THE IMPACT OF CHILDHOOD UNPREDICTABILITY, INTEROCEPTIVE BODY AWARENESS, AND BLOOD GLUCOSE ON EATING BEHAVIOR

by

RANDI P. PROFFITT LEYVA

Bachelor of Arts, 2009
Hendrix College
Conway, Arkansas

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Thesis approved:

Major Professor

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The Impact of Childhood Socioeconomic Status, Interoceptive Body Awareness, and Blood Glucose on Eating Behavior

In recent years, the World Health Organization (WHO) has identified childhood and adult obesity as a growing public health concern world-wide (WHO, 2014). Reports suggest that obesity has doubled since the 1980s, with over 1.4 billion adults and 42 million children having a body mass index (BMI) that qualifies as obese (greater than or equal to 30). According to the Centers for Disease Control (CDC), an estimated 17% of children in the United States (U.S.), ages 2-19, were obese in 2012. Additionally, obesity is more prevalent in low-income communities and disproportionately effects racial/ethnic minorities (Hispanic: 22.4% and Black: 20.2% compared to Caucasian: 14.1%), (CDC, 2011-2012). The rise in obesity is often attributed to both an increase in the consumption of high fat, calorically dense foods, and a decrease in physical activity as forms of work, play, and transportation have shifted (WHO, 2014).

There is a growing body of literature indicating that socioeconomic disadvantage during childhood is a major factor contributing to obesity in adulthood (Gonzalez, et al., 2012; Hill, Prokosch, DelPriore, Griskevicius, & Kramer, 2016; Kestila, Rahkonen, Martelin, Lahti-Koski, & Koskinen, 2009; Poulton, et al.; Wells, Evans, Beavis, & Ong, 2010; Tamayo, Herder, & Rathmann, 2010). For example, some of the primary predictors of obesity within low SES demographics include environmental conditions such a lack of healthy foods, lack of safe space for physical activity, and social factors such as family discord. While there is a clear link between low SES in childhood and adult obesity, there is little known about the mechanisms that promote this association. Here, I seek to examine the impact of exposure to unpredictable early-life conditions on interoceptive body awareness acuity (i.e., internal bodily feelings of hunger, thirst, etc.) and how an awareness of the internal body state drives energy consumption strategies

that last into adulthood. I hypothesize that growing up in an unpredictable environment encourages individuals to adaptively ignore internal bodily cues, such as fullness or hunger, and to eat/overeat opportunistically (when food is available) rather than homeostatically (when hungry or an energy need is present).

Life History Theory and Energy Regulation

Life history theory (LHT) is a mid-level evolutionary theory rooted in principles of ecology and evolutionary biology that provides a strong predictive framework for the impact of early developmental conditions on the adaptive trade-offs organisms are forced to make in the realms of growth, survival, and reproduction (Belsky, Steinberg, & Draper, 1991; Ellis, Figueredo, Brumbach, & Schlomer, 2009; Kaplan & Gangestad, 2005). LHT predicts that exposure to specific early life conditions calibrates behavioral adaptations that maximize survival across the lifespan under similar environmental conditions. So long as conditions remain constant, the tradeoffs organisms make to enhance survival typically prove adaptive throughout the life course. However, when conditions change, previously adaptive behaviors are no longer optimized to maximize survival in new environmental conditions. For example, early environments wrought with unpredictable access to food shape behavioral strategies that maximize caloric intake during periods of food availability. While this strategy is adaptive in the short-term, when the food environment changes, excessive calories and body weight can be detrimental to survival.

Energy balance is integral for maintaining growth, supporting reproductive capabilities, and ultimately ensuring survival. As such, maintain energy balance and regulating the intake and use of energy is hypothesized to be subject to the same adaptive pressures and trade-offs as outlined by LHT. Using this framework, I can predict that growing up in conditions where access

to food is plentiful, it makes good adaptive sense to consume calories only when a physiological energy need is present (i.e., blood glucose drops, the “hunger hormone” ghrelin spikes). Alternatively, in conditions where access to food is scarce or unpredictable, it makes adaptive sense to consume calories opportunistically when food is present, rather than based solely on physiological need. This strategy optimizes energy storage for potential future periods of food scarcity, allowing adequate energy storage in the form of adipose tissue (i.e., body fat). However, when food conditions shift from scarce to plentiful, opportunistic eating is then at odds with maintaining a healthy body weight, which can result in obesity, and present other challenges to optimizing survival.

Recent research by Hill, Prokosch, DelPriore, Griskevicius, and Kramer (2016) lends support for the prediction that energy regulation is calibrated in early childhood. Hill et al. (2016) demonstrated that individuals reared in high socioeconomic (SES) environments consume calories based on current energy need, leading to eating more when energy need is high and eating less when energy need is low. However, they found that individuals reared in low SES environments eat equally high amounts of calories, regardless of energy need. This research suggests that those developing in high SES (i.e., more predictable and resource abundant environments), use blood glucose as a mechanism by which to guide eating behavior, while those from low SES or unpredictable/resource scarce environments do not. Current adult SES had no impact on this relationship.

While research by Hill et al. (2016) demonstrated a clear impact of childhood SES and blood glucose on adult eating behaviors, specific components of the low SES environment contributing to these findings were not explored. The development of body awareness, or interoceptive acuity, is perhaps one key developmental component evolving during early

childhood that impacts eating strategies throughout the life course. Much research indicates that an awareness of the internal sensations of the body, known as interoception, is integral for appropriately interpreting signals from the viscera, cardiopulmonary, and nervous systems to regulate a host of bodily perceptions, including the sensation of when and when to not eat (Craig, 2002). Basic human physiology is thought to drive balanced energy consumption based on calories needed to maintain survival and is known as intuitive or homeostatic eating (Havel, 1999; Woods, Seeley, Porte, & Schwartz, 1998). Homeostatic eating is guided by the perception of internal physiological cues to hunger and satiety (Gast & Hawks, 2000; Tylka & Wilcox, 2006), in contrast to eating in response to external environmental (e.g. smell or sight of food) and emotional cues (Carper, Fisher, & Birch, 2000; Fedoroff, Polivy & Herman, 1997; Polivy & Herman, 1999). Homeostatic eating is guided by behavioral responses to physiological energy need and thus the sensation of being hungry must be properly interpreted by the organism as a cue to consume calories to bring the body back to homeostasis. The physiological sensation (or sense of awareness) that drives the organism to return the body to energy homeostasis is known as interoception. While interoception is global term, describing acuity to multiple internal sensations (Craig, 2002), the focus of this paper will be within the domains of alimentary interoception (sensations of hunger, satiety, and utilizing blood glucose to determine energy need) and heart rate interoception, which is highly correlated with perception of visceral sensations and activation of identical brain structures as alimentary interoception (Craig, 2002; Craig, 2003; Garfinkel, Seth, Barret, Suzuki, & Critchley, 2015; Katkin, 1985; Pollatos & Schandry, 2004; Pollatos, Kirsch, & Schandry, 2005; Schandry, 1981). In the current research, I seek to explore the impact of early developmental calibration to an unpredictable environment and how it shapes individuals to ignore or stifle hunger/satiety signals (or interoceptive

feedback). These signals facilitate survival when food conditions are scarce by driving the organism to eat when food is available rather than only when hungry. This makes adaptive sense as food scarcity endures, individuals who are able to ignore bodily signals of hunger and discomfort are able to continue functioning longer. In contrast, this same ability to ignore bodily signals allows organisms to fail to attend to fullness signals and continue eating even when full. It makes logical sense that when food scarcity ends, these individuals who have been conditioned to ignore interoceptive signals of hunger also ignore the sensation of satiety and thus overeat, resulting in obesity in food rich environments.

Following this line of thinking, the Thrifty Phenotype hypothesis predicts that as developmental exposure to environmental scarcity occurs, a suite of physiological and psychological adaptations occur both in utero and in early childhood that extend into adulthood, (Ellis, et al., 2009; Hales & Barker, 1992; Kuzawa, McDade, Adair, & Lee, 2010; West-Eberhard, 2003; Gluckman et al., 2007). These characteristics include a smaller body size, slower metabolism, more insulin resistance, more opportunistic eating and less physical activity (Barker, 1997; Bateson & Martin, 1999; Robinson, 2001; Gluckman & Hanson, 2004). While these phenotypic changes are adaptive in a resource scarce environment, when conditions change and energy is readily and consistently available, it is possible that individuals calibrated to the thrifty phenotype often overeat and thus exacerbate the predisposition to obesity and other weight-related and cardiovascular health issues.

Interoception

Interoception is broadly defined as the sense of the physiological condition of the body and encapsulates internal sensations such as temperature, pain, heart rate, as well as muscular and visceral sensations such as hunger, fullness, and thirst (Craig, 2002). Interoception is often

described as an awareness of the internal, non-observable sensations occurring within the body that guide our understanding of the state of our body's well-being, energy, stress level, mood, and disposition (Craig, 2003). Interoceptive feedback serves as a cue that a body imbalance exists and requires attention. However, not all individuals perceive bodily feedback in the same way. There are stable, trait-like individual differences in the ability to process and perceive one's bodily signals, or "interoceptive sensitivity" (Herbert, Muth, Pollatos & Herbert, 2012; Herbert & Pollatos, 2012; Stevenson, Mahmut, & Rooney, 2015). On the one hand, some individuals fail to perceive a bodily need until it has reached a critical threshold, such as waiting to eat until blood glucose has plummeted to near fainting levels, or failing to sense pain from an injury/ illness until serious bodily damage or infection have occurred (Craig, 2010). On the other hand, there are individuals on the opposite end of the spectrum who are hyper-aware of the internal happenings of their body, often resulting in significant health anxiety and hypochondriasis (Walker & Furer, 2008). Most people fit somewhere between these two extremes, with varying levels of interoceptive awareness as a result of the activation of neural substrates due to external environmental factors and internal physiological cues such a mechanoreceptors contracting in the stomach (Stevenson et al., 2015).

One type of interoception is alimentary interoception. It is highly variable between individuals. There are several factors thought to impact alimentary interoceptive ability including genetic, developmental, and environmental factors (Stevenson et al., 2015). For example, De Castro has demonstrated across multiple twin studies that there is a heritable genetic component to sensations of hunger ratings after fasting, sensations of stomach fullness after a standard meal, and an overall awareness of the visceral state (De Castro, 1999a; De Castro, 1999b; De Castro, 2011; De Castro, 2002). In contrast to the explanation that genes are solely responsible for the

majority of differences seen in interoceptive acuity, many researchers believe learned behaviors and parental feeding practices have a significant impact on the development of alimentary interoceptive awareness (Stevenson et al., 2015). Somewhat counter-intuitively, a body of cross-sectional and experimental research indicates that feeding practices, such as parental "pressure to clean your plate" (as a learned focus on external cues, rather than internal, interoceptive cues to hunger/satiety) during childhood is *negatively* related to weight (Birch, Fisher, Grimm-Thomas, Markey, Sawyer, & Johnson, 2001; Blissett, Meyer, and Haycraft, 2006; Bran & Skinner, 2005; Faith, Berkowitz, Stallings, Kerns, Story & Stunkard, 2004; Johnson & Birch, 1994; Robinson, Kiernan, Matheson, & Haydel, 2001). However, no longitudinal studies have examined the relationship of parental feeding practices that force children to rely on external cues to direct eating behavior into adulthood, so these results are inconclusive regarding the long-term effects of this practice on adult weight, eating habits, and interoceptive acuity.

Other researchers, such as Harshaw (2008) insist there is an undeniable multi-mechanistic biopsychosocial learning component to feeding cognition and behavior that is comprised of conditioned, learned responses to hunger, thirst, and satiety. Harshaw proposes that the impact of internal (hunger, satiety, thirst), external (parent feeding style, responsiveness to child's needs, availability of food/water), and individual factors (child cues such crying or rooting in search of the mother's breast) is multidirectional in the developmental of interoceptive awareness in babies and children (Harshaw, 2008). There are many studies indicating that "social biofeedback" is crucial to the development of both eating behaviors and interoceptive acuity to hunger, fullness, and satiety (Ammaniti, Ambruzzi, Lucarelli, Cimino, & D'Olimpio, 2004; Birch & Fisher, 1996; Craig, 2003; Bruch, 1969; Gottlieb, 2002; Hall, Arnold, & Myers, 2000; Hebb, 1949). While biological or "hard-wired" hunger clearly drives infants and children to perform expressive

behaviors (e.g., crying) to have needs met, feeding behavior is not solely an innate, inborn characteristic passed down genetically through the generations (Harshaw, 2008). Rather, much comparative and human research finds that feeding behavior is a result of both environmental experience and learned responses. For example, Wright, Fawcett, and Crow (1980) discovered that breast-fed and bottle-fed infants developed distinctly different feeding patterns in the first two months of life. Breast-fed babies consumed specific quantities of breast milk dependent on the amount of time since last feeding, so they ate more when more time had passed and ate less when less time had passed. However, bottle-fed infants consumed the same amount regardless of the time interval since last feeding. The authors suggest that the passive role of babies involved in bottle-feeding versus breast-feeding is responsible for the bottle-fed babies failing to learn to pair interoceptive signals of hunger and fullness (Wright et al., 1980). They suggest the inherent ability of bottle feeding mothers to monitor their infant's intake may in fact drive the mothers to initiate feeding opportunities and thus take a more active role in the feeding process than the passive role allowed by infant initiated breast-feeding. As such, it is clear that parental behavior and responsiveness to the child's needs create environmental differences early in childhood that can have lasting impacts on children's feeding behaviors and the development of interoceptive acuity.

In addition to learned responses to feeding practices, nutritional content of diet is another environmental component thought to significantly impact interoception in both human and non-human animals. For example, researchers have demonstrated that a poor diet, high in saturated fats and sugar (HFS), causes a range of negative developmental consequences in rats and mice. Multiple studies have concluded that the offspring of obese mother rats/mice fed a HFS diet are less physically active, have weaker muscle tone, demonstrate a preference for a HFS diet, are

predisposed to weight gain, have cognitive impairments, and have difficulty resisting eating food when full due to an inability to sense interoceptive satiety signals (Bayol, Macharia, Farrington, Simbi, & Stickland, 2009; Kanoski, Seisel, Mullins, & Davidson, 2007; Davidson, Kanoski, Walls & Jarrard, 2005). These negative developmental outcomes are the consequence of a HFS diet in utero, during lactation, and up to the point of adolescence as compared with offspring of rats fed a standard chow.

Similar sensory and developmental integration impairments have been discovered in obese humans as well, leading researchers to believe that nutrient deficiencies and poor perception of gastric fullness seen in rats may also be responsible for inferior interoceptive acuity in humans. Physiological research from the 1960s permitted researchers to insert intragastic tubes connected to inflatable balloons into the stomachs of obese and non-obese women to directly test their baroreceptor sensitivity. Obese individuals had less sensitive gastric baroreceptors and larger stomach volumes, which is thought to be disruptive to typical interoceptive pathways (Schachter, 1968). Additional research examining interoceptive acuity to heartbeat interoception and BMI discovered that accuracy in heartbeat detection was lower in obese individuals compared to healthy weight participants, indicating that obese individuals are less in tune with the internal signals of their bodies (Herbert & Pollatos, 2014). Similar research discovered that interoceptive accuracy on the heart rate task is generally associated with lower BMIs in young women who report using hunger and fullness sensations to regulate their food intake via intuitive eating practices (Herbert, Blechert, Hautzinger, Matthias, & Herbert, 2013). Lastly, Herbert et al. (2014) had fasting participants drink water until their stomach felt full, then perform a heart rate perception task. Participants who were more accurate at the heart rate task drank significantly less water to feel full than participants who were less accurate in assessing

their heart rate. These results indicate that individuals who are more sensitive to heart rate cues tend to also have more sensitivity to sensations of stomach distention & fullness.

Neuroscientists have discovered an abundance of information on the interoceptive neural pathways that allow humans the ability to subjectively experience emotions, perceive the state of affairs of their internal body, and monitor/maintain homeostatic control (Craig, 2002; Craig 2003; Critchley, & Harrison, 2013; Critchley, Wiens, Rotshtein, Öhman, & Dolan, 2004; Pollatos, Gramann, & Schandry, 2007). Craig (2010) proposes that the integrative perception of all bodily states is beneficial to the organism by maximizing homeostatic efficiency. The bi-lateral, interior insula in human brains is thought to be the epicenter of interoceptive afferent pathways, giving way to humans (and a few other species such as chimpanzees) the capacity for sentience or a "sentient self" (Craig, 2010). Sentience is defined as the ability to feel, perceive, and subjectively experience an awareness of internal bodily sensations and reactions to external stimuli. Critchley and colleagues (2004) made several pivotal discoveries using functional magnetic resonance imaging (fMRI) to examine regional brain activity of participants during a heartbeat perception task. They found activity in the right anterior insula, somatomotor, and cingulate cortices to be predictive of increased accuracy in the heart beat detection task. They also discovered higher grey matter volumes in the surrounding tissue of the anterior insula and found this to be predictive of improved interoceptive accuracy and correlate significantly with self-report ratings of body awareness. Additional research by Craig (2011) supports these findings by further pin-pointing the cascade of brain activity and sensory pathways responsible for interoception and surprisingly, all emotional feelings. Craig outlines the pathway as an "ascending posterior-to-anterior sequence" where interoceptive signals (such as pain, heart rate perception, stomach emptiness) are received and processed in the mid and anterior insula,

concluding in the posterior insula, where all salient homeostatic input is organized and interoceptive body awareness is possible.

Due to the clear differences of interoceptive awareness in humans, I seek to better understand how early life experiences, such as childhood environmental unpredictability may drive these differences and impact energy regulation in adulthood. According to the early-life calibration model of LHT, it is possible that the development of interoceptive acuity impacts energy regulation in the early developmental phases of childhood and forms a lasting blueprint for perception of the internal physiological functioning of the body. It makes adaptive sense for individuals reared in environments in which conditions are unpredictable, where food access is inconsistent, to ignore hunger pains and internal body discomfort that comes with hunger in order to maximize functioning.

Here I build on past research by Hill et al. (2016), to examine the impact of early life unpredictability on interoceptive awareness and eating behavior. I predicted that interoceptive awareness is a mechanism through which individuals guide eating behavior. Specifically, I hypothesized that individuals from resource rich, stable environments attune to interoceptive bodily cues more, thus eat only when an energy need is present. However, individuals from harsh, unpredictable environments adapt to appropriately ignore interoceptive sensations of bodily discomfort that come from hunger, and eat opportunistically whenever food is present, as opposed to only when hungry.

The Current Research

The purpose of the current research was to examine how developmental history affects interoceptive body awareness and eating behavior in adulthood. Across three studies, I examined the correlational relationship between childhood unpredictability, body awareness, mindful

eating, and eating in the absence of energy need in adulthood (Study 1), the impact of childhood unpredictability, interoceptive body awareness, and current energy need (as measured by blood glucose) on calorie consumption in an eating paradigm (Study 2), and the impact of childhood unpredictability, manipulated energy need (via a pre-load drink paradigm), and interoceptive body awareness, measured physiologically through a heart rate perception task, on calorie consumption (Study 3).

Study 1

The purpose of Study 1 was to examine the association between childhood unpredictability, childhood socioeconomic status (SES), body awareness, mindful eating, and eating in the absence of hunger through a correlational design. I predicted that childhood unpredictability would be significantly correlated with childhood SES, childhood food security, adult emotional and mindful eating, adult interoceptive body awareness, and adult eating in the absence of hunger.

Method

Power Analysis

I conducted a priori power analyses utilizing G*Power software (version 3.1; Faul, Erdfelder, Buchner, & Lang, 2009; Faul, Erdfelder, Lang & Buchner, 2007), basing estimates on pilot data related to the current study as well as effect sizes found in Hill et al. (2016). Per recommendations outlined by Cohen (1992) and basing calculations on an alpha level of .05 with power at .80, I determined a minimum of 84 participants would be needed for adequate power.

Participants

Participants included 69 male and female undergraduates from Texas Christian University (TCU). To qualify, participants were between the ages of 18 to 35 and native English

speakers. Participants were not excluded on the basis of race, sexual orientation, or socioeconomic status. The total sample was short 15 participants due to the academic semester and recruitment opportunities ending before the full sample could be collected.

Procedure and Materials

Participants were recruited via the TCU SONA systems website. Participants received course credit for participation. Eligible participants completed a computerized informed consent document and all participation took place using a computerized survey powered by Qualtrics Research Suite (Qualtrics, 2015). Participants saw a battery of questionnaires assessing current hunger level, body awareness, unpredictability of the childhood environment, socioeconomic status, food security, eating behaviors and additional demographic questions. Each measure is described in detail below.

Early Life Measures.

Childhood Unpredictability. The Childhood Unpredictability Schema was used to assess perceptions of environmental and social unpredictability (Cabeza de Baca, Barnett, & Ellis, 2015). Examples items include: "I think I know what is going to happen in my life."; "Basically, I am a trusting person."; "Only a fool would trust most people."; and "There really is no such thing as "luck." (rated on a 7-point scale, 1: *Never*, 9: *Always*). A full scale composite variable was created from all 22 items (Cronbach's $\alpha = .78$). See Appendix A for the full scale items.

Socioeconomic Status. SES will be measured using the MacArthur SES ladder (MacArthur Foundation, 2015) assessing both current and childhood SES. Additionally, childhood SES will be assessed using a variety of questions (i.e., "Based on your best estimate, what was your household's SES during your early childhood (ages 0-12)"; "I grew up in a relatively wealthy neighborhood.", "My family usually had enough money for things when I was

growing up." (rated on a 7-point scale as 1= *Very poor*, 9= *Very Wealthy* and 1 = *Strongly Disagree*, 9 = *Strongly Agree*, respectively. A composite variable was created using the subjective SES questions (Cronbach's $\alpha = .84$). See Appendix B for full scales.

Food Security. Food security is the level at which an individual's food source is secure, constant, and reliable. The United States Household Food Security Survey Module (HFSSM) scale was used to measure the level of childhood (between the ages of 0 to 12 years) food security. The HFSSM is an 18-item survey developed by the United States Drug Administration (USDA) to assess four domains of food security: (1) anxiety about household food supplies, (2) perceptions that the quality or quantity of accessible food is not adequate, (3) reduced adult food intake, and (4) reduced child food intake (USDA, 2008). Example items include, "We worried whether our food would run out before we go the money to buy more."; "The food that we bought just didn't last and we didn't have the money to get more."; (rated on a 7-point scale, 1: *Strongly disagree*, 7: *Strongly agree*). These items were adapted to retrospectively measure food security during childhood ages 0-12 years, via self-report as opposed to parent-report as the measure was designed. As advised by the USDA, items were coded as affirmative if they were above the midpoint (4) on the 7-point scale or "Yes" on the Yes/No questions. Affirmative or non-affirmative responses were combined into a summation composite, then the values were coded as one of four categories of food security: 1 = High Food Security, 2 = Low Food Security, 3 = Low Food Security, and 4 = Very Low Food Security.

The Household Food Insecurity Access Scale (HFIAS) was developed by the United States Agency of International Development (USAID) to measure food access (USAID, 2007). The HFIAS to assess food insecurity with adults to during their childhood (ages 0 to 12) and recent adulthood (during the past 12 months). Example items include, "I was worried that my

household would not have enough food." and "I myself or other household members had to eat smaller meals than we felt we needed because there was not enough food." (rated on a 7-point scale, 1: *Strongly disagree*, 7: *Strongly agree*). Child scale Cronbach's α = .90 and Adult scale Cronbach's α = .97. See Appendix C for all food security measures.

Interoceptive Body Awareness Measures.

Body Awareness. The Body Awareness Questionnaire (BAQ) was used to assess awareness of bodily functioning. The BAQ is an 18-item measure comprised of three sub-scales indicating an ability to detect changes in normal body processes, ability to predict bodily reactions, and sensitivity to bodily cycles and rhythms (Shields, Mallory, & Simon, 1989). Example items include: "I notice differences in the way my body reacts to various foods."; "I can always tell when I bump myself whether or not it will become a bruise."; "I know in advance when I'm getting the flu."; "There seems to be a "best" time for me to go to sleep at night."; and "I notice specific bodily reactions to being overhungry.", (rated on a 7-point scale, 1: *Not at all true of me*, 7: *Very true of me*). An overall scale composite variable was created for the analysis comprised of all 18 items (Cronbach's α = .69). See Appendix D for full scale.

Health Consciousness. The Health Consciousness subscale of The Multidimensional Health Questionnaire (MHQ) was included to assess status of awareness regarding one's own physical health and wellness (Snell & Johnson, 1997). Example items include: "I am very aware of how healthy my body feels." and "I know immediately when I'm not feeling physically well." (rated on a 5-point scale, 1: *Not at all characteristic of me*, 5: *Very characteristic of me*). A full subscale composite variable was created comprised of all five variables of the Health Consciousness items of the MHQ (Cronbach's α = .79). See Appendix E for full scale.

Eating Measures.

Eating in the Absence of Hunger. The Eating in the Absence of Hunger Questionnaire for Children and Adolescents (EAH-C) will be adapted and used to assess the frequency of precipitants to eating when not hungry (Tankofsky-Kraff, Ranzenhofer, Yanovski, Schvey, Faith, Gustafson, et al., 2008). The questionnaire has two scenarios in which participants are to (1) "Imagine that you are eating a meal or snack at home, school, or in a restaurant. Imagine that you eat enough of your meal that you are no longer hungry. In this situation, how often do you keep eating because: Food looks, tastes, or smells so good; Others are still eating; Feeling sad or depressed; Feeling bored, etc. or (2) "Now imagine that you finished eating a meal or snack some time ago and you are not yet hungry. In this situation, how often do you start eating because: Food looks, tastes, or smells so good; Others are still eating; Feeling sad or depressed; Feeling bored, etc." (rated on a 5-point scale, 1: *Never*, 5: *Always*). A full scale composite variable was created from all items 14 items from the "immediately after eating" scenario and "after time passed" scenario (Cronbach's $\alpha = .91$). See Appendix G for full scale.

Mindful Eating. The Mindful Eating Questionnaire was used to assess awareness of both physical and emotional responses associated with eating (Framson, Kristal, Schenk, Littman, Zeliadt, & Benitez, 2009). The questionnaire has five subscales including disinhibition, awareness, external cues, emotional response, and distraction. Examples items (from each sub-scale, respectively): "I stop eating when I'm full even when eating something I love.", "I notice when there are subtle flavors in the foods I eat.", "I recognize when food advertisements make me want to eat.", "When I'm sad I eat to feel better.", and "My thoughts tend to wander while I am eating." (rated on a 7-point scale, 1: *Strongly disagree*, 5: *Strongly agree*). A full scale

composite variable was created from all 28 items (Cronbach's α = .78). See Appendix H for full scale.

Eating Behaviors. The Emotional and Uncontrolled Eating subscales of the Three Factor Eating Questionnaire (TFEQ) were used to measure eating behavior (Stunkard & Messick, 1985). Example items include, "When I feel anxious, I find myself eating."; "Sometimes, when I start eating, I just can't seem to stop." (rated on a 4-point scale, 1: *Definitely false*, 5: *Definitely true*). All items for the two sub-scales were combined to form a full scale composite variable (Cronbach's α = .81). This composite variable is referred to as "Emotional Eating" in the results section, Table 1 for brevity. See Appendix F for full scale.

Demographics. Demographic information including age, gender, racial/ethnic background, birth order, native language, primary sexual orientation, relationship status, height, weight, and perceived body shape were collected.

Results

Bivariate correlation analyses were performed to examine the relationship between 1) predictor variables including childhood unpredictability (higher score indicating more predictability), childhood socioeconomic status (SES), and adult/child food security; 2) mediating variables including body awareness, mindful eating, emotional eating, and 3) the dependent variable eating in the absence of hunger. Results indicated significant correlations between childhood unpredictability and body awareness, mindful eating, health consciousness, adult food security, and eating in the absence of hunger (see Table 1). However, childhood food security, commonly reported component of childhood poverty, was not significantly correlated with any of the other measures and was therefore ruled out as a predictor of interoceptive body awareness and eating in the absence of energy need in subsequent studies.

Next, to test the hypothesized pathway through which unpredictability impacts eating in the absence of hunger, we used the PROCESS macro in SPSS (Hayes, 2013) to test for serial mediation. The model was set to provide a 95% bias-corrected confidence interval using 5,000 bootstrap resamples. In serial mediation, an independent variable (X) is hypothesized to predict a series of mediators (M1, M2) and the dependent variable (DV). For this analysis, childhood unpredictability was entered as the independent variable (with a higher score indicating *more predictability*), body awareness (M1) and mindful eating (M2) as the serial mediators, and eating in the absence of hunger was the DV. Results revealed a significant indirect effect of childhood unpredictability on eating in the absence of hunger (indirect effect = -.10, *SE* = .06, 95% CI [-.28, -.02] via body awareness and mindful eating. Higher childhood unpredictability was associated with body awareness (more predictability = more body awareness), $b = .33$ (*SE* = .13), $p \leq .01$, indicating that childhood *unpredictability* predicted less body awareness. Body awareness in turn was associated with increased mindful eating $b = .48$ (*SE* = .12), $p \leq .001$. Next, mindful eating was associated with decreased eating in the absence of hunger, $b = -.60$ (*SE* = .14), $p \leq .001$. The direct association between childhood unpredictability and eating in the absence of hunger was also significant, $b = -.41$ (*SE* = .15), $p \leq .01$, in the expected direction with more childhood predictability predicting less eating in the absence of hunger. See Figure 1 for a visual representation of the path model.

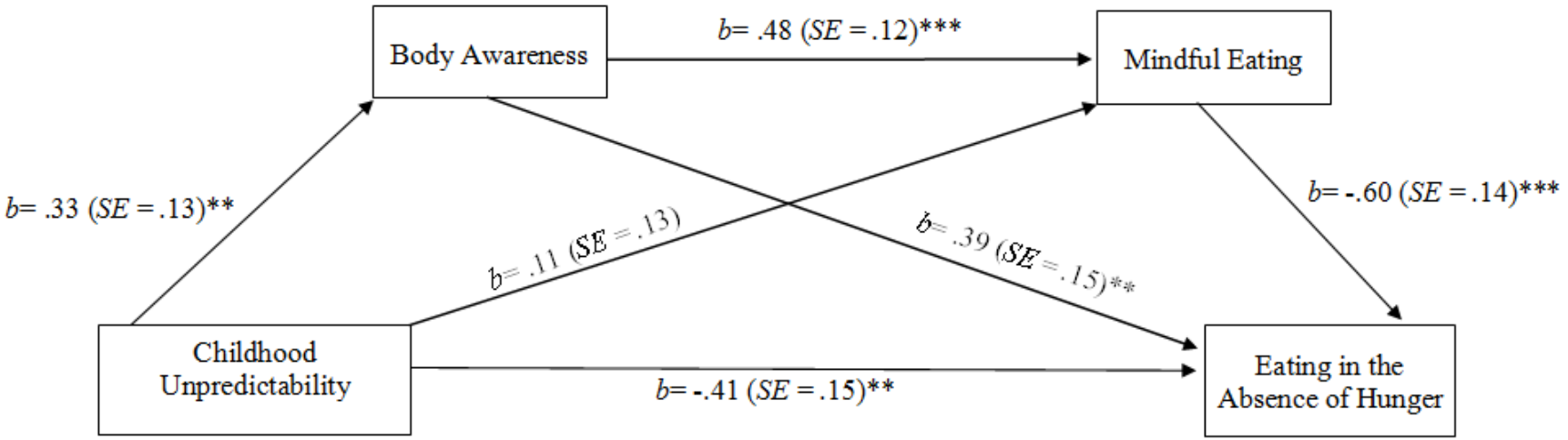

Figure 1. Serial mediation model with Childhood Unpredictability significantly predicting Body Awareness, Mindful Eating, and Eating in the Absence of Hunger. Note: * indicates $p \leq .05$, ** $p \leq .01$, and *** $p \leq .001$.

Table 1.

Pearson's *r* bivariate correlations between measures of Childhood Unpredictability, Adult and Child SES, Adult and Child Food Security, Body Awareness, Mindful Eating, & Emotional/Uncontrolled Eating

	Child Unpredictability	Adult SES	Child SES	Body Awareness	Mindful Eating	Emotional Eating	EAH	Child Food Security	Adult Food Security
Health Consciousness	.32**	.00	-.02	.05	.43***	-.18	-.15	.18	0.03
Adulthood Food Security	-.25*	-.07	.13	.08	-.23†	.22†	.23†	.10	
Childhood Food Security	-.01	-.04	-.09	.05	-.01	.04	.00		
EAH	-.67**	-.19	-.04	-.00	-.46***	.63***			
Emotional Eating	-.23†	-.17	-.24	-.15	-.58***				
Mindful Eating	.28*	.06	.07	.46***					
Body Awareness	.27*	-.06	.07						
Childhood SES	-.02	.64***							
Adulthood SES	.15								

Note. † indicates marginal significance at $p < .07$, indicates significance at *$p < .05$, **$p < .01$, and ***$p < .001$

Discussion

The results from Study 1 indicate that childhood unpredictability is a significant predictor of body awareness (or self-reported interoception) and eating in the absence of energy need. Additionally, body awareness and mindful eating are significant predictors of eating in the absence of hunger. Lastly, the relationship between childhood unpredictability and eating in the absence of hunger is significantly mediated by both body awareness and mindful eating. Taken together, the results of this serial mediation model, along with the significant correlations between the aforementioned variables, indicate that childhood unpredictability is a significant driver in the development of interoceptive body awareness, intuitive (or mindful) eating behaviors, and ultimately, eating in the absence of energy need (for those who were reared in an environment with high unpredictability). While childhood food security, a commonly reported contributor to childhood malnutrition and obesity in poverty circumstances was not significantly correlated with any of the other variables, including childhood SES and childhood unpredictability. Additionally, childhood food security was not predictive of the pattern of results outlined above and was therefore excluded from the mediation analysis. The fact that childhood food security was not predictive of interoception or eating in the absence of energy need in the current study indicates that the impact of low SES in the findings of Hill et al., (2016) were likely driven by a different component of a low SES environment. Based on the current findings, I suggest that the component of low childhood SES that is responsible for this phenomenon is childhood unpredictability.

Study 2

In study two, I assessed the impact of childhood unpredictability, current energy need and self-reported interoceptive body awareness on eating behavior in a laboratory study. Energy

need was assessed through self-reported hunger and blood glucose level. I predicted that individuals from an unpredictable childhood environment would report less interoceptive body awareness and eat more opportunistically, by consuming equally high amounts of snacks (pretzels and cookies) regardless of energy need (high vs. low as determined by blood glucose). Alternatively, I predicted that individuals from predictable childhood environments would report more interoceptive body awareness and eat more homeostatically, by consuming fewer calories when energy need was low and consuming more calories when energy need was high.

Power Analysis

Based on sample and effect sizes used in Hill, et al. (2016), I determined 80 participants would be needed to achieve adequate power.

Method

Participants

Participants were 80 male and female undergraduate students, who participated in exchange for partial course credit. Participants were recruited via TCU's Psychology Research Participation System (SONA). Participants were pre-screened to only include those who were non-obese with a body mass index (BMI) < 30, without diabetes, without food allergies, or any health condition that would impede a blood glucose check (i.e., hemophilia). Participants were scheduled throughout the day and were not instructed to fast prior to the study session; therefore, blood glucose readings were post-prandial.

Procedure and Materials

Participants attended sessions individually in a private laboratory space, where they were informed the purpose of the study was to better understand consumer preferences for snack foods. Participants completed a computerized informed consent and a Health Insurance

Portability and Accountability Act (HIPAA) consent outlining permissions and obligations regarding use of private health information (PHI; such as blood glucose) using Qualtrics Research Suite (Qualtrics, 2015). A post-prandial blood glucose reading was obtained by first cleaning the finger surface with an alcohol preparation pad, then a sterile, 21 gauge Assure® lancet was utilized to prick the side of the index finger (on hand of participants' choosing) to extract a small drop of blood. The drop of blood was placed on a disposable Breeze2 ® glucometer strip. The glucometer provided a numerical blood glucose reading. Participants' finger was then bandaged to ensure blood flow had ceased. All standard blood born pathogen precautions were taken, including the use of nitrile gloves, laboratory coats, and the use of a sharps and biohazardous waste container for disposal of all potentially biohazardous waste. All research staff completed university biosafety training and were further trained in how to properly perform blood glucose readings, dispose of biohazardous waste, and maintain cleanliness standards of the work space.

After the glucose reading was obtained and recorded, participants were informed of the ruse involving a consumer taste test of snack products. The two products included: a 1 ounce (oz) bag of chocolate chip cookies (Chips Ahoy! ® brand) and a .9 oz bag of pretzels (Snyder's ® brand). The snack items were presented to participants in standard white Styrofoam bowls along with an 8 oz bottle of water to cleanse the palate between taste tests.

Participants then experienced a two-minute waiting period in which they were told their confidential product ratings were being uploaded to a secure server. During this waiting period, participants were instructed that they could eat as little or as much of the remaining food as they would like while waiting and completing the remainder of the survey. After the study session, the total number of calories consumed by each participant was calculated by weighing the

uneaten snacks using a Taylor Digital Nutrition Scale ® in grams, which was then subtracted from the starting weight of each sample. The total weight in grams consumed was then converted to calories consumed based on nutritional guidelines on the product package.

Additionally, participants completed questions assessing age, height, weight as well as the measured previously described for study 1 including childhood unpredictability, childhood SES, interoceptive body awareness, and food security. An additional self-report measure of interoceptive body awareness (described below) was added to this study.

Interoception. The Multidimensional Assessment of Interoceptive Awareness (MAIA) scale is comprised of eight sub-scales **Noticing**: awareness of uncomfortable, comfortable and neutral body sensations (α = .65); **Not Distracting**: tendency not to ignore or distract oneself from sensations of pain or discomfort (α = .68); **Not-Worrying**: assessing tendency not to worry or experience emotional distress with sensations of pain or discomfort (α = .62); **Attention Regulation**: ability to sustain and control attention to body sensations (α = .81); **Emotional Awareness**: awareness of the connection between body sensations and emotional states (α = .74); **Self-Regulation:** ability to regulate distress by attention to body sensations (α = .80); **Body Listening:** assessing active listening to the body for insight (α = .84); and **Trusting**: experience of one's body as safe and trustworthy (α = .93), (Mehling et al., 2012). An overall scale composite was formed and used for subsequent analysis (α = .86). See Appendix I for full scale items.

Results

Eight participants were excluded from the analysis due to technical issues (e.g., computer or glucometer failures) during the sessions or failure to pass an attention filter embedded within the study, leaving 72 participants for the final analyses. To test my predictions about the

interactive effects of childhood unpredictability, interoceptive body awareness, and blood glucose (or energy need) on calorie consumption, a conditional moderated mediation regression analysis was performed using the PROCESS macro (Model 14; Hayes, 2013). Five thousand bootstrap resamples were used to generate a bias-corrected 95% confidence interval (CI) for each indirect effect (Preacher & Hayes, 2004). In this model, childhood unpredictability was the independent variable (X), interoceptive body awareness was the mediator (M_i), and number of overall calories consumed (combining cookies and pretzels) was the dependent measure. Blood glucose was entered as the critical moderator in the path between the mediator and the dependent measure.

First, it is integral to note that a higher score on the childhood unpredictability schema is indicative of *less* unpredictability in childhood, whereas a lower score indicates *more* unpredictability in childhood. As illustrated in Figure 2, there was a significant effect of childhood unpredictability on interoceptive body awareness, b= .94 (SE = .20), 95% CI = [.54, 1.34], $t(70) = 4.71$, $p \leq .001$. As childhood unpredictabilit*y* increased, interoceptive body awareness decreased, and conversely, as childhood unpredictability decreased, interoceptive awareness increased. Additionally, the model revealed that the impact of interoceptive body awareness on food intake was moderated by blood glucose, b= -1.22 (SE = .51), 95% CI = [-2.24, -.21], $t(70) = -2.41$, $p = .02$. For participants with high levels of blood glucose (1SD above the mean), calorie consumption was statistically mediated by interoception, b= -39.00, SE = 17.19, 95% CI = [-77.44, -6.93]. However, no such relationship was found for participants with low levels (1 SD below the mean) of blood glucose, b= 7.38, SE = 14.25, 95% CI = [-20.08, 36.84], see Figure 2.

I next performed a moderated regression analysis using the PROCESS macro (Model 1; Hayes, 2013) to probe the moderating effect of blood glucose on the relationship between interoception and calories consumed. Interoception was entered as the predictor variable, blood glucose as the moderator, and calories consumed as the outcome or dependent variable. Participants with low levels of interoception (-1 *SD* below the mean), ate comparable numbers of calories, *b*= 13.78, *SE* = 14.25, 95% CI = [-14.70, 42.26], *t*(68) = .97, *p* = .34, regardless of blood glucose level. However, participants with high levels of interoception (+1 *SD* above the mean) consumed a higher number of calories at low levels of blood sugar and a lower number of calories at high levels of blood sugar, *b*= -.34.04, *SE* = 14.52, 95% CI = [-63.02, -5.06], *t*(68) = -2.34, *p* = .02, (see Figure 3). This pattern of results indicates that interoception is an integral component of homeostatic versus opportunistic energy regulation, with those of high interoceptive body awareness using internal bodily cues to dictate eating behavior and those with low interoceptive body awareness not.

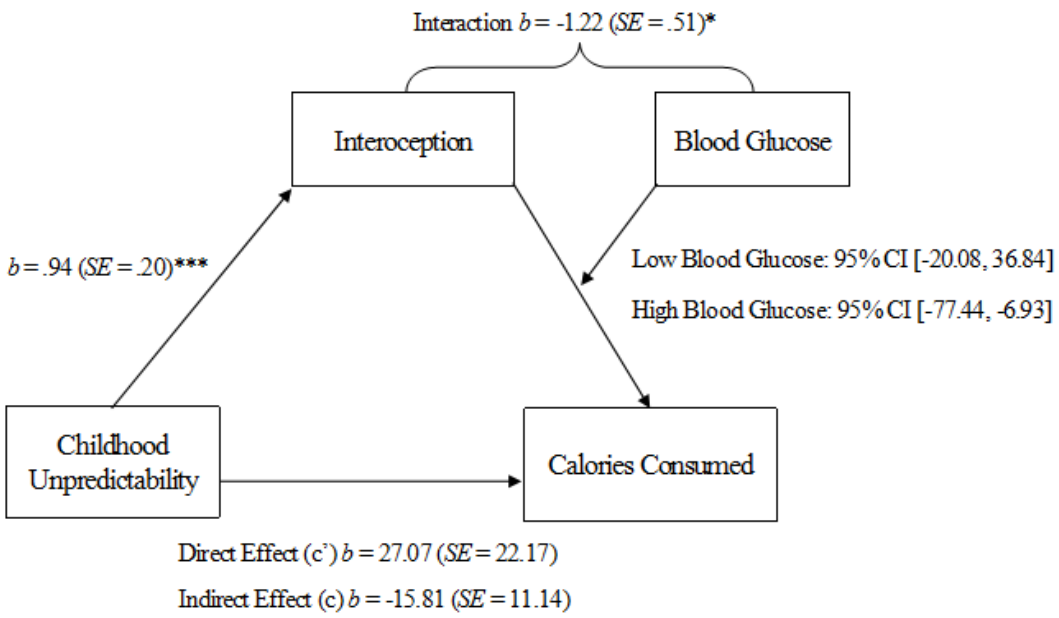

Figure 2. Conditional moderated mediation (Model 14) with Childhood Unpredictability significantly predicting Interoception, with a significant interaction between Interoception and Blood Glucose on Calories Consumed. Note: * indicates $p \leq .05$, ** $p \leq .01$, and *** $p \leq .001$.

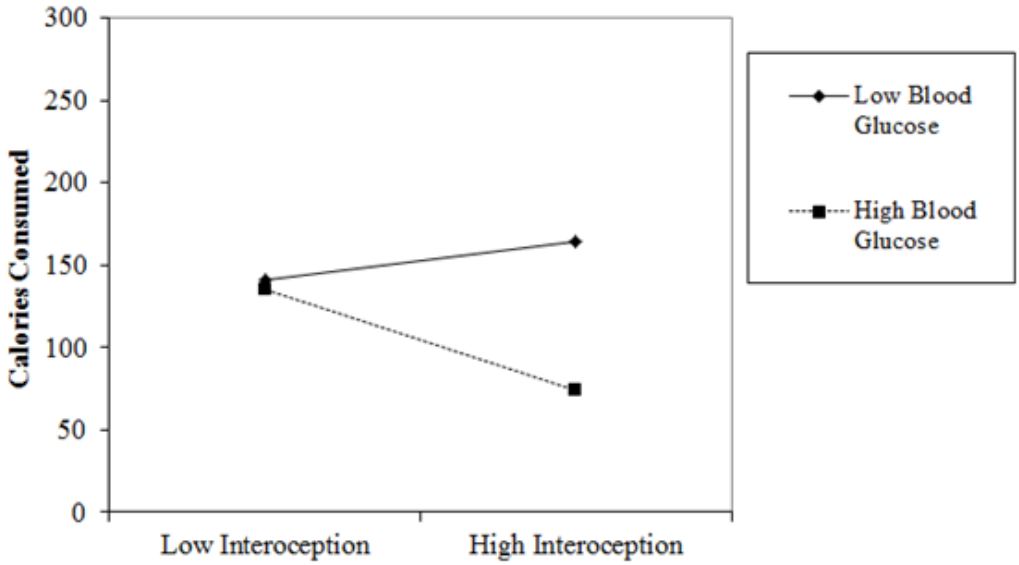

Figure 3. Moderated regression model using the PROCESS macro (Model 1; Hayes, 2013) to probe the effect of blood glucose on interoception and calories consumed.

Discussion

The results of Study 2 conceptually replicate the findings from Study 1, indicating that childhood unpredictability is a significant predictor of interoception. Specifically, a more unpredictable childhood environment was predictive of lower interoception, while a less unpredictable childhood environment was predictive of higher interoception. Further, low interoception was associated with equally high amounts of calorie consumption when energy need was both low and high (as determined by blood glucose). This pattern replicates the pattern of results that emerged in Hill et al. (2016) where individuals from low SES backgrounds ate equally high amounts of calories, regardless of energy need. The findings from the current study take these findings a step farther by (1) indicating that childhood unpredictability is an integral component of growing up poor, which has a significant impact on the development of

interoceptive body awareness and (2) low interoceptive body awareness drives eating in the absence of energy need.

Study 3

The purpose of Study 3 was to extend the methods used in Study 2 by directly manipulating energy need through the use of a drink manipulation, testing interoceptive awareness with an interactive heart rate perception task, and measuring calorie consumption. I manipulated energy need by providing a sugar-sweetened beverage in the experimental condition and water in the control condition. The change in energy need was verified by a change in the pre/post blood glucose measures. As in Studies 1 and 2, interoception was measured by self-report methods of interoceptive body awareness and additionally by the heart rate perception task, a commonly used interoception paradigm used to quantify individual differences in interoceptive awareness (Dunn, Galton, Morgan, Evans, Oliver, Meyer, et al., 2010; Garfinkel et al., 2015; Herbert et al., 2012; Katkin, 1985; Katkin, Reed & Deroo, 1983; Pollatos & Schandy, 2004; Schandry, 1981). Based on model building estimates from Preacher & Hayes (2004), I predicted that interoception would mediate the relationship between childhood unpredictability and calorie consumption, while blood glucose (a proxy for energy need via the drink manipulation) would moderate the relationship between interoception and food intake as well interact with childhood unpredictability to impact calorie consumption.

Method

Power Analysis

I conducted an a-priori power analysis using recommendations from Kline (2011) and moderate effect sizes found in Hill et al., (2016) to determine the number of parameters necessary to achieve adequate power. I concluded that 15 participants per parameter were

needed. Given that there were eleven parameters in the hypothesized model, the projected sample size was 165 participants.

Participants

One hundred sixty-four male and female undergraduate students served as participants in exchange for partial course credit. They were recruited via TCU's Psychology Research Participation System (SONA). Participants were pre-screened to include only those who were non-obese (BMI < 30), without diabetes, without food allergies, and without health conditions that would make a finger prick difficult/dangerous.

Procedure and Materials

Participants attended sessions individually in a private laboratory space, where they were informed that participation involved a series of consumer preferences taste tests. As in study 2, participants completed a computerized informed consent document and a HIPAA consent utilizing Qualtrics Research Suite (Qualtrics, 2015).

The first blood glucose reading was obtained before the study manipulation. Participants were randomly assigned to consume a 12 ounce (oz.) beverage in one of two study conditions: sugar sweetened beverage (Sprite ® soft drink by The Coca Cola Company) or Ozarka ® bottled water. Beverages were poured and presented in identical, unlabeled cups. Participants were provided instructions to consume the beverage within two minutes and then complete several questions assessing their consumer preference for the drink.

Participants were then asked to complete the Heart Rate Perception task (Shandry, 1981; Knoll & Hodapp, 1992). For this task, participants were asked to count their own heart rate, by sitting quietly and sensing their own heart rate without manually taking their own pulse. A Neulog Pulse Sensor was attached to the fifth (or pinky) finger and participants were instructed

by the researcher when to begin counting their own heart beats during four perception trials. The trial durations were: one 30 second practice trial, two 30 second trials, and one 60 second trial. The Neulog software was set to record 10 data points per second of each trial and automatically stop recording data after each trial period ended. Participants' perceived heart rate counts were reported verbally to the RA and recorded for comparison with the pulse sensor software output. An error term was created for the heart rate perception scores of each participant by creating a quotient for each trial. The quotient consisted of subtracting the sensor reading from the participant reported value, then diving by the sensor reading. The absolute value of the three trial quotients was calculated to provide a raw error score, with a *higher* score indicating poorer accuracy of heart rate perception. This raw value was then transformed into a percentage incorrect value. This percentage incorrect value was calculated by multiplying the error score by 100 and finally, a mean error score was calculated by dividing the percentage incorrect by 3 (for 3 trials). This mean percent incorrect for the error score was used in all subsequent analyses as the behavioral measure of interoceptive awareness.

A second glucose reading was then obtained using the same procedure aforementioned, only on a different finger on same hand or index finger of opposing hand. Participants were then asked to redirect their attention to a Qualtrics survey to complete additional survey measures. Participants were presented with a second consumer taste test comprised of a 1 oz. (28 grams) bag of mini Oreos presented in a white Styrofoam bowl and an 8 oz. bottle of water to cleanse the palate between cookies. Participants were first asked to provide their perceived taste rating of the cookies, based solely on sight. Participants were then instructed to sample the product and evaluate the flavor by answering the question, "*How much did you like this product"*. This item will be included to bolster the consumer taste test cover story.

Participants were then instructed to eat as little or as much of the remaining food as preferred while completing the remaining portion of the survey. After the study sessions, the total number of calories consumed was calculated by weighing the uneaten cookies using a nutrition scale then compared with the starting weight of the sample. This value in grams consumed was then converted to calories consumed based on nutritional guidelines on the product package.

Demographic questions were also obtained including age, height, weight, and childhood SES along with questionnaire-based interoception measures such as the BAQ and MAIA scales (Shields et al., 1989; Mehling et al., 2012) and the Childhood Unpredictability Schema (Ellis et al., 2005).

Results

Heart Rate Perception Measure of Interoceptive Awareness.

Thirty-two participants were excluded from the analysis due to technical issues during the session related to computer, glucometer, or heart rate sensor failure, failing to comply with the requested procedures (e.g., not consuming the full beverage), failing the attention filter, or reporting they had previously participated in a similar study. To test my predictions about the interactive effects of childhood unpredictability, interoceptive body awareness (using the heart rate perception task), and drink condition on calories consumed, a conditional mediation regression analysis was performed using the PROCESS macro (Model 14; Hayes, 2013). One-thousand bootstrap resamples were used to generate a bias corrected 95% confidence interval (CI) for each indirect effect (Preacher & Hayes, 2004). In this model, childhood unpredictability was the independent variable (X), interoceptive body awareness using the error rate of the heart

rate perception task was the mediator (M_i), drink condition (Sprite vs. Water) was entered as the moderator (V) and number of calories consumed was the dependent measure (Y).

Results revealed that childhood unpredictability did not predict the heart rate perception interoception measure, b= .95, SE = 3.00, 95% CI = [-4.98, 6.88], t(132) = .32, p = .75. The heart rate perception interoception measure did not predict calories consumed, b= .29, SE = .31, 95% CI = [-.33, .91], t(132) = .91, p = .36. Drink condition also did not predict calories consumed, b= -4.25, SE = 8.95, 95% CI = [-21.95, 13.45], t(132) = -.47, p = .63. Heart rate perception interoception and drink condition also did not interact to predict calories consumed, b= .46, SE = .49, 95% CI = [-1.44, .51], t(132) = -.94, p = .35. However, there was a significant direct effect of childhood unpredictability on calories consumed, b= -18.32, SE = 8.06, 95% CI = [-34.27, -2.37], t(132) = -2.27, p = .025, see Figure 4. Due to the heart rate perception task not mediating the relationship between childhood unpredictability and calories consumed found in Study 2, additional analyses were performed for the current study using the self-report scale measure of interoceptive body awareness used in Study 2.

Scale Measure of Interoceptive Awareness.

For this secondary analysis, thirty-three participants were excluded for the same reasons aforementioned above with one additional participant being excluded for missing data on the interoception measure. To test my predictions about the interactive effects of childhood unpredictability, self-reported interoceptive body awareness, and drink condition on calories consumed, a conditional mediation regression analysis was performed using the PROCESS macro (Model 14; Hayes, 2013). One-thousand bootstrap resamples were used to generate a bias corrected 95% confidence interval (CI) for each indirect effect (Preacher & Hayes, 2004). In this model, childhood unpredictability was the independent variable (X), interoceptive body

awareness using the scale measure was the mediator (M_i), drink condition (Sprite vs. Water) was entered as the moderator (V) and number of calories consumed was the dependent measure (Y).

Results revealed that childhood unpredictability significantly predicted interoceptive body awareness, b= .54, SE = .13, 95% CI = [.29, .79], $t(131) = 4.21$, $p \leq .001$. Childhood unpredictability also significantly predicted total calories consumed, b= -18.81, SE = 8.78, 95% CI = [-36.20, -1.43], $t(131) = -2.14$, $p = .03$, indicating that as childhood unpredictability declined, number of calories consumed also declined. Interoception and drink condition did not significantly predict calories consumed, b= -8.44, SE = 8.14, 95% CI = [-24.55, 7.67], $t(131) = -1.04$, $p = .30$ and b= -5.42, SE = 8.69, 95% CI = [-22.62, 11.79], $t(131) = -.62$, $p = .53$, respectively. However, there was a marginally significant interaction between interoception and drink condition, b= 17.94, SE = 10.67, 95% CI = [-3.19, 39.07], $t(131) = 1.68$, $p = .09$. See Figure 5.

I next performed a moderated regression analysis using the PROCESS macro (Model 1; Hayes, 2013) to probe the marginal effect of drink condition on interoception and calories consumed. A dummy coded condition variable was entered as the predictor variable, interoceptive body awareness as the moderator, and calories consumed as the outcome or dependent variable. Participants with high levels of interoceptive body awareness (+1 *SD* above the mean) consumed a similar quantity of calories in both drink conditions, b= 10.82, SE = 12.48, 95% CI = [-13.87, 35.51], $t(130) = .87$, $p = .39$. However, participants with low levels of interoceptive body awareness (-1 *SD* below the mean), ate marginally different numbers of calories in each condition, eating more calories in the Sprite condition (when energy need was low) and less in the water condition (when energy need remained high), b= -21.40, SE = 12.50, 95% CI = [-46.14, 3.34], $t(130) = -1.71$, $p = .089$ (see Figure 6).

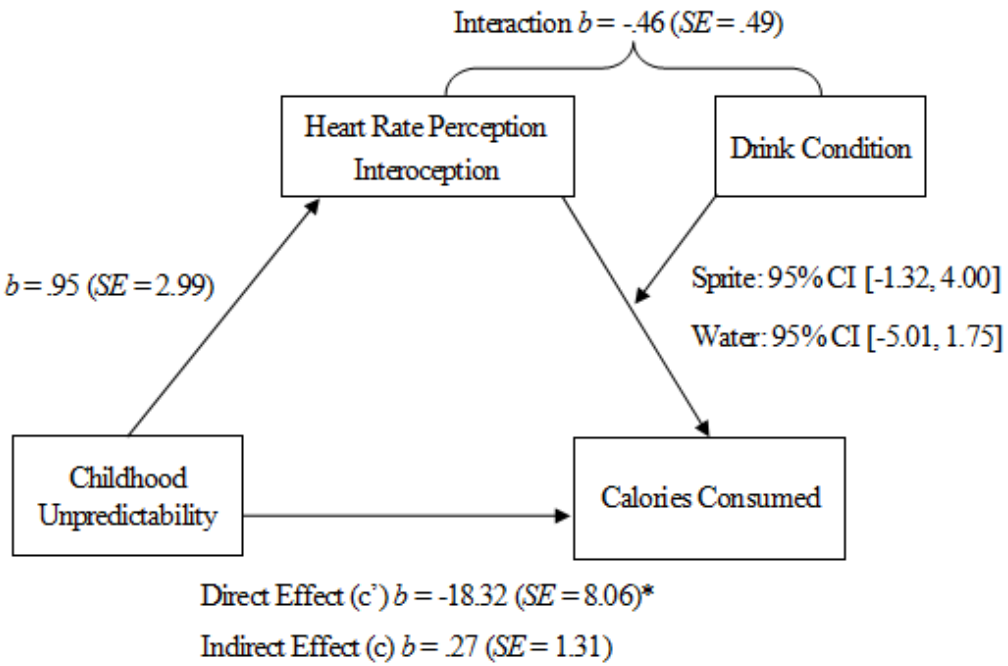

Figure 4. Conditional moderated mediation (Model 14) with Childhood Unpredictability significantly predicting Calories Consumed. Note: * indicates $p \leq .05$.

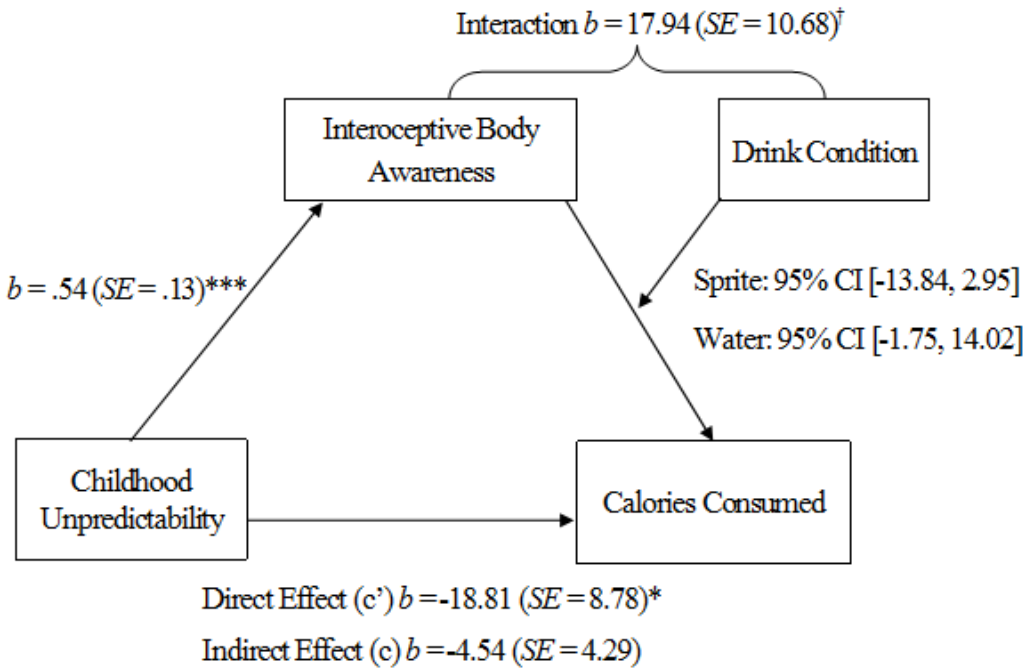

Figure 5. Conditional moderated mediation (Model 14) with Childhood Unpredictability significantly predicting scale measure of Interoceptive Body Awareness, with a marginally significant interaction between Interoceptive Body Awareness and Drink Condition on Calories Consumed. Note: † indicates marginal significance at $p < .09$,* indicates $p \leq .05$, ** $p \leq .01$, and *** $p \leq .001$.

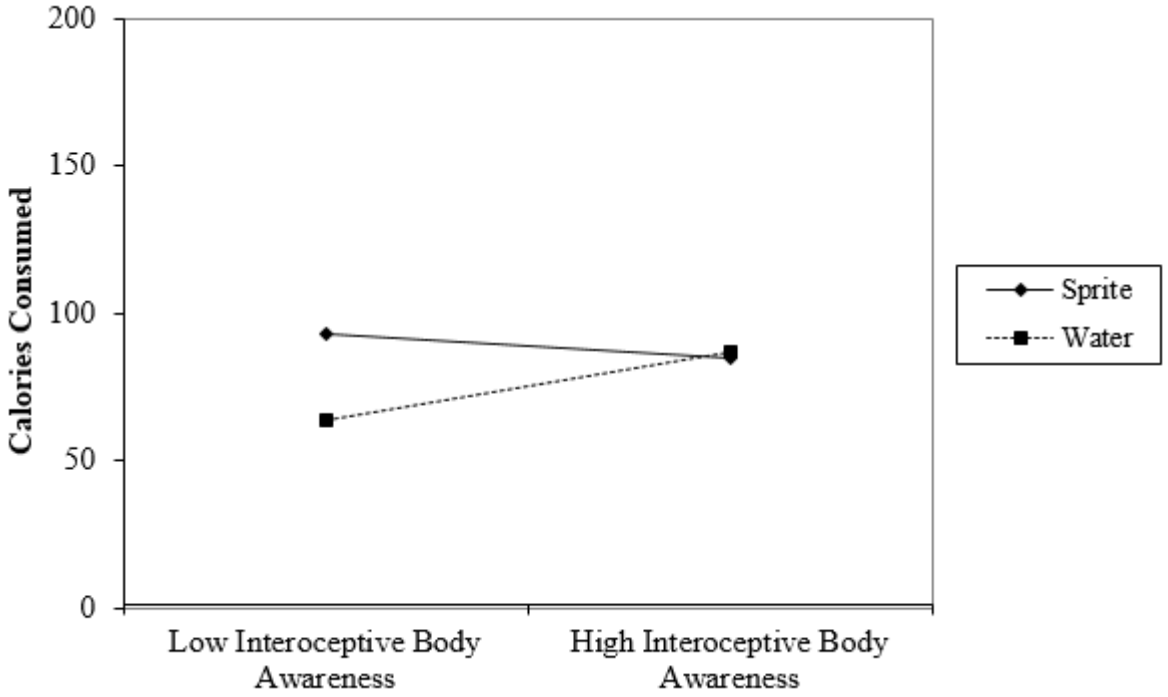

Figure 6. Moderated regression model using the PROCESS macro (Model 1; Hayes, 2013) to probe the marginal effect of drink condition on interoceptive body awareness and calories consumed.

Discussion

While the primary results from Study 3 did not demonstrate the hypothesized relationship between childhood unpredictability, the heart rate perception task of interoception, and the drink condition on calories consumed, the direct effect of childhood unpredictability on calories consumed remained significant. The significant relationship between childhood unpredictability and calories consumed conceptually replicates the findings of Studies 1 and 2. The secondary results from Study 3 indicate that childhood unpredictability remains a significant predictor of self-reported interoceptive body awareness and calories consumed. While the interaction between interoceptive body awareness and the drink condition was marginal, these results are indicative that interoceptive body awareness and current energy need (as manipulated by drink

condition) work together to impact total caloric intake. Taken together, the secondary results of this study indicate that self-perceived interoception may indeed be more important than actual ability to perceive the internal sensations of the body.

General Discussion

Previous research indicates that childhood SES, characterized by low resource availability and unpredictability, is associated with eating in the absence of energy need (Hill et al., 2016). Based on these findings, and the childhood calibration model of LHT, I conducted three studies examining the specific impact of childhood unpredictability on interoceptive acuity, and eating in the absence of energy need. Results from Study 1 indicated that childhood unpredictability was a significant predictor of self-reported interoceptive body awareness, mindful (or intuitive) eating strategies, and eating in the absence of need. Results from Study 2 indicated that participants with low interoceptive awareness do not use blood glucose as a measure of current energy need and eat comparable amounts of calories, while participants high in interoception use blood glucose as an internal cue to eat more when energy need is high, and less when energy need is low. However, in Study 3 there were mixed findings when comparing the heart rate perception measure of interoception versus the self-reported scale measure of interoceptive body awareness. Overall, the results of Study 3 conceptually replicated the findings of Studies 1 and 2 by demonstrating the strong predictive value of childhood unpredictability on energy consumption (both primary and secondary analyses) and self-reported interoceptive body awareness (secondary analyses).

While the heart rate perception task is widely touted as an accurate, highly significant correlate of alimentary and generic interoception (e.g., for acuity to signals of hunger, fullness, satiety, thirst, pain, temperature regulation, etc.), a report by Ring, Brener, Knapp, & Mailloux

(2015) indicates that exposure to the heart rate task across multiple trials allows significant increases in the accuracy of heartbeat counting. The results of this study potentially indicate that "practice makes perfect" in the sense that participants are able to use non-sensory processes, such as counting the seconds passing, rather than truly sensing their heart beat.

Alternative explanations for the pattern of results found in study 3, include potential variability within the sample of participants on uncontrollable extraneous variables such as quality and energy content of diet leading up to the study session, hormone levels of ghrelin ("the hunger hormone"), motilin (which initiates stomach contractions), and leptin (which is indicative of long term energy needs). Additional factors that could have contributed to the pattern of results observed in study 3 include environmental factors such as passage of time since the last meal, sight/smell of the food items early in the morning for fasting sessions (i.e., cookies are not necessarily considered a breakfast food by American dietetic standards), and room temperature in the study session. One last limitation is that while the participants were screened for obesity, a lean body today is not necessarily a lean body five years from now. As the population consisted of undergraduates between the ages of 18-25, some may have a predisposition to obesity, but not yet have the condition. As such, this could impact the pattern of results.

Ultimately, the consistent pattern found across all three studies of childhood unpredictability predicting energy consumption is important in our efforts to better understand the exact component of the low SES environment that impacts eating behaviors. Additionally, it is important to note that childhood unpredictability was a significant predictor of self-perceived interoception via the self-report measure in all 3 studies. While it was not predictive of the heart rate perception measure of interoception, I propose that self-perceived body awareness may be

just as important in regulating energy intake. Perhaps, what one thinks about their perception of the on-goings of their body is important in how they view their body and hence nourish or over-nourish it.

It is also important to note that childhood food security, a commonly purported component of childhood malnutrition and both child and adult obesity was not found to be a significant correlate of childhood unpredictability, childhood SES, interoceptive body awareness, eating styles such as emotional or intuitive eating, or eating in the absence of hunger. As such, the measure was excluded from Studies 2 and 3. Due to the clear impact of general childhood unpredictability, not food unpredictability per say, I maintain that childhood unpredictability is a significant component in the development of self-perceptions of interoceptive body awareness, eating behaviors, and overall energy regulation strategies.

The results of this package of studies is supportive of the adaptive calibration model of LHT that organisms make trade-offs in somatic resources to maximize fitness in the specific environment in which they spend their first 5-7 years of life. Specifically, it makes adaptive sense for individuals reared in chaotic, unpredictable environments to develop an ability to "ignore" uncomfortable bodily signals of hunger and fullness during times of food scarcity, when feeding opportunities are inconsistent. On the contrary, it also makes adaptive sense for individuals reared in predictable, resource environments, who know when and where their next meal is coming from, to develop an acute awareness and sensitivity to the internal workings of their own body. This sensitivity or interoceptive awareness allows these individuals to regulate their eating behaviors due to the predictability of the next meal.

Future research should examine additional interactive measures of interoceptive acuity along with fMRI and other brain scanning technologies to determine if participant with a history

of childhood unpredictability indeed have differing neural pathways as a result of their development. Additionally, future research should examine the impact of rearing in a high SES environment, development of higher interoceptive body awareness, and the impact it has on counting calories or mindset about the food items available for consumption. Research by Crum, Corbin, Brownell, & Salovey (2011) demonstrated that participants experienced significant downshifts in ghrelin levels after consuming a milkshake advertised as decedent and full-calorie (620 calorie); however, participants who consumed the same milkshake advertised as sensible and low calorie (380 calorie), did not experience decreases in ghrelin, indicating that their mindset about the food item consumed significantly impacted their physiological hunger hormone response. Future research should examine the impact of SES on restrictive eating practices such as counting calories and the impact it could have on the current study design.

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Appendix A
Childhood Unpredictability Schema

Please answer how often the following statements apply to your attitudes and/or behaviors.

	Never (1)	(2)	(3)	Sometimes (4)	(5)	(6)	Always (7)
I think I know what is going to happen in my life.	❍	❍	❍	❍	❍	❍	❍
Basically, I am a trusting person.	❍	❍	❍	❍	❍	❍	❍
Getting what I want has little or nothing to do with luck.	❍	❍	❍	❍	❍	❍	❍
I can always solve hard problems if I try hard enough.	❍	❍	❍	❍	❍	❍	❍
Basically, the world is a predictable place.	❍	❍	❍	❍	❍	❍	❍
Only a fool would trust most people.	❍	❍	❍	❍	❍	❍	❍

Please answer how often the following statements apply to your attitudes and/or behaviors.

	Never (1)	(2)	(3)	Sometimes (4)	(5)	(6)	Always (7)
There really is no such thing as "luck."	❍	❍	❍	❍	❍	❍	❍
I can handle unexpected events.	❍	❍	❍	❍	❍	❍	❍
I know what to expect from people in my life.	❍	❍	❍	❍	❍	❍	❍
I have a lot of faith in the people I know.	❍	❍	❍	❍	❍	❍	❍
Becoming a success takes hard work; luck has little or nothing to do with it.	❍	❍	❍	❍	❍	❍	❍
If I am in trouble, I can usually think of a way to fix it.	❍	❍	❍	❍	❍	❍	❍

Please answer how often the following statements apply to your attitudes and/or behaviors.

	Never (1)	(2)	(3)	Sometimes (4)	(5)	(6)	Always (7)
Why worry about the future? There's nothing you can do about it anyway.	❍	❍	❍	❍	❍	❍	❍
I can depend on most people I know	❍	❍	❍	❍	❍	❍	❍
There's no use in really trying to get something I want, because I probably won't get it.	❍	❍	❍	❍	❍	❍	❍
I can usually handle whatever comes my way.	❍	❍	❍	❍	❍	❍	❍
I almost always believe what people tell me.	❍	❍	❍	❍	❍	❍	❍

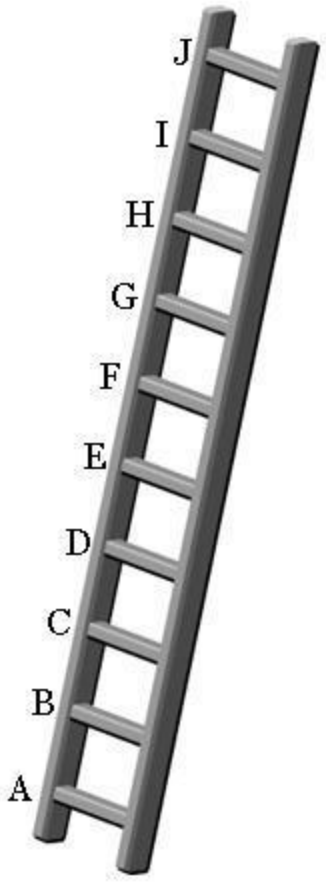
Please answer how often the following statements apply to your attitudes and / or behaviors.

	Never (1)	(2)	(3)	Sometimes (4)	(5)	(6)	Always (7)
Parents usually keep their promises.	❍	❍	❍	❍	❍	❍	❍
When I make plans, I know that I can make them work.	❍	❍	❍	❍	❍	❍	❍
Most people can be counted on to do what they say they will do.	❍	❍	❍	❍	❍	❍	❍
Failing just makes me try harder.	❍	❍	❍	❍	❍	❍	❍
I give up easily.	❍	❍	❍	❍	❍	❍	❍

Appendix B

Socioeconomic Status Scales

Think of this ladder as representing where people stand in the United States. At the top of the ladder are the people who are the best off - those who have the most money, the most education, and the most respected jobs. At the bottom are the people who are the worst off - who have the least amount of money, the least education, and the least respected jobs or no job. The higher up you are on this ladder, the closer you are to the people at the very top; the lower you are, the closer you are to the people at the very bottom.



Where on this ladder are you currently? Select the letter of the rung where you think you | your family stand currently relative to other families in the United States.

- ❍ A (1)
- ❍ B (2)
- ❍ C (3)
- ❍ D (4)
- ❍ E (5)
- ❍ F (6)
- ❍ G (7)
- ❍ H (8)
- ❍ I (9)
- ❍ J (10)

Where on this ladder was your family during early childhood (ages 0 – 12) Select the letter of the rung where you think your family stood during your early childhood, relative to other families in the United States.

- ❍ A (1)
- ❍ B (2)
- ❍ C (3)
- ❍ D (4)
- ❍ E (5)
- ❍ F (6)
- ❍ G (7)
- ❍ H (8)
- ❍ I (9)
- ❍ J (10)

Based on your best estimate, what was your household's socioeconomic status (SES) during your early childhood (ages 0-12)?

- ❍ Very Poor (1)
- ❍ Poor (2)
- ❍ Somewhat Poor (3)
- ❍ Middle Class (4)
- ❍ Somewhat Wealthy (5)
- ❍ Wealthy (6)
- ❍ Very Wealthy (7)

Please rate your agreement or disagreement with each statement below:

	Strongly Disagree (1)	Disagree (2)	Somewhat Disagree (3)	Neither Agree Nor Disagree (4)	Somewhat Agree (5)	Agree (6)	Strongly Agree (7)
I grew up in a relatively wealthy neighborhood.	❍	❍	❍	❍	❍	❍	❍
My family usually had enough money for things when I was growing up.	❍	❍	❍	❍	❍	❍	❍
I felt relatively wealthy compared to the other kids in my school.	❍	❍	❍	❍	❍	❍	❍

Please rate your agreement or disagreement with each statement below:

	Strongly Disagree (1)	Disagree (2)	Somewhat Disagree (3)	Neither Agree nor Disagree (4)	Somewhat Agree (5)	Agree (6)	Strongly Agree (7)
I felt relatively poor compared to the other kids at my school.	❍	❍	❍	❍	❍	❍	❍
My parents had significant financial struggles while I was growing up.	❍	❍	❍	❍	❍	❍	❍
There were times in my childhood when I qualified for reduced cost or free lunch at school.	❍	❍	❍	❍	❍	❍	❍

Appendix C
Food Security Scales

Household Food Insecurity Access Scale (HFIAS) [Child]
Please respond to whether you agree or disagree with following statements in reference to conditions during your childhood (ages 0-12):

	Strongly Disagree (1)	(2)	(3)	Neither Agree or Disagree (4)	(5)	(6)	Strongly Agree (7)
I worried that my household would not have enough food.	❍	❍	❍	❍	❍	❍	❍
I myself or other members of the household were not able to eat the kinds of foods we preferred because of a lack of resources (i.e. money).	❍	❍	❍	❍	❍	❍	❍
I myself or other members of the household ate a limited variety of foods due to a lack of resources.	❍	❍	❍	❍	❍	❍	❍
I myself or other members of the household had to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of foods.	❍	❍	❍	❍	❍	❍	❍

Please respond to whether you agree or disagree with following statements in reference to conditions during your childhood (ages 0-12):

	Strongly Disagree (1)	(2)	(3)	Neither Agree or Disagree (4)	(5)	(6)	Strongly Agree (7)
I myself or other household members ate smaller meals than we felt we needed because there was not enough food.	❍	❍	❍	❍	❍	❍	❍
I myself or other household members had to eat fewer meals in a day because there was not enough food.	❍	❍	❍	❍	❍	❍	❍
At times there was no food to eat of any kind in our household because of lack of resources to get food.	❍	❍	❍	❍	❍	❍	❍
I myself or other household members went to sleep at night hungry because there was not enough food.	❍	❍	❍	❍	❍	❍	❍
I myself or other household members went a whole day and night without eating anything because there was not enough food.	❍	❍	❍	❍	❍	❍	❍

Household Food Insecurity Access Scale (HFIAS) [Adult]

The next section will ask you about very recent conditions in your household, particularly during the last month (4 weeks).

Please respond to whether you agree or disagree with following statements in reference to conditions in your household during the last 4 weeks:

	Strongly Disagree (1)	(2)	(3)	Neither Agree or Disagree (4)	(5)	(6)	Strongly Agree (7)
I worried that my household would not have enough food.	❍	❍	❍	❍	❍	❍	❍
I myself or other household members were not able to eat the kinds of foods preferred because of a lack of resources (i.e. money).	❍	❍	❍	❍	❍	❍	❍
I myself or other household members had to eat a limited variety of foods due to a lack of resources.	❍	❍	❍	❍	❍	❍	❍
I myself or other household members had to eat some foods that we really did not want to eat because of a lack of resources to obtain other types of foods.	❍	❍	❍	❍	❍	❍	❍

Please respond to whether you agree or disagree with following statements in reference to conditions in your household during the last 4 weeks:

	Strongly Disagree (1)	(3)	(4)	Neither Agree or Disagree (5)	(6)	(7)	Strongly Agree (8)
I myself or other household members had to eat a smaller meals than we felt we needed because there was not enough food.	❍	❍	❍	❍	❍	❍	❍
I myself or other household members had to eat fewer meals in a day because there was not enough food.	❍	❍	❍	❍	❍	❍	❍
There was no food to eat of any kind in our household because of lack of resources to get food.	❍	❍	❍	❍	❍	❍	❍
I myself or other household members went to sleep at night hungry because there was not enough food.	❍	❍	❍	❍	❍	❍	❍
I myself or other household members went a whole day and night without eating anything because there was not enough food.	❍	❍	❍	❍	❍	❍	❍

Appendix D

Body Awareness Questionnaire (BAQ)

Please select the best response to the statements below.

	Not at all True of Me (1)	(2)	(3)	(4)	(5)	(6)	Very True of Me (7)
I notice differences in the way my body reacts to various foods.	❍	❍	❍	❍	❍	❍	❍
I can always tell when I bump myself whether or not it will become a bruise.	❍	❍	❍	❍	❍	❍	❍
I always know when I've exerted myself to the point where I'll be sore the next day.	❍	❍	❍	❍	❍	❍	❍
I am always aware of changes in my energy level when I eat certain foods.	❍	❍	❍	❍	❍	❍	❍

	Not at all True of Me (1)	(2)	(3)	(4)	(5)	(6)	Very True of Me (7)
I know in advance when I'm getting the flu.	❍	❍	❍	❍	❍	❍	❍
I know I'm running a fever without taking my temperature.	❍	❍	❍	❍	❍	❍	❍
I can distinguish between tiredness because of hunger and tiredness because of lack of sleep.	❍	❍	❍	❍	❍	❍	❍
I can accurately predict what time of day lack of sleep will catch up with me.	❍	❍	❍	❍	❍	❍	❍

	Not at all True of Me (1)	(2)	(3)	(4)	(5)	(6)	Very True of Me (7)
I am aware of a cycle in my activity level throughout the day.	❍	❍	❍	❍	❍	❍	❍
I don't notice seasonal rhythms and cycles in the way my body functions.	❍	❍	❍	❍	❍	❍	❍
As soon as I wake up in the morning, I know how much energy I'll have during the day.	❍	❍	❍	❍	❍	❍	❍
I can tell when I go to bed how well I will sleep that night.	❍	❍	❍	❍	❍	❍	❍

	Not at all True of Me (1)	(2)	(3)	(4)	(5)	(6)	Very True of Me (7)
I notice distinct body reactions when I am fatigued.	❍	❍	❍	❍	❍	❍	❍
I notice specific body responses to changes in the weather.	❍	❍	❍	❍	❍	❍	❍
I can predict how much sleep I will need at night in order to wake up refreshed.	❍	❍	❍	❍	❍	❍	❍
When my exercise habits change, I can predict very accurately how that will affect my energy level.	❍	❍	❍	❍	❍	❍	❍
There seems to be a “best” time for me to go to sleep at night.	❍	❍	❍	❍	❍	❍	❍
I notice specific bodily reactions to being overhungry.	❍	❍	❍	❍	❍	❍	❍

Appendix E

Health Consciousness Scale

The items below refer to people's health. Please read each item carefully and decide to what extent it is characteristic of you. Give each item a rating of how much it applies to you by marking your response using the following scale:

	Not at all Characteristic of Me (1)	Slightly Characteristic of Me (2)	Somewhat Characteristic of Me (3)	Moderately Characteristic of Me (4)	Very Characteristic of Me (5)
I am very aware of how healthy my body feels.	❍	❍	❍	❍	❍
I notice immediately when my body doesn't feel healthy.	❍	❍	❍	❍	❍
I'm sensitive to internal bodily cues about my physical health.	❍	❍	❍	❍	❍
I know immediately when I'm not feeling physically well.	❍	❍	❍	❍	❍
I'm very aware of changes in my physical health.	❍	❍	❍	❍	❍
Select the "Slightly Characteristic of Me" option for this item.	❍	❍	❍	❍	❍

Appendix F

Three Factor Eating Scale

The next section will ask you questions about your opinions and behaviors.

Please select the best response to the statements below.

	Definitely False (1)	Mostly False (2)	Mostly True (3)	Definitely True (4)
When I smell a delicious food, I find it very difficult to keep from eating, even if I have just finished eating a meal.	❍	❍	❍	❍
I deliberately take small helpings as a means of controlling my weight.	❍	❍	❍	❍
When I feel anxious, I find myself eating.	❍	❍	❍	❍
Sometimes when I start eating, I just can't seem to stop.	❍	❍	❍	❍

Please select the best response to the statements below.

	Definitely False (1)	Mostly False (2)	Mostly True (3)	Definitely True (4)
Being with someone who is eating often makes me hungry enough to eat also.	❍	❍	❍	❍
When I feel blue, I often overeat.	❍	❍	❍	❍
When I see a real delicacy, I often get so hungry that I have to eat right away.	❍	❍	❍	❍
I get so hungry that my stomach often seems like a bottomless pit.	❍	❍	❍	❍

Please select the best response to the statements below.

	Definitely False (1)	Mostly False (2)	Mostly True (3)	Definitely True (4)
I am always hungry so it is hard for me to stop eating before I finish the food on my plate.	❍	❍	❍	❍
When I feel lonely, I console myself by eating.	❍	❍	❍	❍
I consciously hold back at meals in order not to weight gain.	❍	❍	❍	❍
I do not eat some foods because they make me fat.	❍	❍	❍	❍
I am always hungry enough to eat at any time.	❍	❍	❍	❍

How often do you feel hungry?
- ❍ Only at meal times (1)
- ❍ Sometimes between meals (2)
- ❍ Often between meals (3)
- ❍ Almost always (4)

How frequently do you avoid "stocking up" on tempting foods?
- ❍ Almost never (1)
- ❍ Seldom (2)
- ❍ Usually (3)
- ❍ Almost always (4)

How likely are you to consciously eat less than you want?
- ❍ Unlikely (1)
- ❍ Slightly Likely (2)
- ❍ Moderately Likely (3)
- ❍ Very Likely (4)

Do you go on binges though you are not hungry?

- ❍ Never (1)
- ❍ Rarely (2)
- ❍ Sometimes (3)
- ❍ At least once a week (4)

One a scale of 1 to 8, where 1 means no restraint in eating (eating whatever you want, whenever you want it) and 8 means total restraint (constantly limiting food intake and never "giving in"), what number would you give yourself?

_____

Appendix G

Eating in the Absence of Hunger

Now imagine that you finished eating a meal or snack some time ago and you are not yet hungry.

In this situation, how often do you start eating because:

	Never (1)	(2)	(3)	(4)	Always (5)
Food looks, tastes or smells so good	❍	❍	❍	❍	❍
Others are still eating	❍	❍	❍	❍	❍
Feeling sad or depressed	❍	❍	❍	❍	❍
Feeling bored	❍	❍	❍	❍	❍
Feeling angry or frustrated	❍	❍	❍	❍	❍
Feeling tired	❍	❍	❍	❍	❍
Feeling anxious or nervous	❍	❍	❍	❍	❍

Appendix H
Mindful Eating Scale

In the next section, we're interested in your eating habits. Please answer the questions as honestly as possible. Please select the best response to the statements below:

	Strongly Disagree (1)	Moderately Disagree (2)	Somewhat Disagree (3)	Neither Agree nor Disagree (4)	Somewhat Agree (5)	Agree (6)	Strongly Agree (7)
I stop eating when I'm full even when eating something I love.	❍	❍	❍	❍	❍	❍	❍
When a restaurant portion is too large, I stop eating when I'm full.	❍	❍	❍	❍	❍	❍	❍
When I eat at "all you can eat" buffets, I tend to overeat.	❍	❍	❍	❍	❍	❍	❍
If there are leftovers that I like, I take a second helping even though I'm full.	❍	❍	❍	❍	❍	❍	❍
If there's good food at a party, I'll continue eating even after I'm full.	❍	❍	❍	❍	❍	❍	❍
When I'm eating one of my favorite foods, I don't recognize when I've had enough.	❍	❍	❍	❍	❍	❍	❍
When I'm at a restaurant, I can tell when the portion I've been	❍	❍	❍	❍	❍	❍	❍

served is too large for me. If it doesn't cost much more, I get the larger size food or drink regardless of how hungry I feel.	❍	❍	❍	❍	❍	❍	❍

	Strongly Disagree (1)	Moderately Disagree (2)	Somewhat Disagree (3)	Neither Agree nor Disagree (4)	Somewhat Agree (5)	Agree (6)	Strongly Agree (7)
I notice when there are subtle flavors in the foods I eat.	❍	❍	❍	❍	❍	❍	❍
Before I eat I take a moment to appreciate the colors and smells of my food.	❍	❍	❍	❍	❍	❍	❍
I appreciate the way my food looks on my plate.	❍	❍	❍	❍	❍	❍	❍
When eating a pleasant meal, I notice if it makes me feel relaxed.	❍	❍	❍	❍	❍	❍	❍
I taste every bite of food that I eat.	❍	❍	❍	❍	❍	❍	❍
I notice when the food I eat affects my emotional state.	❍	❍	❍	❍	❍	❍	❍
I notice when foods and drinks are too sweet.	❍	❍	❍	❍	❍	❍	❍

Please select the best response to the statements below.	Strongly Disagree (1)	Moderately Disagree (2)	Somewhat Disagree (3)	Neither Agree nor Disagree (4)	Somewhat Agree (5)	Agree (6)	Strongly Agree (7)
I recognize when food advertisements make me want to eat.	❍	❍	❍	❍	❍	❍	❍
I notice when I'm eating from a dish of candy just because it's there.	❍	❍	❍	❍	❍	❍	❍
I recognize when I'm eating and not hungry.	❍	❍	❍	❍	❍	❍	❍
I notice when just going into a movie theater makes me want to eat candy or popcorn.	❍	❍	❍	❍	❍	❍	❍
When I eat a big meal, I notice if it makes me feel heavy or sluggish.	❍	❍	❍	❍	❍	❍	❍
At a party where there is a lot of good food, I notice when it makes me want to eat more food than I should.	❍	❍	❍	❍	❍	❍	❍

Please select the best response to the statements below.

	Strongly Disagree (1)	Moderately Disagree (2)	Somewhat Disagree (3)	Neither Agree nor Disagree (4)	Some what Agree (5)	Agree (6)	Strongly Agree (7)
When I'm sad I eat to feel better.	❍	❍	❍	❍	❍	❍	❍
When I'm feeling stressed at work I'll go find something to eat.	❍	❍	❍	❍	❍	❍	❍
I have trouble not eating ice cream, cookies, or chips if they're around the house.	❍	❍	❍	❍	❍	❍	❍
I snack without noticing that I am eating.	❍	❍	❍	❍	❍	❍	❍

Please select the best response to the statements below.

	Strongly Disagree (1)	Moderately Disagree (2)	Somewhat Disagree (3)	Neither Agree nor Disagree (4)	Somewhat Agree (5)	Agree (6)	Strongly Agree (7)
My thoughts tend to wander while I am eating.	❍	❍	❍	❍	❍	❍	❍
I think about things I need to do while I am eating.	❍	❍	❍	❍	❍	❍	❍
I eat so quickly that I don't taste what I'm eating.	❍	❍	❍	❍	❍	❍	❍
I snack without noticing that I am eating.	❍	❍	❍	❍	❍	❍	❍

Appendix I

Multidimensional Assessment of Interoceptive Awareness (MAIA)

Below you will find a list of statements. Please indicate how often each statement applies to you generally in daily life.

	Never (1)	(2)	(3)	(4)	(5)	Always (6)
When I am tense, I notice where the tension is located in my body.	❍	❍	❍	❍	❍	❍
I notice when I am uncomfortable in my body.	❍	❍	❍	❍	❍	❍
I notice where in my body I am comfortable.	❍	❍	❍	❍	❍	❍
I notice changes in my breathing, such as whether it slows down or speeds up.	❍	❍	❍	❍	❍	❍
I distract myself from sensations of discomfort.	❍	❍	❍	❍	❍	❍
When I feel pain or discomfort, I try to power through it.	❍	❍	❍	❍	❍	❍
When I feel physical pain, I become upset.	❍	❍	❍	❍	❍	❍
I start to worry that something is wrong if I feel any discomfort.	❍	❍	❍	❍	❍	❍
I can notice an unpleasant body sensation without worrying about it.	❍	❍	❍	❍	❍	❍

Below you will find a list of statements. Please indicate how often each statement applies to you generally in daily life.

	Never (1)	(2)	(3)	(4)	(5)	Always (6)
I can pay attention to my breath without being distracted by things happening around me.	❍	❍	❍	❍	❍	❍
I can maintain awareness of my inner bodily sensations even when there is a lot going on around me.	❍	❍	❍	❍	❍	❍
When I am in conversation with someone, I can pay attention to my posture.	❍	❍	❍	❍	❍	❍
I can return awareness to my body if I am distracted.	❍	❍	❍	❍	❍	❍
I can maintain awareness of my whole body even when a part of me is in pain or discomfort.	❍	❍	❍	❍	❍	❍
I am able to consciously focus on my body as a whole.	❍	❍	❍	❍	❍	❍
I notice how my body changes when I am angry.	❍	❍	❍	❍	❍	❍
When something is wrong in my life, I can feel it in my body.	❍	❍	❍	❍	❍	❍
I notice that my body feels different after a peaceful experience.	❍	❍	❍	❍	❍	❍

Below you will find a list of statements. Please indicate how often each statement applies to you generally in daily life.

	Never (1)	(2)	(3)	(4)	(5)	Always (6)
I notice that my breathing becomes free and easy when I feel comfortable.	❍	❍	❍	❍	❍	❍
I notice how my body changes when I feel happy/joyful.	❍	❍	❍	❍	❍	❍
When I feel overwhelmed I can find a calm place inside.	❍	❍	❍	❍	❍	❍
When I bring awareness to my body, I feel a sense of calm.	❍	❍	❍	❍	❍	❍
I can use my breathe (breathing) to reduce tension.	❍	❍	❍	❍	❍	❍

Below you will find a list of statements. Please indicate how often each statement applies to you generally in daily life.

	Never (1)	(2)	(3)	(4)	(5)	Always (6)
When I am caught up in thoughts, I can calm my mind by focusing my body/breathing.	❍	❍	❍	❍	❍	❍
I listen for information from my body about my emotional state.	❍	❍	❍	❍	❍	❍
When I am upset, I take time to explore how my body feels.	❍	❍	❍	❍	❍	❍
I listen to my body to inform me about what to do.	❍	❍	❍	❍	❍	❍
I am at home in my body.	❍	❍	❍	❍	❍	❍
I feel my body is a safe place.	❍	❍	❍	❍	❍	❍
I trust my body sensations.	❍	❍	❍	❍	❍	❍

VITA

Personal Background	Randi Parker Proffitt Leyva Born November 4, 1986 in Grapevine, Texas Daughter of Jeffrey Ray Proffitt and Jami Parker Proffitt Married Victor Gonzalez Leyva, May 21, 2011
Education	Diploma, Mena High School, Mena, Arkansas, May 2005 Bachelor of Arts, Psychology and Spanish, Hendrix College, Conway, Arkansas, 2009
Experience	Clinical Research Assistant, Cook Children's Health Care System Fort Worth, Texas, 2009-2012 Research Coordinator, University of North Texas Health Science Center, Fort Worth, Texas, 2012-2014 Graduate Assistant, Department of Psychology, Texas Christian University, Fort Worth, Texas, 2014-2016 Teaching Assistant, Department of Psychology, Texas Christian University, Fort Worth, Texas, 2016-Present
Professional Memberships	Society for Personality and Social Psychology Human Behavior and Evolution Society International Society for Evolution, Medicine, and Public Health Southwestern Psychological Association Psi Chi National Honor Society in Psychology

ABSTRACT

THE IMPACT OF CHILDHOOD UNPREDICTABILITY, INTEROCEPTIVE BODY AWARENESS, AND BLOOD GLUCOSE ON EATING BEHAVIOR

by Randi Proffitt Leyva

Thesis Advisor: Sarah E. Hill, Associate Professor of Psychology

Life History Theory predicts that growing up in harsh and unpredictable environments should promote the development of adult phenotypes that can survive such environments. Guided by these insights, researchers have recently proposed that growing up poor should promote eating strategies that promote survivability in resource scarce environments. Here, I build on this research, examining the role that body awareness plays in regulating patterns of eating behavior observed among those from unpredictable environments. Across two studies, I found that individuals' exposure to unpredictable environments predicted lower body awareness, which predicted eating in the absence of hunger. Results suggest that body awareness may be a critical mediator of behavioral strategies that promote survival in unpredictable environments, including eating in the absence of hunger.