THE IMPACT OF COGNITIVE LOAD ON WOMEN'S

DECISION MAKING FOR FOOD CHOICES

by

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ABSTRACT

Objective: This study investigated the impact of cognitive load on the decision making process when selecting food, using a sample of female young adults in the Central Texas region. Methods: 100 women completed a three-part study. For the first portion, participants rated food preference while performing a digit span task. Following this task, participants completed a survey that included demographic questions, hunger ratings, a food susceptibility scale, and a scale for restrained, external, and emotional eating. Finally, participants completed an operation span task, which was included as a possible moderating factor. Results: Food preference for unhealthy food was higher overall but reported more often during the low load task than the high load task. Participants who were sensitive to negative emotions and external food cues were more likely to select unhealthy food options, while individuals' who showed restrained eating were more likely to respond quickly to food stimuli during high load. Conclusion: These data extend previous work by showing that individual differences in eating behavior can impact individuals' selection of foods at different levels of cognitive load.

I. INTRODUCTION

Tempting food cues are omnipresent in today's society: ads for foods are common in television commercials, cable networks, radio, magazines, newspapers, websites/social media, and on public billboards. In 2006, over 7 billion dollars were spent in the US on food, beverage and candy advertising. Of that advertising, $3.1 billion was spent oncommercial television advertisements, $1.4 billion went to cable networks, $1.9 billion to magazines, $326 million to radio, $133 million to the internet, $76 million to billboards/outdoor sources,and $50 million to newspapers, (Advertising Age, 2007). One study on food and drink brand advertising in movies released from 1995-2000 found that 33% of the 15 G rated movies and 80.8 % of the 47 movies R rated movies included in their sample had oneor more brand placements. Of the movies that included at least onebrand placement, there was an average appearance of the brand in the movie 8.6 times (Sutherland, MacKenzie, Purvis, & Dalton, 2010). As our aptitude for new media has increased (e.g., via social media and mobile devices), companies have added advertising to websites and apps (Boyland& Whalen, 2015). Third party advertisers can place banner advertising on other companies' websites, phone apps, and videos, and some of the highest expenditures made are on food advertising (Boyland& Whalen, 2015; Faberm Lee & Nan, 2004); in 2013, Facebook's top advertising expenses included advertising for Starbucks, Nestle and CocaCola (Boyland& Whalen, 2015).

In 2010, 11-29% of television advertising in North and South America, Asia, Australia, and Western Europe was food advertising, which represented the second-most advertised product behind only channel promotions. In Canada, the US, and Germany, more than 80% of the televised food advertisements were for foods that are high in fat, sodium, or calories (Kelly et al., 2010). High quality advertising from successful fast food companies such as McDonalds has shown to have a significant increase on sales growth (Young & Page, 2014) Therefore, it is no surprise that the presence of these cues has been identified as one cause of the obesity epidemic in the US today (Van Dillen, 2013). Finding ways to reduce obesity is of great importance in order to combat obesity-related diseases and healthcare costs(Harvey & Ogden 2014).According to data collected from the National Health and Nutrition Examination Survey (2009-2010), more than 33% of children and adolescents between age 6 and 19 have been classified as obese or overweight, at least 66% of adults in the US are categorized as overweight, and more than 33% are classified as obese (Ogden, Carroll, Kit, &Flegal, 2012). Obesity puts individuals at an increased risk for a variety of health problems and diseases (Abdullah, 2011; Demattia& Denney, 2008; Drewnowski&Darmon, 2005). One study on the relationship between mortality and duration of obesity found that after adjusting for cardiovascular disease, diabetes, BMI, age, and biomedical risk factors, people who had lived between 5-14.9 years with obesity had double the risk of mortality, and almost triple for those who lived 15 or more years with obesity (Abdullah et al., 2011).

There has been a significant increase in rates of obesity for children, adolescents, and adults from 1999 to 2014 (Ogden, Carroll, Fryar, &Flegal, 2015). One possible reason is the increased availability of food, especially unhealthy food. For example, from the late 19th to the 20th century a US household went from spending about 50% of their household income on food to spending only 12% (Drewnowski&Darmon, 2005; Karnani, Mcferran, &Mukhopadhyay, 2016). Because federal policy provides subsidies for high calorie food items such as meat and high fructose corn syrup, the prices for consumers appear reduced compared with healthier food options (Karnani, Mcferran, &Mukhopadhyay, 2016). This cost differential poses a problem when trying to encourage people to adopt what seems to be a more expensive lifestyle to benefit their health (Drewnowski&Darmon, 2005).

Based on the ecological systems theory proposed by Bronfenbrenner (1986), Davidson and Birch (2001) developed the Childhood Overweight model. This model examines the ecological niche surrounding the child and identifies what factors might have an influence on a child’s weight from the multiple environments in which the child lives. For example, if the child lives in a community where there is less immediate access to healthier foods they are less likely to consume them (Drewnowski&Darmon, 2005). Another example would be vending machines in schools, which often are stocked with unhealthy food options, thus providing children with easy fast access to snacks with poor nutritional value (Karnani, Mcferran, &Mukhopadhyay, 2016). This model is beneficial in explaining how the effects of society, family, and individual factors combine and intensify the causes of obesity (DeMattia& Denney, 2008).

The healthiness of food can be defined by multiple factors, including nutrient richness, calorie density, fat content, and the amountof processing.Glanz et al. (2012) separated healthy and unhealthy foods based on nutritional value. For their study, they included the Nutrient Rich Foods approach by following a nutrient index created to help people make healthier food decisions based on the nutritional composition of each food item. A study by Templeton, Stanton, and Zaki (2016) separated food stimuli for their study as healthy or unhealthy based on average calorie content of the food item per 100 grams (lower calorie items being healthier) in order to test if social norms could alter a person’s preference for entire food categories (i.e., healthy versus unhealthy) rather than single food items. Another way food healthiness can be classified is by fat content/fat type. RelayHealth (2010) classified saturated fat and trans-fat that come from dark meats and animal products as “bad” fats and polyunsaturated/monounsaturated fats that can be found in some vegetables, fish, and legumes as “good” fats. Sparrenberger, Friedrich, Schiffner, Schuch, and Wagner, (2015) classified food as healthy or unhealthy by the amount of processing on a spectrum with ultra-processed foods being considered most unhealthy because they are often high in calories, contain high amounts of saturated fats, trans fats, sodium and they are considered to be a poor source of nutrients.

II. LITERATURE REVIEW

Decision Making & Food Choices

Nutritional choices are part of daily life, but how much effort do individuals actually exert when they decide what to consume? Resisting unhealthy foods and making healthier food choices (i.e., dietary self-control) can be cognitively taxing and require effort when exerting dietary self-control. Dietary self-control is characterized by an individual's ability to select healthier food items over less healthy options (Ha et al., 2016; Sullivan, Hutcherson, Harris, & Rangel, 2015). Ha et al. (2016) argued that unhealthy food choice is primarily automatic and satisfies the short-term goal of satisfying hunger and/or cravings, so choosing to reject unhealthy food options is a cognitively demanding decision. To test this idea, Ha et al. (2016) examined dietary self-control in children using mouse-tracking technology. They tested 18 children between the ages of 8 and 13 (M = 11.07) years of age. After fasting for 3 hours, participants began the study by rating 60 food items on a 4-point Likert scale to determine perceived tastiness, healthiness, and liking. Then, participants used a mouse-tracking paradigm to indicatewhether or not they wanted to eat each food item. Participants were presented with a food image in the center of the screen and indicated whether or not they wanted to eat the food item shown by moving their mouse cursor towards the answer "yes" or "no" located in opposing corners of the display. For one block, participants were asked to answer what they wanted to eat; in another block,they were asked what they did not want to eat. Dietary self-control scores were calculated by the recorded mouse trajectories of each participant with more curvilinear lines indicating that higher cognitive effort was exerted. The results showed that the participants had to exert more cognitive effort to resist unhealthy stimuli and that children with higher BMI had more difficulty rejecting unhealthy food items.

Gillebaart, De Ridder, and Schneider (2015) suggested that because healthy food satisfies a long-term goal of health and wellbeing, individuals who are already in the process of obtaining these goals will have less difficultyrejecting unhealthy food options.In contrast, those who are not actively monitoring their eating behaviors may have more difficulty saying “no” to unhealthy foods options. Self-control is a contributing factor during the decision-making process, and Gillebaart, et al.(2015) proposed that the quicker an individual identifies that decision making must occur and recognizes the need for self-control, the faster they can resolve the conflict. To test this idea,Gillebaart et al. (2015) examined the relationship between self-control and conflict magnitude (i.e., the combination of experienced and objective conflict perceivedby an individual) in relation to food choices. To measure this experienced conflict was assessed by asking the participant how conflicted they felt toward the food stimuli and objective conflict was assessed by asking participants how negative and positive they felt toward the food stimuli. Participants were recruited from an online crowdsourcing platform, and the sample consisted of 146 participants (59 women) between 19 and 63 years of age. Participants were asked to complete an online survey about 11 different food images: 4 of the items were unhealthy foods and 7 were healthy foods. The participants filled out a self-control questionnaire and then rated the food items on a Likert scale for healthiness, conflict, positiveness, negativeness, and tastiness. Results showed that participants had similar ratings of objective response conflict for each food item but that higher self-control was associated with lower levels of experienced response conflict, indicating that though objective response conflict was present,individuals with higher self-control wereable to resolve the initial conflict faster, which resulted in lower scores of experienced response conflict. These results indicate that certain food items may elicit the same amount of response conflict in multiple individuals but that those who have higher self-control are able to resolve the conflict better than others (Gillebaart, 2015).

Food choice also can be dependent on the availability of other alternatives. When presented with multiple behavior options that have equal accessibility, and limitations, people usually will pick the option that is most reinforcing (Epstein, Salvy, Carr, Dearing, &Bickle, 2010). Forexample,given a choice between a health and unhealthy option on a menu, people may be likely to select the unhealthy option to satisfy a short-term goal of immediate gratification. A study by Lusk and Briggerman (2009) attempted to measure peoples' value of food to gain insight about what causes consumers to choose one food over another. A survey was created and sent to 2,000 households at random; 220 (11.4%) completed surveys were returned. The sample included35% women, 61% of the participants had college degrees, and the average age was 56 years old. The values identified include naturalness, price, convenience, taste, tradition, origin, safety, appearance, environmental impact, and fairness. On average, safety was the most important food value and that origin of food item was the least important value to participants. These results suggest individuals are less concerned with the nutritional value of their food and more concerned about their ability to safely consume it.

Mai, Symmank, and Seeberg-Elverfeldt (2016) suggested individuals may experience the halo effect when selecting food,wherein an association is made between healthiness and the perceived value of colors.They conducted a study to determinehow consumers assessed food in pale colored packaging compared with darker packaging. The sample included 179 individuals, 53% women, with an average age of 38 years old. The stimuli used included 5 items that had their colors altered so that one image of the food packaging appeared as a lighter hue and another image of the same food packing appeared as a much darker hue. The procedureinvolved using the Implicit Association Task across seven blocks to categorize the food stimuli that appeared on the screen to determine which food looked healthy or tasty to the consumer.Results showed that participants rated the darker packaging as tastier and the lighter hue packaging as healthier, indicating that the individuals perceived items in lighter-color packaging as healthier and less flavorful.

Anothermethod used to assess food decisions is to have individuals categorize photos of food as healthy or unhealthy. Several studies have addressed this topic using food stimuli (Gillebaart, De Ridder, & Schneider, 2015; Ha et al., 2016; Schneider et al., 2015; Van Dillen, Papies, & Hofmann, 2013). Schneider et al. (2015)found that food stimuli in the form of photos had stronger effects than stimuli presented in the form of words whenassessing conflict in decision making.Food decision also changes with age.Farragher, Wang, and Worsley (2016) found that vegetable and fruit consumption was positively associated with age, and that women who are starting families werelikely to increase their consumption of vegetables.

Romero and Biswas (2016) highlighted the role of mental representation in food decisions. They suggested that because peoplein most countries naturally organize items by magnitude from left to right (Lourenco & Longo, 2010) and that becausethey perceive healthier foods as lighter and therefore lower in magnitude, individuals would be likely to put lower calorie food items to the left and higher calorie food items to the right. To test this idea, participants viewed a menu of food items similar to what might be found in a restaurant. As predicted, participants were more likely to select healthier items that were located on the left of the menu. Romero and Biswas (2016) suggested that individuals are able to exert greater self-control when food items are in an order that is consistent with their natural mental representation.

Self-report questionnaires that indicate food choicehave also been used to assess eating behavior. The Dutch Eating Behavior questionnaire (DEBQ: Strien, Frijters, Bergers, &Defares, 1986), for example, is widely used as a measure of eating behavior assesses three different aspects of eating(Van Strien, 2002; Mason et al., 2017) emotional, external, and restrained eating (Cappelleri et al., 1986). Emotional eating refers to eating behavior in response to feeling negative emotions such as stress and sadness (Mason et al., 2017). External eating refers to an individual’s eating behavior in response to environmental cues such as others eating, the smell of food, or the mere presence of food (Mason et al., 2017). Restrained eating refers to exerting self-control over the type and amount of food eaten, often used for the purpose of weight control (Mason et al., 2017). Another questionnaire used to study eating behavior is the Power of Food Scale (PFS) which is a questionnaire intended to measure an individual’s susceptibility to food cues in an environment where cues for tempting food items are abundant (Cappelleri et al., 2009, Lowe et al., 2009). Several studies have used this scale to assess hedonic food cue sensitivityand how it relates to weight and diet outcomes in adult and child populations (Lipsky et al., 2016; Mitchell, Cushing, &Amaro, 2016; Laurent, 2015; Schüz, Schüz, & Ferguson, 2015). The PFS is a measure that can be used alongside the DEBQ because it assesses the impact of a hedonic food environment on an individual's preference and cravings for foods regardless of their current state of hunger with the intention of evaluating an individual's response to appetite while the DEBQ evaluates an individual's motivation to eat (Lipsky et al., 2016).

Gender and Food Choice

Obesity is an issue that creates health disparities in the U.S. population. For example, lower socioeconomic status correlates with higher levels of obesity particularly in women (Ogden, Lamb, Carroll &Flegal, 2010). Women who do not have a college degree are more likely to be obese than those who do. Furthermore, as education level for women decreases prevalence of obesity increases (Ogden, Lamb, Carroll &Flegal, 2010). Women are well represented in the literature on weight loss, but they are seldom targeted if they belong to low-income groups (Harvey & Ogden, 2014).

Many studies using different methods of analysis have found gender differences in food choice (Tagney et al., 2004; Boek, Bianco-Simeral, Chan, &Goto, 2012; Chambers, Lobb, &Traill, 2008; Machin, Giminez, Vidal & Ares, 2014; Heiman &Lowengart, 2014). On average, women tend to make more health conscious food decisions than men (Chambers et al., 2008; Boek et al., 2012), therefore it is important that we account for the differences in food choice between genders to better understand the underlying factors that influence how genders respond to information about food (Heiman et al., 2010).

One study conducted by Boek et al. (2012) collected survey data to observe the relationship between gender and food choice in college students. Results showed significant differences between male and female preference.Specifically, when examining eating location, men gave higher ratings for larger dining facilities whereas women preferred cafe style dining locations (Boek et al., 2012). When determining food dislike, men were significantly more likely to choose taste, cost, and quality as undesirable attributes whereas women were significantly more likely to dislike food based on poor nutritional content (Boek et al., 2012). When rating food by healthiness, though men and women both reported high fat content as the main reason for giving food items a low health rating, men were significantly more likely to report high sodium content as an attribute of unhealthful food (Boek et al., 2012). Chambers et al. (2008) also discovered gender differences in food choice using focus groups. The study included 43 people grouped by age and gender. Initial data collection involved participants filling out self-report surveys with information regarding diets, alcohol consumption, body satisfaction, and reasons to eat healthy or eat otherwise (Chambers et al., 2008). Content discussed during the focus group included topics such as food consumption and purchase choice, the value of cooking, eating in moderation, and trustworthy information about healthy food (Chambers et al., 2008). Results showed women were more likely than men to discuss body dissatisfaction in a group setting, particularly younger women (aged 18-30). Women also reported their opinion of their appearance being affected by the food they chose to eat, suggesting that the food choices women makeare is related to their perception of their appearance (Chambers et al., 2008).

In a related study, rather than look directly at food choice and gender, Machen et al. (2014) intended to identify factors influencing the purchase and consumption in the context of food choice while treating gender as a moderator. To explore the underlying motives of food choice this study used a free listing task with four listings to represent each representing a different context (Machin et al., 2014). Results showed women scored higher than men in the context of health/nutrition indicating that women assign higher value to nutritional content and are more interested in health-related issues when making their food decisions (Machin et al., 2014). Another difference was found showing that women considered the quality “easy preparation" to be less important in the context of dinner when compared to men.The authors suggest these results could be because women are mainly the ones who prepare and select foods (Machin et al., 2014). The article further suggests the differences in food selection and eating patterns may be due to variances in the way men and women conceptualize food quality(Machin et al., 2014). Heiman et al., (2014) found similar results, their study consisted of three groups, a control group and two experimental groups. The first (control) group was presented with a menu and prices listed next to each of the various food items, the second group (experimental 1) experienced calorie content manipulation which showed the food menu with calorie amount listed next to the prices of each item, and the third (experimental 2) group experienced calorie manipulation alongside a burn time manipulation which showed the same menu but under each item along with the price and calories of the items a description of the physical activity necessary to burn off the calories of the food items was described (Heiman et al., 2014). Participants were asked to rate the food items from the menu based on taste, healthiness, contribution to weight gain/loss, nutritional value, and caloric density (Heiman et al., 2014). Results showed that for the two experimental groups the female’s perception of the calorie density of the chicken sandwich and hamburger items from the menu increased, no effect was observed for the male’s perception in these groups (Heiman et al., 2014). Because this difference was not found in the control group the study suggests it is the calorie information and burn time information has a larger impact on food perception in females than males (Heiman et al., 2014). Looking at the control group the gender difference seen were significant for the tastiness rating of the salad and the chicken sandwich, with the females rating the two items as tasty significantly more often than males (Heiman et al., 2014). Calorie information caused a change in the perception of hamburger tastiness by women, while eliminating the difference in perception of tastiness between men and women for the chicken sandwich (Heiman et al., 2014). Calorie information caused perception changes for the females regarding the salad and chicken sandwich, the group that had calorie manipulation gave higher cost ratings to these two items than the control group did (Heiman et al., 2014). The most noteworthy observation this study made was for rating of vegetables, overall men gave lower rating for tastiness of vegetables and females gave higher ratings for tastiness of vegetables. Because of the evidence provided by Boek et al. (2012) that tastiness is the number one determinant of food choice, it is important to acknowledge that perception of tastiness may be a reflection of gender differences (Heiman et al., 2014).

Cognitive Load and Food Selection

Cognitive load is a term used to describe the degree of mental effort being exerted in working memory. The potential impact of this variable in food selection has recently received some attention (Hofmann, Deutsch, Lancaster, &Banaji, 2010; Van Dillen et al. 2013; Van Dillen & Andrade, 2015; Van Beurden, Greaves, Smith, & Abraham, 2016). For example, the impact of attractive stimuli can bereduced when high concurrent cognitive load ispresent. Van Dillen et al. (2013) suggestedthat cognitive load reduces desire for attractive stimuli by restricting the features to which people attend.

One common way to manipulate cognitive load in the laboratory is to use a concurrent digit span task.This task has been used as a component of intelligencetests, and it is also commonly utilized when assessing diagnosed or suspected learning disabilities (David, 2016). Two versions include the digit span forward task and the digit span backward task (Giofrè, Stoppa, Feriolo, Pezzuti, &Cornoldi, 2016). When completing a digit span forward task, participants either see or hear a sequence of digits and are asked to correctly recall the whole sequence; the maximum length sequence a participant can correctly recall indicates their working memory capacity. Digit span backwards involves the same steps except the subject is required to recall the sequence in inverse order. The latter is thought to consume more working memory resources. According to the model developed by Baddeley and Hitch (1974), working memory is composed of three main components: (a) the central executive, which performs a variety of tasks including the allocation of resources; (b) the phonological loop, which carries out subvocal rehearsal in order to maintain verbal material; and (c) the visuospatial sketch pad, which uses visualization to maintain visual material (Galotii, 2014). Forward versus backward digit span tasks have been associated with different components of working memory: forward digit span has been related to the phonological loop while backward digit span has been associated with concurrent activity in the phonological loop and the central executive (Giofrè et al., 2016; Alloway, Gathercole, Kirkwood, and Elliot, 2009).Digit span forward is considered passive (using a limited amount of executive control), while other tasks involving dual processing such as listening span tasks are considered active (usinga large amount of executive resources) (Giofrè et al., 2016). Though digit span backward requires larger amounts of executive resources than digit span forward still requires a smaller amount of executive resources than listening span tasks (Giofrè et al., 2016).

Several dual-process paradigmssuch as the Reflective Impulse Model (RIM; Strack&Deutsch, 2004), the Context Executive and Operating Systems Model (CEOC; Borland 2014), and the Temporal Self-Regulation Theory (TST; Hall & Fong, 2007) suggest that impulsive, or automatic processes in addition to deliberate conscious control of action shape our patterns of behavior (Van Beurden, Greaves, Smith, & Abraham, 2016). Applying this perspective to food choice, we have eating impulses (urges) that are recognized by our reflective system, and in certain circumstances we are able to use our reflective system to override those impulses (resist temptation). A recent review by Van Beurden et al. (2016) noted several techniques that have been used to assess eating behavior. The different techniques reviewed were organized into 1of 2categories: impulse-focused techniques or reflective-focused techniques. The impulse-focused category included techniques that attempt to modify the strength of urges that are triggered due to a stimulus by targeting the impulsive system (Van Beurden et al., 2016). The reflective-focused category included techniques that attempted to engage cognitive resources (reflective system) by suppressing/managing cravings before choosing to act on them. Of the 92 studies included in the review, 17 different techniques were used. The most commonly used techniques included priming (9), cue exposure (9), inhibition training (9), physical activity (6), mindfulness strategies (19), visuospatial loading (16), and implementation intentions (9) (Van Beurden et al., 2016). In comparison, cognitive load was relatively understudied, with only one published article (i.e., Van Dillen, Papies, & Hofmann, 2013) having examined this technique in 3 experiments.

Results from the first 2 experiments by Van Dillen et al. (2013)indicated that high cognitive load may prevent individuals from assessing the hedonic value of food stimuli. Experiment 3 extended the previous two experiments by looking at eating behavior more directly.Participants were assigned to 1 of 2 groups with varying cognitive load (nonev. high) and were asked tocategorize images as edible or inedible followed by a digit span task. The image bank included neutral food, tempting food and non-food objects.Participants completed the Power of Food Scale (PFS: Lowe et al., 2009) to determine their preexisting susceptibility to attractive food itemsand then performed a filler task. Following this, participants were shown a digit span (no cognitive load or 8-digit cognitive load) and then an image of an object they needed to categorize as edible or inedible using 2 keys (edible yes/no).After the study,participants could pick a snack from healthy and unhealthy food items left on a table. Results showed that participants categorized tempting food items more quickly than neutral food items, especially those that scored high on the PFS, but only for the no load group. There was no significant difference in response time when cognitive load was high. These results were consistent with Studies 1 and 2 and further provide support for the finding that high load can prevent unhealthy food choice by preventing an individual from processing a hedonic food cue (Van Dillen et al., 2013).

Working Memory Capacity Tasks

Working memory is considered a stable construct explaining the cognitive system that gives us access to information we need for continuing cognitive processes (Wilhelm, Hildebrandt, &Oberauer, 2013). The term working memory capacity is used to describe the individual differences in a person's ability to use their working memory (Wilhelm et al., 2013). Three of the most commonly used working memory tasks include reading span (Daneman& Carpenter, 1980), operation span (Turner & Engle, 1989), and counting span (Case, Kurland, & Goldberg, 1982). These tasks are able to predict cognitively complex behavior such as reading comprehension, reasoning, and problem solving (Conway, Kane, Bunting, Hambrick, & Wilhelm, 2005). Working memory tasks in general have executive attention demands rather than domain specific demands (Conway et al., 2005). This distinction is what separates the concepts short-term memory capacity (STMC) and working memory capacity (WMC), where STMC mainly represents domain-specific storage, WMC mainly represents domain-general executive attention (Conway et al., 2005). Whereas STMC measures such as the digit span require individuals to practice rehearsal and storage of information, WMC measures have an added component forcing individuals to simultaneously process additional information (Conway et al., 2005). In general, research has shown that measures of working memory span are usually stronger predictors of general intellectual abilities than measures of short-term memory span (Conway et al., 2005). We anticipate individuals with a higher working memory capacity will perform better on a digit span task so in this study we will analyze working memory as a subject variable.

Reading span involves participants reading sentences aloud, and determining if the sentences are logical, while remembering the last word from the sentence for later recall (Conway et al., 2005). Turner and Engels (1989) elaborated on the reading span task by developing a new task that showed reading ability could be predicted using a procedure that did not involve reading of sentences at all. They did this using their operation span task. In operation span two mathematical operations are shown, one is simple multiplication/division, and the second operation is simple addition/subtraction with answers shown for both. Participants are required to determine if the solution to the equation is correct or incorrect, and this is followed by a 4-6 letter word the participant reads aloud and memorizes for later recall (Conway et al., 2005). Though the underlying structure of the three tasks being discussed is the same, the third working memory measure, counting span differs from the other two tasks because rather than memorizing words counting span requires individuals to count shapes and remember the count number for later recall (Conway et al., 2005). In the counting task participants would point and count aloud the number of green spots presented on a white background (yellow dots were also present to distort vision and were not meant to be counted), they would then need to remember the total number of dots of each set for later recall (Conway et al., 2005).

Self-Control

Resisting temptation, breaking habits, and good self-discipline all reflect aspects of self-control (Tangney, 2014). The concept of self-control has beendefined by Hofmann, Luhmann, Fisher, Vohs, andBaumeister (2014) defined self-control as “the ability to override or change one’s inner responses, as well as to interrupt undesired behavioral tendencies (such as impulses) and refrain from acting on them”(p. 1). Though a person’s state of self-control can fluctuate over time, it is considered a stable part of an individual’s personality (Gillebaart, De Ridder, & Schneider, 2015). This steady degree of control each individual possess is referred to as trait self-control (Tangney, Baumeister, & Boone, 2004). Trait self-control can bea contributing factor during the decision making process. The faster a person realizes they will need to exert self-control, the faster they can resolve conflict during the decision making process (Gillebaart et al., 2015).

The ability to exert self-control can be difficult to maintain when dealing with strong desires. According to the Elaborated Intrusion theory (Kavanagh, Andrade, & May, 2005), unconscious associative processing of stimuli is the precursor to desire whereas the controlled processing that takes place as a result of cognitive elaboration is what elicits desire. This is true for both short and long-term goals. For example, if an individual sees a dessert that he or she has enjoyed in the past, the desire to consume the item is only present after the individual has imagined (cognitive elaboration) the pleasure of indulging in the food item (Van Dillen et al., 2015). Or, if a person sees others exercising, and they have a long-term goal to be more physically fit the desire to exercise will only be present after they have imagined their current state and compared it to a future state where achievement has occurred (Van Dillen et al., 2015). Because the immediate reward of satisfying a short-term goal is easier to imagine than it is to imagine satisfying a long term goal such as health and well-being people have more difficulty exerting self-control when faced with desire (Van Dillen et al., 2015).

Hofmann, Deutsch, Lancaster, &Banaji (2010) suggested that stimulus control and/or response control may reduce the automatic positive feelings caused by tempting food stimuli. To test this idea, Hofmann et al. (2010) conducted a study includingfour groups of participants, a consummatory group, a nonconsummatory transformation group, an implementation intentions group and a control group. Participants in the consummatory group were asked to focus as concretely as possible on sensory aspects (taste and feel) of eating a piece of chocolate. Participants in the nonconsummatory group were asked to imagine the piece of chocolate in an unusual way that was completely unrelated to consumption. The implementation intentions group was asked to imagine a goal of not eating chocolate and to write down their intention to refuse the chocolate. The control group came up with city names in alphabetical order. After manipulations occurred, the participants' automatic evaluations for the chocolate were assessed using the Implicit Association Test (Karpinski& Steinman, 2006). This was followed by an explicit attitude measure where participant's rated tastiness and likability of the chocolate. Results showed that the participants in the nonconsummatory group exhibited less automatic positivity towards the chocolate than both the control and consummatory groups. Moreover, the implementation intentions group showed the largest reduction in automatic positivity towards chocolate (Hofmann et al., 2010). These finding indicate that implementation intentions method may reduce the automatic positivity a tempting cue elicits. This study highlighted how certain self-control techniques may be useful when fighting temptation.This strategy allows a person to influence automatic stimulus assessment as well as conscious attitudes, which in turn can lead to the perceived hedonic appeal of a tempting cue to lose its value (Hofmann et al., 2010).

Present Study

The present study was designed to investigate the impact of cognitive load on the decision-making process when selecting food. Cognitive load was categorized as low load vs. high load, based on the degree of mental effort necessary to recall one (low load) or eight (high load) digits. Food was categorized as healthy vs. unhealthy based on nutrient content, and we examined a population in south central Texas, which is important to assess because of the health concerns associated with this area. Texas is rankedas 10th highest in the nation in obesity rates among adults with 32.4% of the adult Texas population being classified as obese.Even more concerning, Texas ranks 6th highest for combined scores of overweight and obese with 68.7% of adults meeting this criteria (Segal, Rayburn, &Martin, 2016). Educating people about the importance of nutrition is beneficial for promoting long-term health and well-being (Ha et al., 2016). The hypotheses of this study flow from work by Van Dillen et al. (2013).

The primary hypothesis is thatthere wouldbe a main effect of cognitive load on response times. Specifically, there should be longer response times for higher cognitive load compared with lower cognitive load. This would be evidence for theuse of controlled process during food selection, which is consistent with the findings of Van Dillen et al. who showed that when comparing no load and high load groups, participants had significantly faster RTs in the no load condition. In addition, there should be an interaction between food type and cognitive load. Specifically, there should be shorter RTs for unhealthy choices compared with healthy choices when cognitive load is low,but no difference in response times between health and unhealthy choices when cognitive load is high. Similarly, Van Dillen et al. showedthat in a no load condition participants categorized attractive foods faster than neutral foods whereas the high load group showed no significant difference in RTs between food type.

Anothermajor hypothesis is that PFS scores wouldhave a moderating effect on cognitive load and response times for unhealthy food choices. Participants who score higher on the PFS (high susceptibility) will have faster RTs than those who score low on PFS (low susceptibility) for unhealthy choices when load is low but there will be no noticeable difference in RTs for participant's who score higher on the PFS when cognitive load is high. This extends work the by Van Dillen et al., who showed their studies during the low load condition participants that scored high on were significantly faster at categorizing attractive food items when compared to neutral food items.In order to identify possible covariates, we hypothesized that operation span scores would be significantly related to digit span accuracy. Because the operation span and digit span task are both used to assess working memory, we expected to see a significant positive relationship between these scores. We also assessed hunger as a possible covariate, though participants were asked to fast three hours prior to participating to ensure varying hunger levels do not influence our results we will assess the relationship between hunger and response time for food stimuli. We hypothesized that participants who scored high for hunger would have a faster response time to food stimuli.

III. RESEARCH METHODS AND DESIGN

Method

Participants

A total of 100 women who were 18 years of age or olderwere recruited from Introduction to Psychology class sections using the Psychology Human Subjects Pool and Introduction to Statistics lab sections via email.Five participants were removed from statistical analyses due to errors during data collection. Errors included program crashes during the operation span task (n = 3) and participants not responding to the digit stimuli during the dual task (n = 2). The 95 participants who were included in the analysis had a mean age of 20 (SD = 2); 33.7% were White/non-hispanic, 21.1% were Black/nonhispanic, 34.7% were Hispanic/Latino/a, 2% were Asian, and 10.4% were biracial or multiracial or other. All procedures and measures were approved by the Texas State University institutional review board before beginning data collection.

Stimuli and Measures

Food Stimuli. Ninety images of food (45 healthy foods and 45 unhealthy foods) that are likely to appear in an individual's diet were selected and normed for the study population. Sixty of the stimuli came from a set of previously validated images (Van Dillen, Papies, & Hofmann, 2013) and 30 images were added. All images are presented with a completely white background and no visiblelogos. The stimuli in the healthy category included foods that are high in nutrient density (e.g., carrots, bananas, nuts); the food images in the unhealthy category included foods that are low in nutrient density (e.g., fried food, cake, candy). Taste and health ratings were collected for each image to confirm they were correctly categorized. All images in the healthy category were rated as higher in healthiness than all images in the unhealthy category in pilot testing. From the pool of 90 images, 56 images (28 healthy, 28 unhealthy) were matched by taste scores to be used during data collection. T-tests confirmed a significant difference between groups for healthiness, $t(184) = 72.55$, $p < .001$ whereas no significant difference existed for tastiness, $t(187) = 0.78$, $p = .434$**.** Finally, 4 non-food images were selected to ensure the participants were paying attention to the stimuli shown during the study. These images were acquired from a previous study conducted by Van Dillen et al. (2013).

Digit Span Forward. Digit span forward is a subtest from theWechsler Intelligence Scale (WIS) and is used to measure working memory capacity by asking participants to memorize and recall a span of digits representing different levels of cognitive load ranging from 1 to 8 digits in length. This study assed cognitive load using a low and high digit span, participants were asked to recall twenty-eight stimuli that were 1 digit in length (i.e., low load) and twenty-eight stimuli that were 8 digits in length (i.e., high load).

Power of Food Scale. The Power of Food Scale (PFS) was used to assess an individual's preexisting susceptibility to attractive food items (Lowe et al., 2009).This scale is a 15 item self-report measure; Participantsreportedtheir answers to these items using a 5-point Likert scale (1 = do not agree at all to 5 = strongly agree). Each participant was given a power of food score from an average of the 15 items (e.g., "I love the taste of certain foods so much that I can't avoid eating them even if they're bad for me," and "When I eat delicious foods I focus a lot in how good it tastes"; Cronbach's alpha = .89). Higher scores for these items indicated higher levels of susceptibility to attractive food items. This questionnaire was administered using Qualtrics software.

Dutch Eating Behavior Questionnaire. The Dutch Eating Behavior Questionnaire (DEBQ) is used to assess three domains of eating, with subscales for each including external, emotional, and restrained eating behaviors (Strien, Frijters, Bergers, &Defares, 1986). This study used the English translated version of the questionnaire (Van Strien, 2002).The DEBQ is a 33 item self-report measure; Participants reported their answers using a 5 point Likert scale (1 = seldom to 5= very often). The emotional eating subscale includes 13 items (e.g., "Do you have a desire to eat when you are emotionally upset?"; Cronbach's alpha = .92), the restrained eating subscale includes 10 items (e.g., "Do you take into account your weight with what you eat?"; Cronbach's alpha = .85), and the external eating subscale includes 10 items (e.g., "If you see or smell something delicious, do you have a desire to eat it?" Cronbach's alpha = .80).

Operation span. Participants completed an operation span task to assess their baseline working memory capacity (Turner & Engle, 1989). A shortened version of the operation span(alpha = .87) developed by Foster, Shipstead, Harrison, Hicks, Redick, and Engle (2015) was used. In the operation span task, a mathematical operation involving a combination of simple multiplication/division and simple addition/subtraction was shown (distractor task), followed by a letter (item for later recall). Participants first saw the mathematical operation, then they were shown an answer to the mathematical operation and reported its accuracy by clicking true or false. Next, participants were shown a single letter that they were asked to remember for later recall. After the mathematical operation-letter sequences finished, the participants were asked to recall the letters that appeared during the trial in the order they appeared. The sequence of mathematical operation-letter repeated for 3 trials and increased to a maximum of 7 trials, or until the participant was able to complete 85% of the trial correctly (Foster et al., 2015). Partial operation span scores were calculated that indicated the total number of items that were recalled correctly by the participant during the memory trials.

Demographic Questionnaire. Participants were asked to provide their age, gender, ethnicity, academic classification, and level of hunger using Qualtrics software.

Procedure

Participantswere asked to fast for 3 hours before the beginning of the experiment. Upon arrival, after giving consent participantsweregiven a description and visual aid explaining the dual-task procedure (digit span forward and food selection). After confirming the participants understand the task and gave consent they performed the dual-task procedure using Eprime software. Next, participants completed a questionnaire includingdemographic questions, the Dutch Eating Behavior Questionnaire, and the Power of Food Scale.Finally, participants completed an Operation Span Task to assess their working memory capacity.

During the dual-task participants were will be asked to answer questions about randomized imagesof healthy and unhealthy foods. The level of cognitive load (low v. high)varied within participants. Thus, the experiment used a 2 X 2 (food type by cognitive load) within-subjects factorial design. The low load condition required participants to recall 1 digit in a digit span task, and the high load condition required participants to recall 8 digits in a Digit Span task.

Each trial of the dual-task for both conditions included 4 screens that appeared for 2 seconds each, this series of events is illustrated in *Figure 1*.

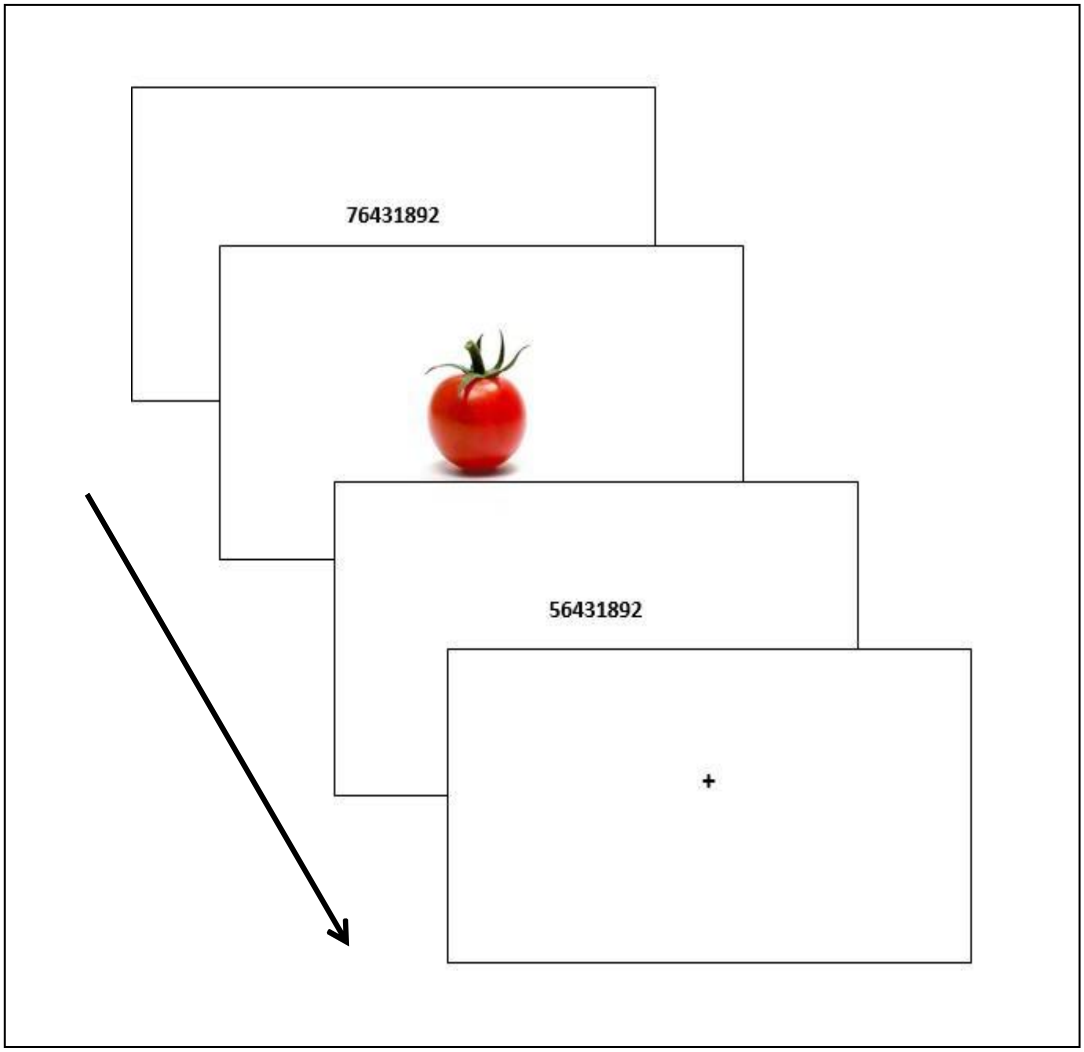


Figure 1. Study Design

For the high load condition at the beginning of the trial the participants were presented with a screen that included a digit span (8 digits), during the 2 seconds allotted the participant was asked to memorize the digit span on the screen. After the two seconds elapsed, the next screen appeared that included a food image stimulus. While this second screen was displayed the participant was asked to press 1 for yes or 2 for no on their keyboard indicating their response to the question “do you want to eat this?” within the 2 second time limit. The third screen to appear was another digit span stimulus (8 digits).

While this screen was displayed, the participant was asked to press 1 for yes or 2 for no on their keyboard indicating their response to the question “is this the same digit span you previously saw, in the same order you saw them in?”. Following this screen there was a fourth screen with a plus sign located in the center of the screen indicating to the participant that the current trial has ended and the next screen to appear would be the first screen of the next trial. The low load condition followed the same procedure but participants were presented with a single digit (presented on the first and third screen of each trial), rather than 8 digits. There also were four nonfood images that appeared in one of 4 trials to ensure participants are paying attention to the stimuli during the dual-task. The trials appeared at random during the experiment, there is not set order to determine when the participants received a trial for the high load condition, the low load condition, or the nonfood images. Response time was recorded for all response, and accuracy was recorded for the digit span task.

IV. RESULTS

All statistical analyses were conducted at $p < .05$ unless otherwise noted. Responses to the stimuli that were missing or less than 200 ms for food (1.5%) and digit span (12.5%) conditions were excluded from analysis. Due to a programming error in1 of the 4 versions used for counterbalancing purposes, participants did not time out at 2000 ms during presentation of the food stimuli trials. Therefore, all trials with response times over 2000 ms for food stimuli were excluded from analysis in that version.

As expected, participants performed better on the cognitive load task in the low-load condition (*M* = 92%, *SD* = 7%)compared with the high load condition (*M* = 59%, *SD* = 9%). A one-sample t-test was conducted to check that participants were getting accuracy scores during the high load task that were higher than the 50% chance level. Results showed that participants in our sample scored significantly higher than a 50% average ($t[88] = 8.96$, $p < .001$). Participants had an average response time of 812ms (*SD* = 137ms) during the low load condition, and an average response time of 1,054ms (*SD* = 219ms) during the high load condition. There was a significant relationship between digit span accuracy (r = .22, p = .043), and operation span scores (*M* = 53.4, *SD* = 12.1)therefore, operation span was used as a covariate in all subsequent analyses. We also examined hunger as a possible covariate. Participants had an average hunger score of 3.38 (*SD* = 1.32).However, there was no significant correlation between hunger and response time to food stimuli ($r = -.06$, $p = .58$), so this variable was not examined further.

A 2x2 within-subjects factorial ANCOVA was conducted to assess the impact of cognitive load and food type on response time to food stimuli while controlling for operation span scores. Inconsistent with our hypothesis, there was no significant interaction between cognitive load and food type (*F* [1, 85] = .143, *p*= .707). No significant main effects emerged for cognitive load (*F* [1, 85] = .168, *p*= .683) or food type (*F* [1,85] = 1.06, *p*= .305) see *Figure 2*.Due to the low significance of the operation span partial scores (p = .043) the ANCOVA was also run without the covariate.[1]

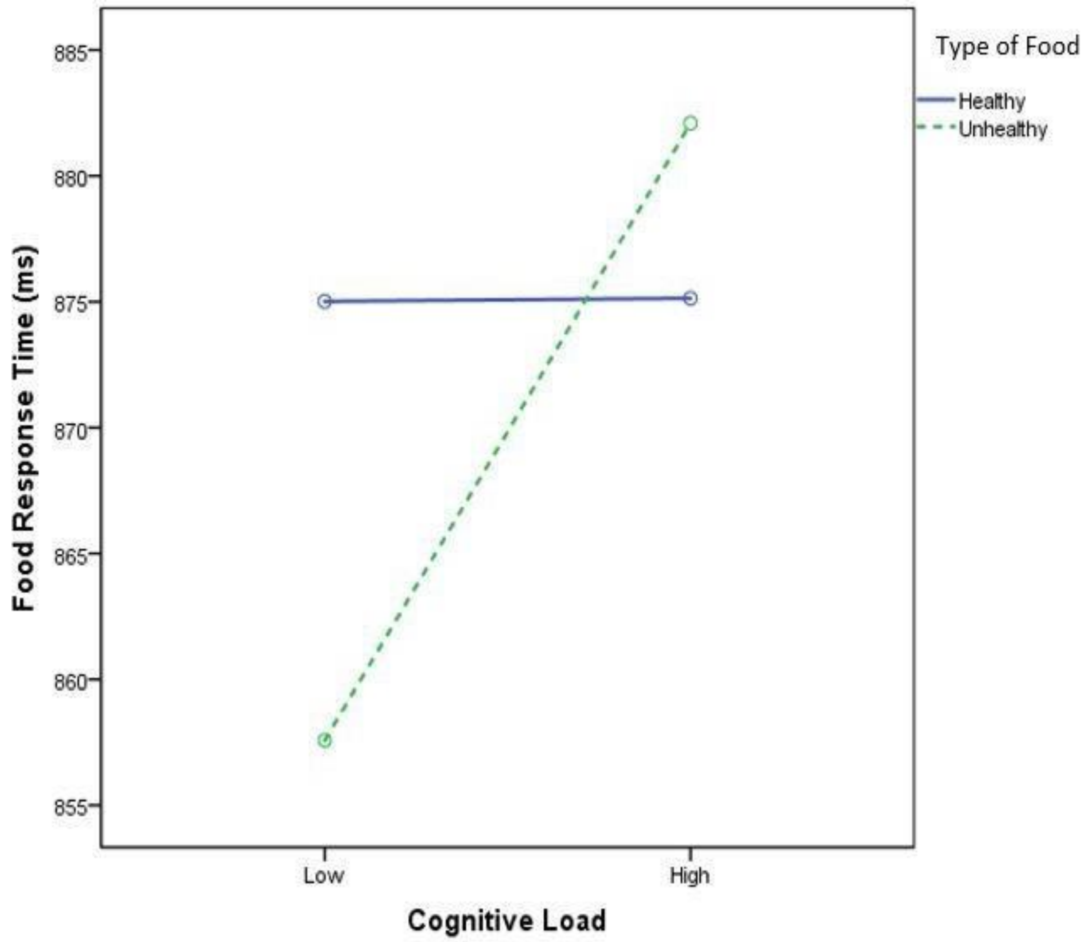


Figure 2. Relationship Between Cognitive Load and Food for Response Times

A 2x2 within-subjects factorial ANCOVA was conducted to assess the main effects of cognitive load and food type on food choiceof food stimuli while controlling for operation span scores. Food choice scores represent the percentage of times participants answered “yes” to the presented food stimuli during the trials. Overall, participants were more likely to select unhealthy foods (*M* = 80%, *SD* = 18%) compared to healthy foods (*M* = 70%, *SD* = 21%), (*F* [1,85] = 7.32, *p*= .008). Results showed there was a significant main effect of food type (*F* [1, 85] = 7.03, *p* = .01) but no main effect of cognitive load (*F* [1, 85] = .00, *p* = 1.0) see *Figure 3*. No significant interaction emerged between cognitive load and food type (*F* [1,85] = 3.18, *p* = .078).

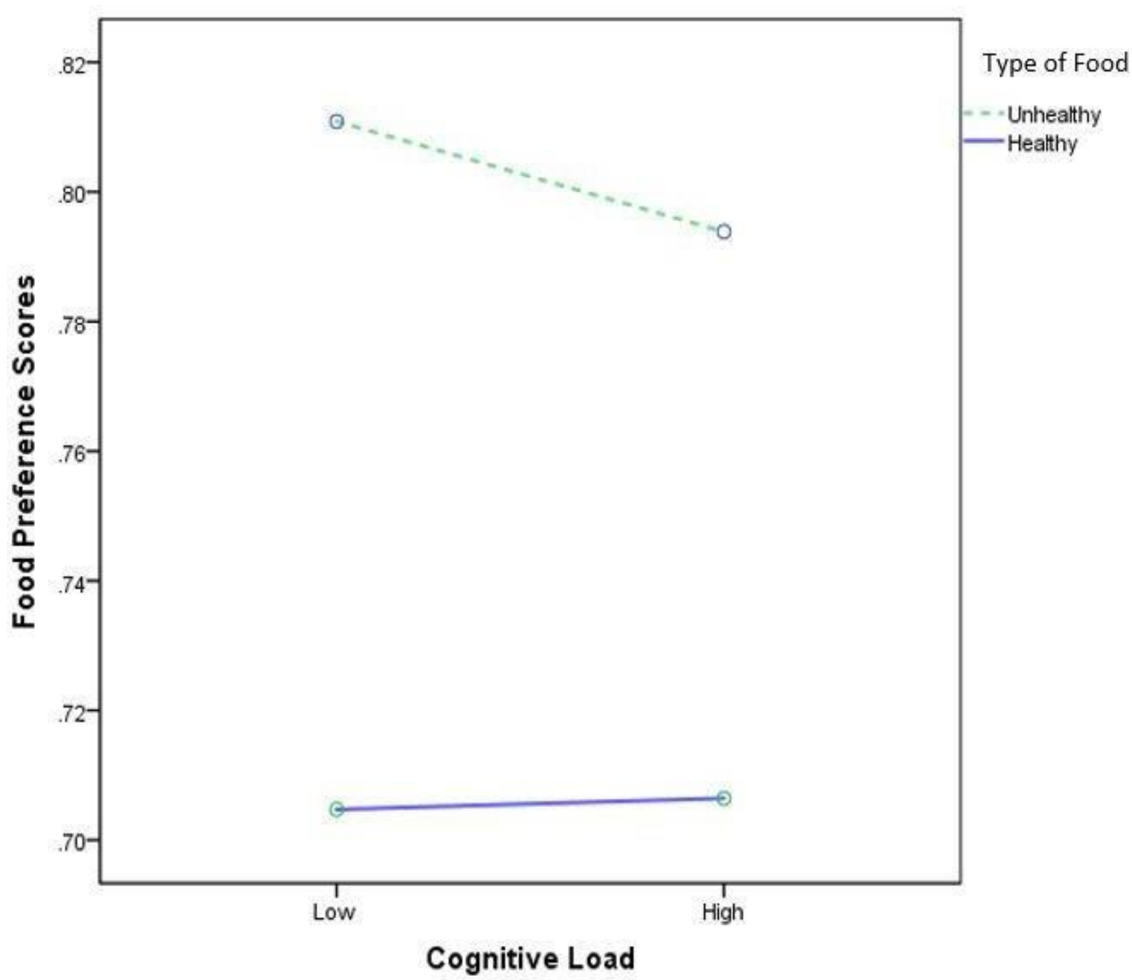


Figure 3. Relationship Between Cognitive Load and Food for Food Preference Scores

To explore changes in food choice by load, two oneway ANCOVAS were conducted. No significant difference emerged for preference of healthy food stimuli (*F* [1, 85] =

1.48, $p = .228$), or unhealthy food stimuli(F [1, 85] = 2.47, $p = .12$) between low and high load conditions.

Individual differences among participants were assessed using the PFS and DEBQ. The relationship between these scores and food choice response times are shown in (*Table 1*). The DEBQ scores were significantly related to response time when cognitive load was high, for the restrained eating subscale. Indicating individuals that scores higher on the DEBQ restrained eating subscale had faster response times for food stimuli during the high load condition.

Table 1. Pearson's r scores listed below

Condition	**Power of Food Scale (PFS)**	**Dutch Eating Behavior Questionnaire (DEBQ) - Full**	**DEBQ Emotional Eating Sub-scale**	**DEBQ External Eating Sub-scale**	**DEBQ Restrained Eating Sub-scale**
Low Load RT (unhealthy food)	-0.187	-0.194	-0.208	-0.058	-0.116
Low Load RT (healthy food)	-0.081	-0.016	-0.013	0.086	-0.077
High Load RT (unhealthy food)	-0.126	-0.195	-0.163	-0.009	-0.213*
High Load RT (healthy food)	-0.056	-0.172	-0.156	0.057	-0.214*

*Significance lower than .05

Looking at food type preference (*Table 2*), the full DEBQ as well as the emotional eating subscale were significantly related. In addition, the external eating subscale was also significantly associated with food type preference.Indicating individuals that scores higher on the full DEBQ, emotional eating, and external eating subscale had higher preference for unhealthy food stimuli during both cognitive load condition.

Table 2. Pearson's r scores listed below

Condition	**Power of Food Scale (PFS)**	**Dutch Eating Behavior Questionnaire (DEBQ) - Full**	**DEBQ Emotional Eating Sub-scale**	**DEBQ External Eating Sub-scale**	**DEBQ Restrained Eating Sub-scale**
Low Load Accept (unhealthy food)	0.063	0.278*	0.261*	0.326**	0.056
Low Load Accept (healthy food)	0.027	0.115	.095	0.111	0.059
High Load Accept (unhealthy food)	0.175	0.29*	0.28*	0.333**	0.052
High Load Accept (healthy food)	-0.011	0.143	0.099	0.116	0.113

*Significance lower than .05
**Significance lower than .005

V. DISCUSSION

This study assessed the impact of cognitive load on decision making during food selection accounting for working memory capacity and hunger level. Individual differences for PFS and DEBQ scores also were assessed by comparing response time and food choicescores. Overall, participants showed a higher preference for unhealthy food stimuli, indicating our sample's preferences are comparable to the sample used by Van Dillen et al. (2013). As expected, participants in our sample performed better on the digit span task during the low-load conditions compared to the high-load condition, which is consistent with previous literature indicating the performance accuracy will be higher and response time faster for lower load tasks (Giofrè, et al., 2016; Alloway et al., 2009). Because these tasks are both used to assess working memory we expected to see a positive correlation between these two measures. Consistent with our hypothesis, results showed that participants with higher working memory, indicated by higher operation span scores, also had higher accuracy for the digit span tasks. This is supported by previous literature identifying both measures as appropriate assessments of working memory (Conway, A., Kane, M., Bunting, M., Hambrick, D., Wilhelm, O., & Engle, R.,2005; Weitz, O'Shea, Zook& Needham, 2011).

Contrary to what we hypothesized,there was no significant interaction between cognitive load and food type for food response time scores. Moreover,there was no significant main effect of cognitive load on food type. The direction of the means, however, were in the predicted direction. The lack of statistical significance was unexpected considering the findingsof Van Dillen et al. (2013), who did find a significant interaction for food response scores between the same cognitive load and food type conditions used in this study, as well asa main effect for cognitive load on food response time that we were unable to replicate. Because the original study published in 2013 is one of the only other studies to attempt to influence food choice using cognitive load (Van Beurden et al., 2016) it is difficult to determine why these results differed.

One study conducted by Zimmerman and Shimoga in 2014 attempted to assessed the impact of cognitive load (low load vs. high load) and advertising type (food advertisement vs. non-food advertisement) on food selection (snacks available during study break). Results showed that participants in the high load food advertisement group were significantly more likely to select unhealthy snack choices during the break after completing the manipulation task. Though food selection was not occurring in the same task as the cognitive load manipulation, the cognitive load task still had a significant impact on the food choice being made. In the 2013 study conducted by Van Dillen et al., the participants selected a snack at the end of the experiment and the participants snack choice was recorded. Results showed that participants that scored higher on the PFS were significantly more likely to select and unhealthy snack choice after completing the no load task compared to the high load task (Van Dillen et al., 2013). Another study conducted by Van Dillen and Andrade (2016) tested if blocking cognitive resources could regulate sensitivity to hedonic food cues. Using the PFS to measure hedonic food cue sensitivity, participants were first shown a menu to induce food craving and if they were in the experimental group were asked to perform a distractor task (solving a puzzle or playing tetris). Results showed that participants that scores high on the PFS reported stronger craving and were significantly more likely to select the unhealthy snack when offered after the experiment when no cognitive load distraction was given. Results also showed that for all participants in the cognitive load distraction condition regardless of PFS score were unresponsive to the high calorie snacks offered at the end of the experiment (Van Dillen et al., 2016). These conflicting results indicate more research should be done to assess the influence of cognitive load on food decision making to better identify the significance of this relationship.

When looking at differences in food choiceamong the four conditions results showed there was a significant main effect of food type. Specifically, regardless of cognitive load condition participants scored higher food choicefor unhealthy food compared to healthy food stimuli.Though the simple main effects were not significant for healthy and unhealthy food choice among conditions, *Figure 3* indicates that participants showed a decrease in preference for unhealthy food when engaging in high load trials. It is possible that we did not see a change in unhealthy food stimuli preference because the difficulty of the task was not high enough during the high load condition. Though Van Dillen et al.(2013) were able to find significance for the same high load task other studies have increased the difficulty of the digit span condition by having participants type out the digit span using a keyboard during recall (Zimmerman et al., 2014; Whitelock, Nouwen, van den Akker, & Higgs, 2018). In this case, it may be that some participants did not give full effort to the digit span task and simply chose to guess 1 of the 2 alternatives during the digit recognition task.

The study conducted by Ha et al. (2016) showed that when children were instructed to make healthy food choices during a food selection task, the participants had to exert greater cognitive effort and experienced longer response times when rejecting an unhealthy food compared to when they were selecting it. This study also found that children with higher BMIs rejected healthy foods more often than children with lower BMIs (Hat et al., 2016). Future studies should consider measuring for BMI, as this is something we did not account for in the current study. It is possible that participants in our study with higher BMI scores may have shown a higher preference for unhealthy food items during the dual task.

Looking at individual differences for the PFS and DEBQ, results showed that participants who scored high on the DEBQ restrainedeating subscale had significantly lower response times for both food conditions at high load. The DEBQ assesses motivation to eat and the restrainedeating subscale is associated with exerting self-control over the type and amount of food eaten(Van Strien, 2002; Lipsky et al., 2016; Mason et al., 2017; Wilson, Darling, Fahrenkamp, D'Auria, & Sato, 2015).Because exerting self-control can be difficult to maintain and cognitively taxing on its own (Van Dillen et al., 2015; Gillebaart et al., 2015; Tangney, Baumeister, & Boone, 2004), it is possible that the difficulty of the high load condition may have impeded the participant's ability to control their desire to select the food stimuli. This may have led to faster response timesfor individuals that were more likely to engage in restrained eating practices. Looking at food choicescores compared to the two individual difference measures and subscales (PFS & DEBQ), results showed that participants who scored higher on the DEBQ overall, and on the emotional eating and external eating subscales also showed higher preference for unhealthy food among both cognitive load conditions. Emotional eating occurs in response to emotional distress and tends to involve the consumption of foods that a low in nutritional value and high in calories (Lazarevich, Irigoyen Camacho, del Consuelo Velázquez-Alva, & Zepeda, 2016). If participants who are high on emotional eating are more likely to consume unhealthy foods as a means of coping, this may explain why we see high food choicescores for both cognitive load conditions for individuals that are more likely to experience emotional eating. Higher scores for external eating indicate higher susceptibility to external food cues (Schüz, et al., 2015; Lipsky et al., 2016; Mason et al., 2017), because the food stimuli can be considered an external food cue and unhealthy food is more tempting than the healthy food stimuli (Epstein et al., 2010) this may explain the relationship between these two scores.

There was no significant relationship for food response time or food choiceratings and PFS scores for any of the four conditions. These results are inconsistent with the results of Van Dillen et al. (2013) who found a three-way interaction between cognitive load, food type and PFS scores for their high load condition. To further analyze this interaction their study separated participants into two groups (low PFS and High PFS scores), participants that scored high on the PFS showed faster response time while categorizing healthy food compared to unhealthy food stimuli at low load and no significant difference in response time among stimuli at high load (Van Dillen et al., 2013). Participants that scores low for PFS showed no significant difference in response time to food stimuli at either cognitive load condition (Van Dillen et al., 2013).

It is important to note the possibility of Type I error occurring due to multiple bivariate correlations being conducted using the same dataset(Young & Westfall, 1993). Because the analyses was exploratory rather than confirmatory, type I error is not as serious a concern but an adjustment for multiplicity still could have been conducted (Young & Westfall, 1993). A common method of correction used is the Bonferroni correction. To perform a Bonferroni correction for Pearson's correlations the p-value (.05) need to be divided by the amount of comparisons being made during analysis

(Young & Westfall, 1993). To do this for the current sample the p-value would be divided by 40 resulting in a new p-value of $p<.00125$. If this correction had been implemented none of the correlations conducted would have come out significant. The Bonferroni correction is considered to be conservative and is not always recommended and there is some disagreement in the field for when it should or should not be used (Armstrong, 2014; Bender & Lange 1999).

Limitations

There were some limitations that need to be acknowledged when considering the present study. Because the participants from this study included undergraduates from a Texas University, this study has limited generalizability when considering other populations. Texas is ranked 6th highest in the nation for overweight obese adult state populations (Segal, Rayburn, & Martin, 2016). It is possible that results may differ for eating behavior and food choicein locations where individuals are more health.We did not ask participants to report stress or fatigue levels at any time during the experiment. These variables may have influenced participant's scores, particularly for the high load condition that required participants to exert a higher amount of cognitive effort. Participants were only able to give a binary response of "yes" or "no" to express their food preference when viewing the food images. Because of the limited response choices the data may not have been as accurate a representation of participants' food preference as a Likert scale measure would be. Moreover, food choicewas self-reported by participants. It is possible that the food participants report liking to eat is not representative of their actual food choices in everyday life. This also may have been influenced by a participant's ability to exert impulse control. Impulse control can vary from person to person and the ability to inhibit impulses may have influenced the food selection made during the dual task. Future studies should consider controlling for working memory capacity, it is possible the reason our results were inconsistent with previous findings is because other studies did not account for differences in working memory capacity among participants. Also, because this experiment was conducted in a lab and participants are responding to images of food on a screen the generalizability of these results to a real world setting is limited. Though Van Dillen et al. (2013) and Zimmerman et al. (2014) address this by including a snack choice component in their studies it would be beneficial to see how the cognitive load manipulation might impact eating behavior in daily practice as a form of intervention. Results may also differ if other demographics groups were assessed such as males or individuals from other age groups such as children or adolescents.

Conclusion

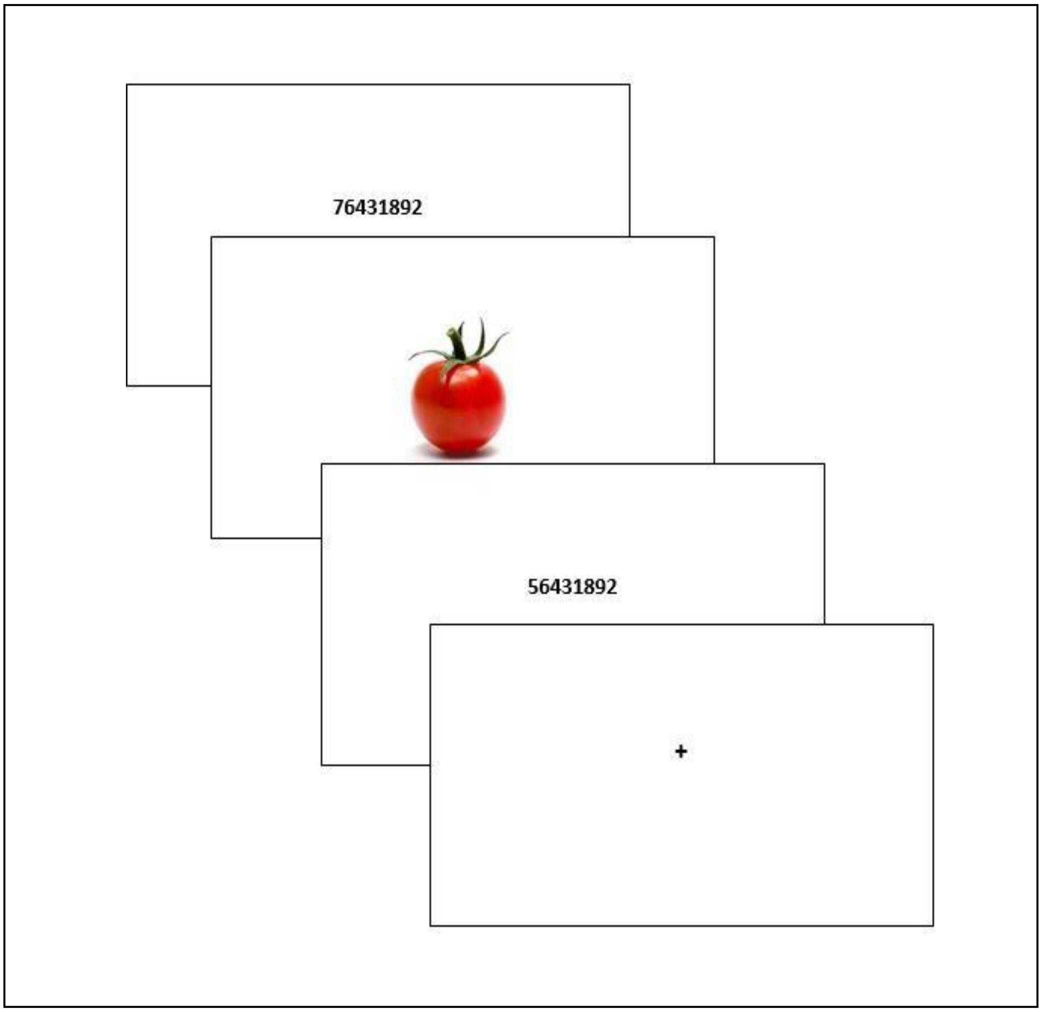
This study explored the impact of cognitive load on food selection by assessing the response time and preference towards food stimuli while under high and low cognitive load. Results indicated that regardless of cognitive load condition, food choice for unhealthy food was higher overall and though high load was able to reduce unhealthy food choice it was not to a significant degree. Correlational results showed that individuals who are sensitive to negative emotions and external food cues are more likely to select unhealthy food options. Additionally, individuals' that practice restrained eating are more likely to respond quickly to food stimuli while exerting high levels of cognitive effort possible due to the negative feeling brought on by the difficulty of the task.

Footnote

[1]A 2x2 within-subjects factorial ANCOVA was conducted to assess the impact of cognitive load and food type on response time to food stimuli. Inconsistent with our hypothesis, there was no significant interaction between cognitive load and food type (F [1, 88] = 3.52, p= .064). No significant main effects emerged for cognitive load (F [1, 88] = 2.06, p= .155) or food type (F [1,88] = .284, p= .595).

APPENDIX SECTION

Study Design



LITERATURE CITED

Abdullah, A., Wolfe, R., Stoelwinder, J. U., Courten, M. d., Stevenson, C., Walls, H. L., &Peeters, A. (2011). The number of years lived with obesity and the risk of all-cause and cause-specific mortality. *International Journal of Epidemiology, 40*(4), 985-996. doi:10.1093/ije/dyr018

Advertising Age, 2007. 100 leading national advertiser. In: Advertising Age (Ed.), 2007 Marketer Profiles Yearbook.

Alloway, T. P., Gathercole, S. E., Kirkwood, H., & Elliott, J. (2009). The cognitive and behavioral characteristics of children with low working memory. *Child Development*, *80*(2), 606-621. doi:10.1111/j.1467-8624.2009.01282.x

Armstrong, R. A. (2014). When to use the Bonferroni correction. *Ophthalmic & Physiological Optics*, *34*(5), 502-508. doi:10.1111/opo.12131

Bender, R., & Lange, S. (1999). Multiple test procedures other than Bonferroni’s deserve wider use. *BMJ : British Medical Journal*, *318*(7183), 600.

Boek, S., Bianco-Simeral, S., Chan, K., &Goto, K. (2012). Research Brief: Gender and race are significant determinants of students' food choices on a college campus. *Journal of Nutrition Education and Behavior*, *44*, 372-378. doi:10.1016/j.jneb.2011.12.007

Borland, R. (2014). *Understanding hard to maintain behaviour change: A dual process approach*.West Sussex, UK: Wiley & Sons.

Boyland, E. J., & Whalen, R. (2015). Food advertising to children and its effects on diet: Review of recent prevalence and impact data. *Pediatric Diabetes*, *16*(5), 331-337. doi:10.1111/pedi.12278

Bronfenbrenner, U. 1. (1986). Ecology of the family as a context for human development: research perspectives. *Developmental Psychology*, *22*723-742.

Cappelleri, J., C.,Bushmakin, A., G.,Gerber, R., A,Leidy N., K.,SextonC., C.,Karlsson, J.,Lowe, M., R., (2009). Evaluating the Power of Food Scale in obese subjects and a general sample of individuals: Development and measurement properties. *International Journal of Obesity*, *33*(8), 913-922. doi:10.1038/ijo.2009.107

Case, R., Kurland, M. D., & Goldberg, J. (1982). Operational efficiency and the growth of short-term memory span. *Journal of Experimental Child Psychology, 33,* 386-404.

Chambers, S., Lobb, A., Butler, L. T., &Traill, W. B. (2008). The influence of age and gender on food choice: a focus group exploration. *International Journal of Consumer Studies*, *32*(4), 356-365. doi:10.1111/j.1470-6431.2007.00642.

Conway, A., Kane, M., Bunting, M., Hambrick, D., Wilhelm, O., & Engle, R. (2005). Working memory span tasks: A methodological review and user's guide. *Psychonomic Bulletin & Review*, *12*(5), 769-786.

Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. *Journal of Verbal Learning & Verbal Behavior*, *19,* 450-466.

David, H. (2016). Response to: Another look at the Spearman's hypothesis and relationship between digit span and General Mental Ability. *Learning and Individual Differences*, *45*133-134. doi:10.1016/j.lindif.2016.01.010

Davison, K., & Birch, L. (2001). Childhood overweight: A contextual model and recommendations for future research. *Obesity Reviews*, *2*(3), 159-171.

DeMattia, L., & Denney, S. (2008). Childhood Obesity Prevention: Successful Community-Based Efforts. *The Annals of the American Academy of Political and Social Science*, *615*, 83-99.

Drewnowski, A., &Darmon, N. (2005). The economics of obesity: dietary energy density and energy cost. *The American Journal of Clinical Nutrition*, *82*(1 Suppl), 265S-273S.

Epstein, L. H., Salvy, S. J., Carr, K. A., Dearing, K. K., & Bickel, W. K. (2010). Food reinforcement, delay discounting and obesity. *Physiology & Behavior*, *100*(5), 438-445. doi:10.1016/j.physbeh.2010.04.029

Faber, R. J., Lee, M., & Nan, X. (2004). Advertising and the consumer information environment online. *The American Behavioral Scientist*, *48*(4), 447-466.

Farragher, T., Wang, W. C., &Worsley, A. (2016). The associations of vegetable consumption with food mavenism, personal values, food knowledge and demographic factors. *Appetite*, *97*29-36. doi:10.1016/j.appet.2015.11.005

Galotti, M. K. (2014). Fifth edition, *Cognitive Psychology: In and Out of the Laboratory*. California: SAGE Publications Inc.

Gillebaart, M., De Ridder, D., & Schneider, I. (2015). Effects of Trait Self-Control on Response Conflict About Healthy and Unhealthy Food. *Journal of Personality*, doi:10.1111/jopy.12219 Giofrè, D., Stoppa, E., Ferioli, P., Pezzuti, L., &Cornoldi, C. (2016). Forward and backward digit span difficulties in children with specific learning disorder. *Journal of Clinical And Experimental Neuropsychology*, *38*(4), 478-486. doi:10.1080/13803395.2015.1125454

Glanz, K., Hersey, J., Cates, S., Muth, M., Creel, D., Nicholls, J., & ... Zaripheh, S. (2012). Effect of a Nutrient Rich Foods Consumer Education Program: Results from the Nutrition Advice Study. *Journal of the Academy of Nutrition and Dietetics*, (1),

Ha, O., Bruce, A. S., Pruitt, S. W., Cherry, J. C., Smith, T. R., Burkart, D., & Lim, S. (2016). Healthy eating decisions require efficient dietary self-control in children: A mouse-tracking food decision study. *Appetite*, *105*575-581. doi:10.1016/j.appet.2016.06.027

Hall, P. A., & Fong, G. T. (2007). Temporal self-regulation theory; A model for individual health behavior. *Healthy Psychology Review, 1*, 6-52.

Harvey, J. R., & Ogden, D. E. (2014). Obesity treatment in disadvantaged population groups: where do we stand and what can we do? *Preventive Medicine*, *68*71-75. doi:10.1016/j.ypmed.2014.05.015

Heiman, A., &Lowengart, O. (2014). Calorie information effects on consumers' food choices: sources of observed gender heterogeneity. *Journal of Business Research*, *67*(5), 964-973. doi:10.1016/j.jbusres.2013.08.002

Hofmann, W., Deutsch, R., Lancaster, K., &Banaji, M. (2010). Cooling the heat of temptation: Mental self-control and the automatic evaluation of tempting stimuli. *European Journal Of Social Psychology*, *40*(1), 17-25.

Hofmann, W., Luhmann, M., Fischer, R. R., Vohs, K. D., &Baumeister, R. F. (2014). Yes, but are they happy? Effects of traitself-control on affective well-being and life satisfaction. *Journal of Personality*, 82, 265–277.

Karnani, A., Mcferran, B., &Mukhopadhyay, A. (2016). The Obesity Crisis as Market Failure: An Analysis of Systemic Causes and Corrective Mechanisms. *Journal Of The Association Of Consumer Research*, *1*(3), 445-470. doi:10.1086/686244

Karpinski, A., & Steinman, R. B. (2006). The single category implicit association test as a measure of implicit social cognition. Journal of Personality and Social Psychology, *91*, 16–32.

Kelly, B., Chapman, K, Halford, J., Boyland, E., Bautista-Castaño, I., Serra-Majem, L.,... Raine, K. (2010). Television food advertising to children: A global perspective. *American Journal of Public Health*, *100*(9), 1730-1736. doi:10.2105/AJPH.2009.179267

Laurent, J. S. (2015). Original Article: Psychometric properties for the Children's Power of Food Scale in a diverse sample of pre-adolescent youth. *Applied Nursing Research*, *28*, 127-131. doi:10.1016/j.apnr.2014.09.001

Lazarevich, I., Irigoyen Camacho, M. E., del Consuelo Velázquez-Alva, M., & Zepeda, M. Z. (2016). Relationship among obesity, depression, and emotional eating in young adults. *Appetite*, *107*639-644. doi:10.1016/j.appet.2016.09.011

Lipsky, L., Nansel, T., Haynie, D., Liu, D., Eisenberg, M., & Simons-Morton, B. (2015). Power of Food Scale in association with weight outcomes and dieting in a nationally representative cohort of U.S. young adults. *Appetite*, *105*, 385-391. doi:10.1016/j.appet.2016.06.012

Lourenco, S. F., & Longo, M. R. (2010). General Magnitude Representation in Human Infants. *Psychological Science*, (6). 873.

Lusk, J. L., &Briggeman, B. C. (2009). Food Values. *American Journal of Agricultural Economics*, *91*(1), 184-196. doi:10.1111/j.1467-8276.2008.01175.x

Machín, L., Giménez, A., Vidal, L., & Ares, G. (2014). Influence of context on motives underlying food choice. *Journal of Sensory Studies*, *29*(5), 313-324. doi:10.1111/joss.12107

Mai, R. r., Symmank, C. c., &Seeberg-Elverfeldt, B. (2016). Light and Pale Colors in Food Packaging: When Does This Package Cue Signal Superior Healthiness or Inferior Tastiness?. *Journal of Retailing, 92*(4), 426-444.

Mason, T. B., Pacanowski, C. R., Lavender, J. M., Crosby, R. D., Wonderlich, S. A., Engel, S. G., & ... Peterson, C. B. (2017). Evaluating the Ecological Validity of the Dutch Eating Behavior Questionnaire Among Obese Adults Using Ecological Momentary Assessment. *Assessment*, 1073191117719508. doi:10.1177/1073191117719508

Mitchell, T. B., Cushing, C. C., &Amaro, C. M. (2016). Psychometric properties of the Power of Food Scale in a community sample of preadolescents and adolescents. *Journal of Child and Family Studies*, *25*(9), 2733-2739. doi:10.1007/s10826-016-0444-3

Ogden, C. L., Carroll, M. D., Fryar, C. D., &Flegal, K. M. (2015). Prevalence of Obesity Among Adults and Youth: United States, 2011-2014. *NCHS Data Brief*, (219), 1-8.

Ogden, C. L., Carroll, M. D., Kit, B. K., &Flegal, K. M. (2012). Prevalence of obesity in the United States, 2009-2010. *NCHS Data Briefs*, (82)

Ogden, C.L., Lamb, M.M., Carroll, M.D., Flegal, K.M., (2010). Obesity and socioeconomic status in adults: United States 1988–1994 and 2005–2008. NCHS Data Brief No. 50 National Center for Health Statistics, Hyattsville, MD

RelayHealth. (2010). Fats in the Diet, Good and Bad: Recommendations for a Healthy Diet. *CRS - Senior Health Advisor*, 1.

Schneider, I. K., van Harreveld, F., Rotteveel, M., Topolinski, S., van der Pligt, J., Schwarz, N., &Koole, S. L. (2015). The path of ambivalence: Tracing the pull of opposing evaluations using mouse trajectories. *Frontiers in Psychology*, 6

Schüz, B., Schüz, N., & Ferguson, S. G. (2015). It's the power of food: individual differences in food cue responsiveness and snacking in everyday life. *International Journal ff Behavioral Nutrition and Physical Activity*, *12*(149)

Segal LM, Rayburn J, Martin A. (2016) The State of Obesity: Policies for a Healthier America 2015. *The Robert Wood Johnson Foundation and Trust for America's Health*; 1-144.

Sparrenberger, K., Friedrich, R. R., Schiffner, M. D., Schuch, I., & Wagner, M. B. (2015). Ultra-processed food consumption in children from a Basic Health Unit. *Jornal De Pediatria*, 91(6), 535-542.

Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of social behavior. *Personality and Social Psychology Review: An Official Journal of The Society for Personality and Social Psychology, Inc*, *8*(3), 220-247.

Sullivan, N., Hutcherson, C., Harris, A., & Rangel, A. (2015). Dietary self-control is related to the speed with which attributes of healthfulness and tastiness are processed. *Psychological Science*, 26(*2*), 122-134. http://dx.doi.org/10.1177/0956797614559543.

Sutherland, L. A., MacKenzie, T., Purvis, L. A., & Dalton, M. (2010). Prevalence of food and beverage brands in movies: 1996-2005. *Pediatrics*, *125*(3), 468-474. doi:10.1542/peds.2009-0857

doi:10.1016/j.jped.2015.01.007

Tangney, J.)., Boone, A.)., &Baumeister, R.). (2004). High Self-Control Predicts Good Adjustment, Less Pathology, Better Grades, and Interpersonal Success. *Journal of Personality*,*72*(2), 271-324.

Templeton, E. M., Stanton, M. V., &Zaki, J. (2016). Social Norms Shift Preferences for Healthy and Unhealthy Foods. *Plos ONE, 11*(11), 1-16. doi:10.1371/journal.pone.0166286

Turner, M. L., & Engle, R. W. (1989). Is working memory capacity task dependent? *Journal of Memory & Language, 28,* 127-154.

Van Beurden, S. B., Greaves, C. J., Smith, J. R., & Abraham, C. (2016). Techniques for modifying impulsive processes associated with unhealthy eating: A systematic review. *Health Psychology, 35*(8), 793-806. doi:10.1037/hea0000337

Van Dillen, L. F., & Andrade, J. (2016). Derailing the streetcar named desire. Cognitive distractions reduce individual differences in cravings and unhealthy snacking in response to palatable food. *Appetite, 96,* 102-110. doi:10.1016/j.appet.2015.09.013

Van Dillen, L., Papies, E., & Hofmann, W.(2013). Turning a blind eye to temptation: How cognitive load can facilitate self-regulation. *Journal of Personality and Social Psychology*, *104*(3), 427-443. doi:10.1037/a0031262

Van Strien, T., Frijters, J. R., Bergers, G. A., &Defares, P. B. (1986). The Dutch Eating Behavior Questionnaire (DEBQ) for assessment of restrained, emotional, and external eating behavior. *The International Journal of Eating Disorders (Print)*, (2), 295.

Van Strien, T. (2002). DEBQ. Dutch Eating Behavior Questionnaire. Thames Valley Test Company: Bury St Edmunds.

Wechsler, D. (2003). WISC–IV technical and interpretivemanual. San Antonio, TX: The Psychological Association

Weitz, D., O'Shea, G., Zook, N., & Needham, W. (2011). Working memory and sequence learning in the hebb digits task: Awareness is predicted by individual differences in operation span. *American Journal of Psychology*, *124*(1), 49-62.

Westfall, P. H. (1993). *Resampling-based multiple testing: examples and methods for p-value adjustment*. Hoboken, NJ: Wiley-Interscience

Whitelock, V., Nouwen, A., van den Akker, O., & Higgs, S. (2018). The role of working memory sub-components in food choice and dieting success. *Appetite*, *124*24-32. doi:10.1016/j.appet.2017.05.043

Wilhelm, O., Hildebrandt, A., &Oberauer., K., (2013). What is working memory capacity, and how can we measure it? *Frontiers in Psychology*, *4*, 1-22. doi:10.3389/fpsyg.2013.00433/full

Wilson, S. M., Darling, K. E., Fahrenkamp, A. J., D'Auria, A. L., & Sato, A. F. (2015). Predictors of Emotional Eating During Adolescents' Transition to College: Does Body Mass Index Moderate the Association Between Stress and Emotional Eating? *Journal of American College Health*, *63*(3), 163-170. doi:10.1080/07448481.2014.1003374

Young, C. & Page, A. (2014). A Model for Predicting Advertising Quality as a Key to Driving Sales Growth. *Journal of Advertising Research*, *54*(4), 393-397.

Zimmerman, F. J., &Shimoga, S. V. (2014). The effects of food advertising and cognitive load on food choices. *BMC Public Health*, *14*(1), 1-18. doi:10.1186/1471-2458-14-342