Interestingly, findings from the current study suggest that the objective rates of emotional eating are higher in the males. Some research has suggested that men who struggle to identify their emotions engage in more emotional eating (Larsen et al., 2006); another study suggests that men binge eat as a response to strong negative emotions that they direct outward while women eat in response to negative emotions they direct inward (Costanzo, Musante, Friedman, Kern, & Tomlinson, 1999). It is possible that the stressful task was not one that led to self-loathing in the females and that the young boys still struggle to identify their emotions and so, direct their frustration outward. However, it is also possible that these results are due to the boys being more impulsive than the female participants.

Food security did not predict any outcomes, but it still could have affected the results. Past research has shown that feeding patterns differ based on food security status and the availability of food (Bronte-Tinkew, Zaslow, Capps, Horowitz, & McNamara, 2007; Kaiser et al., 2002). However, new evidence suggests that food security status is not always consistent across time and that families do not change their behaviors surrounding food as their status changes (Perez, 2016). This could suggest that the physiological reactivity to food is different, not only between food secure and insecure individuals, but also within food insecure samples depending on if their status is stable or flexible.

It could also be the case that after controlling for confounding variables, emotional eating as a behavior is governed more by the conscious aspects of the dual-process theory which would be more in line with hypothesis two: impulsivity and effortful control moderate the relationship between stress reactivity and emotional eating. However, similar to hypothesis one, there was no evidence supporting moderation by impulsivity, attentional focusing, or inhibitory control. This was also unforeseen due to previous findings.

First, no measures of emotional eating were predicted by impulsivity or inhibitory control. This was unforeseen because research has linked impulsivity and inhibitory control to unhealthy eating habits and obesity (Bartholdy, Dalton, O’Daly, Campbell, &

Schmidt, 2016; Jasinka et al., 2012); specifically, increased levels of impulsivity and decreased levels of inhibitory control have been associated with higher rates of emotional eating in adults (Jasinka et al., 2012). A review of brain-imaging studies also found that when shown high-calorie foods, obese individuals show less response in brain regions that have been implicated in inhibitory control compared to normal weight individuals. Similarly, in response inhibition tasks involving food and non-food stimuli, obese individuals show decreased levels of inhibitory control which is consistent with findings that adults with these deficits show poorer weight loss treatment results (Stice, Lawrence, Kemps, & Veling, 2016). In children, research has shown that levels of impulsivity tend to be higher in obese individuals and those who binge eat (Farrow, 2012), while sugar and carbohydrate intake is increased in children with lower levels of inhibitory control (Levitan et al., 2015). Research also suggests that increased negative emotions, like stress, disrupt the ability to inhibit responses; this effect increases as age decreases (Cohen-Gilbert, & Thomas, 2013). Furthermore, previous research has suggested a negative correlation between HRV and impulsivity in male adults (Hansen, Johnsen, & Thayer, 2003) and children with ADHD (Allen, Matthews, & Kenyon, 2000; Beauchaine, Katkin, Strassberg, & Snarr, 2001), as well as a positive correlation between HRV and inhibitory control (Gillie, Vasey, & Thayer, 2014).

There are a few reasons that the current study may not replicate this vast research. It is important to note that the measures of impulsivity and effortful control used in this study were parent-reported questionnaires; many of the studies cited above use objective and reliable markers of impulsivity and inhibitory control like the stop signal reaction time (SRRT) and the continuous performance test (CPT). It is possible that the parent-report measures are not capturing the same construct as these experimental tasks, a finding that has been highlighted in past research (Muris, van der Pennen, Signomd, & Mayer, 2008). The studies on impulsivity were also only for men; the effects of impulsivity and inhibitory control may not have been seen over and above HRV because this study controlled for gender first. Finally, many of the studies exploring HRV used a measure of resting HRV instead of reactive HRV; as discussed above, the inclusion of reactive HRV as the predictor may have limited the current findings.

Interestingly, attentional focusing was predictive of parent-reported emotional overeating such that children with decreased ability to focus their attention were reported to have increased rates of emotional eating. Past research does support this finding, suggesting that decreased levels of attentional focusing is associated with changes in weight (Hotham & Sharma, 2015). Increased attention to food and body stimuli have been found among individuals with eating disorders (Harrison, Sullivan, Tchanturia, & Treasure, 2010), and several brain imaging studies suggest that overeating is associated with reactivity in regions of the brain associated with attention when presented with food cues (Stice et al., 2016). However, it is interesting that attentional focusing did not predict any of the objective eating measures. Future research will need to continue exploring the role of attentional focusing on objective emotional eating measures and how this construct could be implemented in obesity preventions and interventions.

While attentional focusing did predict emotional overeating, like impulsivity and inhibitory control, it was still not associated with HRV. Research has found that individuals with low HRV have difficulty regulating their attentional resources (Johnsen et al., 2003), and that resting HRV levels are positively correlated with performance on attention tasks (Hovland et al, 2012). Again, the findings from the current study could be due to the use of reactive HRV which should be addressed in the future.

Limitations and Future Research

The current study had several limitations not already discussed above. First, the Hispanic sample is based on the exclusion criteria that participants speak English fluently. This decision was made because the effortful control measures have not been tested on Hispanic populations that do not speak English, but it does limit the generalizability of the findings to English-speaking Hispanics. Another limitation of this study is that the eating laboratory task only tests self-regulation with respect to sweet foods. This study was limited to sweet foods because when loss of control eating occurs in children, adolescents and adults, sweet foods such as chocolate are preferred (Allison & Timmerman, 2007; Theim et al., 2007); however, this also limits the generalizability of the findings. Finally, this study involves a cross-sectional design which limits the ability to establish causal relationships.

Despite the null findings of this study, this area of research should not be abandoned. In addition to exploring the avenues of research outlined above (i.e., addressing the limitations, looking at physiological reactivity to food across and within food security groups), research should aim to explore this research in a college-aged sample. Not only would this allow for comparison of the model in developmentally different groups, but it could allow for the examination of how impulsivity, effortful control, and physiological reactivity to stress relate to momentary emotional eating, as well as how they relate to behaviors developed over time to deal with college stress (i.e., stimulant use, poor sleep habits, eating, weight gain). Furthermore, future research should consider developing latent constructs of the variables. With latent constructs made up of self/parent-report, observational data, and behavioral tasks, there will be a much better representation of the underlying construct which may provide a clearer picture, and a more unbiased result compared to relying on a single measured variable (MacCallum & Austin, 2000).

Future research should also explore emotional eating outside of a dual-process theory lens; other models may provide useful insights on the mechanisms underlying emotional eating. For example, the extended version of the dual-pathway model of bulimic pathology (see Figure 2; Van Strien, Engels, Van Leeuwe, & Snoek, 2005) might be used to explore the mechanisms behind what predisposes someone to emotionally eat. This model combines sociocultural, dietary, and affect regulation factors to explain binge eating behaviors. In the original dual-pathway model, body concerns are indirectly linked to overeating through two distinct pathways: dieting and negative affect (Stice, 2001). The extended model adds two additional variables to the negative affect pathway: interoceptive deficits and emotional eating. These additions indicate that increased food consumption is a response to emotional distress in individuals who have difficulty recognizing, identifying, and discriminating among internal cues (i.e., hunger, emotional states; Van Strien et al., 2005). The childhood temperament literature may also provide a model that could explain emotional eating. There is a wide body of evidence suggesting that high levels of negative reactivity (i.e. expressed and felt distress, as well as behavioral and attentional aversion) during infancy and childhood, as well as decreased levels of self-regulation (i.e., effortful control and orienting) may be risk factors for obesity (Anzman-Frasca, Stifter, & Birch, 2012). A proposed pathway that could link the research between reactivity and self-regulation begins when children with low regulation have a hard time controlling their expressions of distress; parents may soothe them with food (Anzman-Frasca, Stifter, & Birch, 2012). When these children grow, they may turn to energy-dense foods in order to sooth their own distressing emotions. Finally, a model of the determinants of health could also be used to understand emotional eating within an ecological framework (Institute of Medicine Staff, 2001). As seen in Figure 3, this model highlights that behavior is not simply an individual choice, but is shaped by many factors operating at different levels. Because social and physical environments, as well as genetics influence biological and behavioral determinants of health, this may provide a more complete picture of emotional eating and obesity. Furthermore, this model would suggest that prevention and intervention efforts would be more effective if they targeted multiple levels of this model.

Summary and Conclusions

The current study assessed whether impulsivity and effortful control moderated the impact of reactive HRV on a variety of emotional eating measures. Results did not support the hypotheses that reactive HRV would predict emotional eating or that the relationship was moderated by impulsivity and effortful control. Despite these null findings, and in light of several limitations, it is still hypothesized that emotional eating involves physiological *and* impulsivity/effortful control processes.

Future research needs to continue in this area in order to tease apart the relationship between these factors and determine for which combination of factors emotional eating (and therefore obesity risk) increases. Significant findings will inform intervention and prevention programs designed to reduce the risk for emotional eating in this group. Furthermore, findings in this area may expand beyond the domain of eating and obesity research. People who struggle with impulsivity/effortful control and physiological reactivity may struggle academically, with social skills, and/or behavioral problems (e.g., aggressiveness, impulsivity) in addition to emotionally eating and/or being overweight. Thus, this research stands to inform a more global prevention effort that targets the dual-process model of coping with stress.

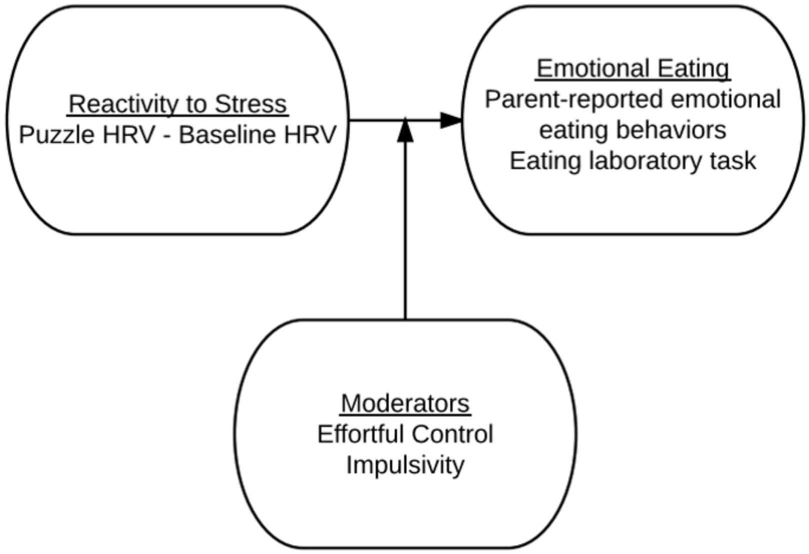

Figure 1. Proposed study model.

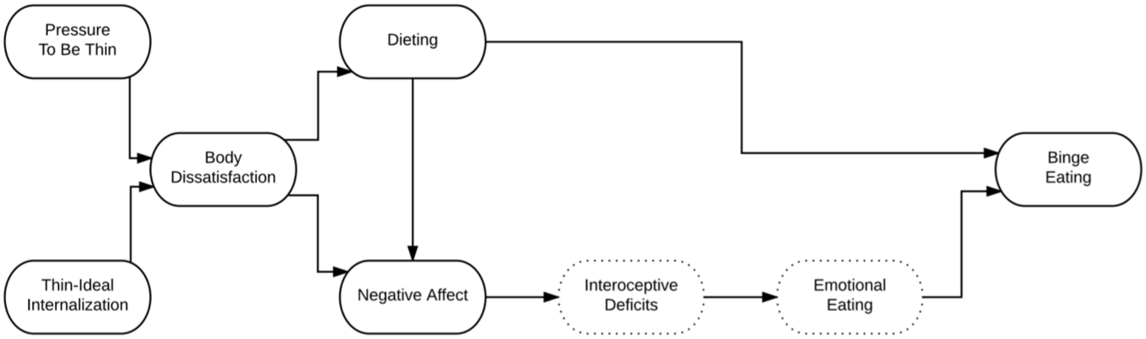

Figure 2. The dual-pathway model of bulimic pathology – extended.

Note: Solid variables come from the original model (Stice, 2001). Dotted variables were added to the extended model (Van Strien et al., 2005)

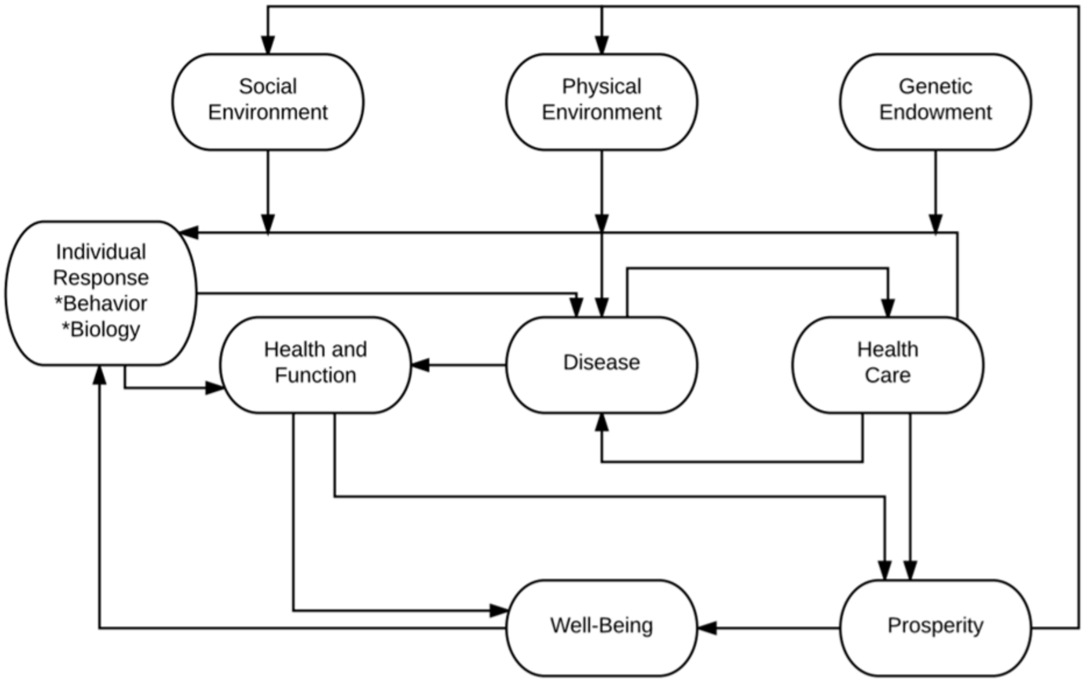

Figure 3. A model of the determinants of health. (Institute of Medicine Staff, 2001, p. 25)

Table 1. Sample demographics

Child Age	N (%)	M (SD)	Range
4	116 (47%)		
5	61 (24.7%)		
6	67 (27.1%)		
Child Gender			
Male	126 (51%)		
Female	116 (47%)		
Child Ethnicity			
Hispanic	81 (32.8%)		
Non-Hispanic	163 (66%)		
Child Weight Status			
Overweight	79 (32%)		
Normal Weight	143 (57.9%)		
Underweight	7 (2.8%)		
Guardians Relation to Child			
Father	20 (8.1%)		
Mother	220 (89.1%)		
Step-Father	1 (0.4%)		
Grandfather	2 (0.8%)		
Age of Guardian	238	32.71 (7.05)	20-63
Family Monthly Income			
$0 – $1,000	43 (17.4%)		
$1,001 – $2,000	44 (17.8%)		
$2,001 – $3,000	36 (14.6%)		
$3,001 – $5,000	37 (15.0%)		
$5,001 – $7,000	24 (9.7%)		
$7,001 – $9,000	30 (12.1%)		
$9,001 – $11,000	7 (2.8%)		
$11,001 – $13,000	5 (2%)		
$13,001 – or more	16 (6.5%)		

Table 2. Original Descriptive Statistics of Study Variables

	N	Mean	SD	Range	Skew	Kurtosis
BMI	226	16.41	1.76	12.50 – 22.80	0.78	1.10
Ethnicity[a]	244	1.67	0.47	1.00 – 2.00	-0.72	-1.50
Food Security[b]	214	0.79	0.41	0.00 – 1.00	0.05	0.33
Child Gender[c]	242	1.48	0.50	1.00 – 2.00	0.08	-2.01
Emotional Overeating[d]	243	6.83	2.92	4.00 – 20.00	1.48	3.34
Emotional Undereating	243	10.81	3.21	4.00 – 19.00	-0.14	-0.49
Total Calorie Consumption	220	92.12	35.49	0.00 – 142.00	-0.45	-0.32
Rate of Calorie Consumption	216	0.31	0.13	0.00 – 0.74	0.10	0.41
Rate of Fat Calorie Consumption	217	0.01	0.00	0.00 – 0.02	-0.45	-0.16
Impulsivity	242	4.56	1.01	1.80 – 7.00	-0.11	0.03
Attentional Focusing	243	4.80	1.12	1.67 – 7.00	-0.37	-0.18
Inhibitory Control	243	4.60	1.09	1.60 – 6.80	-0.28	-0.43
Baseline HRV (SDNN)[d]	212	64.62	30.55	15.80 – 256.63	1.86	7.31
Puzzle Task HRV (SDNN)[d]	208	58.32	30.04	4.38 – 180.98	1.61	3.06
Reactivity to Stress (SDNN)[e]	202	-6.12	23.30	-109.06 – 138.77	1.14	10.33

[a] Ethnicity: 1.00 = Hispanic, 2.00 = Non-Hispanic
[b] Food Security: 0.00 = Food Insecure, 1.00 = Food Secure
[c] Child Gender: 1.00 = Male, 2.00 = Female
[d] Corrected with Square root-transformation for analyses
[e] Reactive HRV – Baseline HRV; negative = suppression, positive = elevation

Table 3. Correlations

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.	Child Age[a]	1.0																
2.	Child BMI	.10	1.0															
3.	Child Ethnicity[b]	-.03	-.19**	1.0														
4.	Child Gender[c]	.04	.00	.01	1.0													
5.	Food Security[d]	-.03	-.08	.19**	-.00	1.0												
6.	Household Income	-.03	-.17*	.14*	-.01	.31**	1.0											
7.	Emotional Overeating[e]	.06	.14*	-.02	.02	-.15*	.02	1.0										
8.	Emotional Undereating	.03	-.03	.09	.03	.00	.22**	.46**	1.0									
9.	Total Calorie consumption	.10	-.02	-.04	-.21**	-.04	-.05	-.14*	-.10	1.0								
10.	Rate of Calorie Consumption	.13	-.03	-.03	-.21**	-.07	-.08	-.15*	-.13	.97**	1.0							
11.	Rate of Fat Calorie Consumption	.05	-.04	-.03	-.20**	-.01	-.06	-.14*	-.13	.92**	.92**	1.0						
12.	Impulsivity	-.01	.14*	.10	-.17**	-.09	-.02	.03	.08	.17*	.17*	.16*	1.0					
13.	Inhibitory Control	.08	-.09	-.06	.19**	.09	.05	-.09	-.09	-.12	-.10	-.12	-.31**	1.0				
14.	Attentional Control	.05	-.14*	.07	.17**	.20**	.11	-.26**	-.11	-.11	-.08	-.10	-.33**	.61**	1.0			
15.	Baseline HRV (SDNN)[e]	.11	.00	-.01	-.09	-.11	.03	.00	.03	.13	.13	.09	.09	.06	.00	1.0		
16.	Puzzle Task HRV (SDNN) [e]	-.03	.02	-.05	-.15*	-.09	-.00	.00	-.01	.16*	.16*	.14	.05	-.02	.01	.73**	1.0	
17.	Reactivity to Stress (SDNN)[f]	-.13	.06	-.03	-.07	.03	-.05	.02	-.02	.06	.05	.10	-.04	-.09	.02	-.37**	.37**	1.0

[a] Child Age: 1.00 = 4 years old, 2.00 = 5 years old, 3.00 = 6 years old
[b] Ethnicity: 1.00 = Hispanic, 2.00 = Non-Hispanic
[c] Child Gender: 1.00 = Male, 2.00 = Female
[d] Food Security: 0.00 = Food Insecure, 1.00 = Food Secure
[e] Corrected with Square root-transformation for analyses
[f] Reactive HRV – Baseline HRV; negative = suppression, positive = elevation

Table 4. Hierarchical regression analyses for Hypothesis 1

	Model Summary			Coefficients		
	R^2	Adj. R^2	F(df)	ß	*t*	*p*
Emotional Overeating						
Step 1	.038	.016	1.691 (4, 169)			
BMI				.038	1.695	.092
Ethnicity				.038	.447	.655
Food Security				-.183	-1.868	.063
Child Gender				.015	.195	.846
Step 2	.039	.010	1.356 (5, 168)			
Stress Reactivity (HRV)				.007	.233	.816
Emotional Undereating						
Step 1	.010	-.014	.416 (4, 169)			
BMI				-.030	-.214	.831
Ethnicity				.628	1.165	.246
Food Security				-.129	-.210	.834
Child Gender				.167	.340	.735
Step 2	.010	-.020	.337 (5, 168)			
Stress Reactivity (HRV)				-.031	-.165	.869
Rate of Total Calorie Consumption						
Step 1	.050	.027	2.220 (4, 169)			
BMI				-.003	-.507	.613
Ethnicity				-.004	-.199	.842
Food Security				-.024	-.982	.327
Child Gender				-.054	-2.758	.006**
Step 2	.052	.024	1.836 (5, 168)			
Stress Reactivity (HRV)				.004	.581	.562
Rate of Fat Calorie Consumption						
Step 1	.042	.019	1.835 (4, 169)			
BMI				-9.309E-5	-.660	.510
Ethnicity				.000	-.388	.698
Food Security				-9.979E-5	-.164	.870
Child Gender				-.001	-2.600	.010**
Step 2	.049	.021	1.740 (5, 168)			
Stress Reactivity (HRV)				.000	1.161	.247
Total Calorie Consumption						
Step 1	.046	.023	2.031 (4, 169)			
BMI				-.541	-.350	.727
Ethnicity				-2.318	-.396	.692
Food Security				-3.377	-.507	.613
Child Gender				-14.625	-2.745	.007**
Step 2	.048	.020	1.692 (5, 168)			
Stress Reactivity (HRV)				1.233	.605	.546

Note. HRV and the moderators were centered prior to analysis, ** $p < .01$

Table 5. Hierarchical regression analyses (using Impulsivity and Inhibitory Control) for Hypothesis 2

	Model Summary			Coefficients		
	R^2	Adj. R^2	F(df)	*ß*	*t*	*p*
Emotional Overeating						
Step 3	.044	.004	1.091 (7, 166)			
Impulsivity				-.012	-.295	.769
Inhibitory Control				-.037	-.947	.345
Step 4	.046	-.007	.873 (9, 164)			
HRV x Impulsivity				.015	.498	.619
HRV x Inhibitory Control				.007	.286	.775
Emotional Undereating						
Step 3	.022	-.019	.536 (7, 166)			
Impulsivity				.194	.737	.462
Inhibitory Control				-.241	-.991	.323
Step 4	.026	-.027	.492 (9, 164)			
HRV x Impulsivity				.136	.746	.457
HRV x Inhibitory Control				.073	.487	.627
Rate of Total Calorie Consumption						
Step 3	.074	.035	1.888 (7, 166)			
Impulsivity				.019	1.832	.069
Inhibitory Control				-.002	-.237	.813
Step 4	.082	.031	1.622 (9, 164)			
HRV x Impulsivity				-.006	-.840	.402
HRV x Inhibitory Control				.004	.730	.466
Rate of Fat Calorie Consumption						
Step 3	.072	.033	1.852 (7, 166)			
Impulsivity				.000	1.704	.090
Inhibitory Control				.000	-.619	.537
Step 4	.086	.035	1.705 (9, 164)			
HRV x Impulsivity				.000	-1.532	.127
HRV x Inhibitory Control				-4.063E-5	-.278	.781
Total Calorie Consumption						
Step 3	.072	.033	1.831 (7, 166)			
Impulsivity				4.948	1.745	.083
Inhibitory Control				-1.543	-.589	.557
Step 4	.078	.028	1.546 (9, 164)			
HRV x Impulsivity				-1.545	-.789	.431
HRV x Inhibitory Control				.998	.619	.537

Note. HRV and the moderators were centered prior to analysis

Table 6. Hierarchical regression analyses (using Impulsivity and Attentional Focusing) for Hypothesis 2

	Model Summary			Coefficients		
	R^2	Adj. R^2	F(df)	ß	*t*	*p*
Emotional Overeating						
Step 3	.093	.055	2.438 (7, 166)*			
Impulsivity				-.039	-.948	.345
Attentional Focusing				-.118	-3.156	.002**
Step 4	.096	.046	1.933 (9, 164)			
HRV x Impulsivity				.011	.392	.696
HRV x Attentional Focusing				-.012	-.524	.601
Emotional Undereating						
Step 3	.028	-.013	.682 (7, 166)			
Impulsivity				.157	.595	.552
Attentional Focusing				-.338	-1.410	.160
Step 4	.031	-.022	.589 (9, 164)			
HRV x Impulsivity				.114	.627	.532
HRV x Attentional Focusing				-.048	-.330	.742
Rate of Total Calorie Consumption						
Step 3	.074	.034	1.882 (7, 166)			
Impulsivity				.020	1.925	.056
Attentional Focusing				.001	.140	.889
Step 4	.080	.030	1.589 (9, 164)			
HRV x Impulsivity				-.006	-.872	.384
HRV x Attentional Focusing				.003	.540	.590
Rate of Fat Calorie Consumption						
Step 3	.071	.032	1.818 (7, 166)			
Impulsivity				.000	1.743	.083
Attentional Focusing				-9.464E-5	-.402	.689
Step 4	.085	.035	1.687 (9, 164)			
HRV x Impulsivity				.000	-1.458	.147
HRV x Attentional Focusing				5.044E-5	.358	.721
Total Calorie Consumption						
Step 3	.071	.032	1.807 (7, 166)			
Impulsivity				5.042	1.767	.079
Attentional Focusing				-1.121	-.433	.666
Step 4	.077	.026	1.515 (9, 164)			
HRV x Impulsivity				-1.592	-.813	.417
HRV x Attentional Focusing				.809	.520	.604

Note. HRV and the moderators were centered prior to analysis, * < .05 ** p < .01

References

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