A Brief Intervention to Reduce Sugar Consumption on College Campuses

by

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Background: Research suggests that high sugar consumption is linked to a variety of health complications, including cardiovascular disease and diabetes. Previous research also suggests that adolescents and young adults (ages 16-19) are the highest consumers of sugar and SSB's. Previous interventions featuring either psychoeducation, implementation intentions, and corrected perceptions of peer sugar consumption (norms) have been successful in helping various populations engage in more healthful behaviors. Additionally, data from earlier research on a 90-minute sugar reduction workshop with college students appeared to reduce sugar consumption at a follow up. This study sought to determine the effectiveness of this intervention with the use of a control group.

Methods: One hundred and twenty-six undergraduates were randomly assigned to either a control group or a group designed to receive the intervention to reduce their sugar consumption. The study also set out to measure the impact of factors thought to moderate (health literacy, health orientation, and hedonic hunger) the impact of the intervention and mediate (health literacy, corrected perceived peer sugar consumption) the impact of the intervention. Participants completed measures of sugar consumption at baseline and at one-month follow up.

Results: There were no significant differences between the intervention group and the control group with regards to sugar or SSB consumption at one-month follow-up. There was a trend towards reduced SSB consumption in both the intervention and control groups. Health literacy was positively associated with overall daily sugar intake at baseline and was positively associated with study completion. Attrition was high (42%) and was related to the use of a peer versus a graduate student facilitator and lower health literacy scores at baseline. Meditation and moderation were unable to be determined given the lack of intervention effect. Perceptions of peer sugar consumption were significantly and positively related to participant's own SSB consumption, but not overall sugar consumption. Overall, this sample tended to *underestimate* the levels of peer sugar consumption and reported significantly less overall sugar consumption than previous samples.

Discussion: Participants in the current sample appeared to consume less sugar than nationally representative age-matched samples from 10 years ago. Selection and cohort effects are discussed. It is possible that individuals are consuming less sugar than in the previous decade, and this may be due to increased awareness and understanding of the effects of sugar consumption. Future research should further examine the health impacts of these potential reductions, as well as assess the current needs of college students based on up-to-date health behavior data.

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Doctor of Philosophy in Health Psychology

By

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DEDICATION

This dissertation is dedicated to my grandfather, William Miller. I have been inspired by tales of his curiosity and intellect with regards to the world around him. I hope to embody that same spirit in my own academic pursuits. I also would like to dedicate this dissertation to my parents, who have provided unyielding love and support throughout my academic journey. None of this would have been possible without them.

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CHAPTER I: INTRODUCTION

Sugar consumption has increased dramatically within the United States over the course of the past 100 years (Barnard, 2010; Gortner, 1975). Currently, the highest consumers of sugar tend to be college aged males followed closely by college-aged females (Marriott, Cole & Lee, 2009). These high consumption rates are concerning given that research has found that high levels of sugar consumption have been related to the development of weight gain, diabetes, cardiovascular disease, as well as renal and hepatic dysfunction (Tappy & Le, 2015). Given this knowledge, there have been numerous efforts to reduce sugar consumption in child (Ames, Wurpts, Pike, MacKinnon, Reynlds & Stacy, 2016), young adult (Rosas et al., 2017) and rural underserved (Zoellner et al., 2016) populations. These interventions have proven to be successful at reducing sugar consumption. Nevertheless, many of these interventions are time intensive and costly. One intervention that has shown early promise is a one-day, 90-minute workshop directed towards college students known as Sugar Busters (Taylor et al., 2015). Early research has demonstrated that this intervention was successful in reducing sugar consumption at one-week follow up in a small sample of undergraduates. This study seeks to extend these findings by comparing Sugar Busters to a wait list control group, extending the follow-up time to one month and seeks to explore moderational (health literacy, health orientation, and hedonic hunger) and mediational factors (changes in health literacy and corrections in perceptions of peer sugar consumption) that influence intervention effectiveness. This study will also seek to add personal normative feedback as a component of the Sugar Busters intervention.

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CHAPTER II: LITERATURE REVIEW

Sugar Consumption and National Trends

Sugar and fructose consumption in particular have seen a large increase in the United States over the course of the 20th century (Barnard, 2010; Gortner, 1975; Marriott et al., 2009). One early study examining these patterns using United States Department of Agriculture data [USDA] from 1909 to 1973 show overall decreases in the consumption of starch and fiber, increases in fat consumption, and marked increases in per capita sugar consumption (Gortner, 1975). Furthermore, more recent data from food availability surveys suggest that sugar consumption has continued to increase across the latter portions of the 20th century from 1970 to 2007 going from 54.1 kg/person per year to 62.0 kg/person per year (Barnard, 2010). While sugar derived from corn increased from 7.2 kg/person per year in 1970 to 33.1 kg/person per year in 2007, the amount of sugar derived from cane and beet decreased from 46.3 kg/person per year to 28.2 kg/person per year over the same time period (Barnard, 2010), yielding a more modest overall net increase in sugar consumption. While food availability data does not account for food lost to waste and may overestimate population level consumption (Barnard, 2010), it does provide a rough general estimate that can be compared across time and provides insight into overall dietary trends at a national level. Interestingly, studies such as Gortner (1975) and Barnard (2010) both analyze nutritional data to explain the increased presence of specific diseases related to either malnutrition or excess caloric consumption and its relationship to chronic illness and obesity. In later sections, I will address these specific relationships.

In another examination of specific trends in fructose consumption, Marriott et al. (2009) used data from both the nationally representative Nationwide Food Consumption Study [NFCS] of 30,770 participants assessed between 1977-1978 and the USDA's nationally representative National Health and Nutrition Examination Surveys [NHANES] of 25,165 participants assessed between 1999-2004 (Marriott et al., 2009). Marriott et al. (2009) specifically, were interested in examining overall sugar consumption, as well as a components analysis of sugar consumption, attempting to estimate the portion of sugar that constitutes added sugar, as opposed to sugars naturally occurring in fruits, vegetables, dairy products and nuts. Findings indicated that overall consumption of sweetener amongst the American public increased from about 151 g/day per person in 1973 to 176 g/day per person in 2003, constituting a 16.6% increase overall. Results also showed that sugar consumption peaked in 1999, with the average American adult consuming roughly 188 g/day of sugar, gradually declining to 175.6 g/day in 2003. Authors also noticed a stark shift from roughly 1975 onward in which there was a rapid expansion in the amount of sweetener derived from High Fructose Corn Syrup (HFCS), which constitutes a variety of sugar that can be found as HFCS-42, which is 42% glucose, 58% sucrose fructose and HFCS-55, which is 55% fructose, 42% glucose and 3% comprised of other sugars. Data from the US Economic Research service published by Putnam and Allshouse (1999) indicate that that there was a steady shift towards using HFCS-55. While 100% of all HFCS consumed in 1970 was HFCS-42, by 1999 only 38% HFCS-42 was being consumed with the rest (62%) being HFCS-55 (Putnam & Allshouse, 1999). The 32.7% decline in sucrose consumption from 1978 to 2003 coincides with a 60.8% increase in HFCS consumption during these years (Marriott et al., 2009). This finding also fits with data from Barnard (2010) and suggests that there were modest increases in overall sugar consumption from the 1970's to the early 2000's, with consumption peaks occurring in the late 1990's. Furthermore, this data also fits with suggestions that the majority of the increase in fructose consumption is likely driven by an increase in consumption of sugar sweetened beverages, as discussed later, which tends to favor HFCS over sucrose (Bleich, Wang, Wang & Gortmaker, 2008; Marriott et al., 2009). Finally, this data also indicates that the source and variety of sugar has changed as well, with increases in added sugars, particularly sugar derived from corn (Marriott et al., 2009). Indeed, there has been quite a great deal of speculation that the increases in sugar, and fructose consumption, coincide with the increasing prevalence of cardiorenal, cardiovascular and metabolic disease over the course of the 20th century within the United States (Johnson et al., 2007). For example, Johnson et al. (2007) indicate that the rates of chronic disease, such as diabetes and cardiovascular disease is higher among populations of individuals that also are disproportionately high in the consumption of SSB's. Additionally, Bray, Nielson and Popkin (2004) suggest that this net increase in HFCS consumption is a significant contributing factor to the current obesity epidemic in the United States.

One specific area of research within sugar consumption trends has been that of Sugar Sweetened Beverage (SSB) consumption (Bleich et al., 2008). This is likely because there have been notable increases in SSB consumption in the latter portions of the 20th century. Unfortunately, Popkin (2010) examined data from the USDA and found that SSB consumption was not officially tracked until 1970. Nevertheless, Popkin (2010) found an increase in SSB consumption from 87.4 kcal per day for children in

1977-1978 to 153.7 kcal per day in 2005-2006. Popkin (2010) found similar trends for adults going from 64.4 kcal per day in 1977-1978 to 141.7 kcal per day in 2005-2006. Interestingly, Popkin (2010) considered SSB's to be soda and fruit drinks and did not consider juices to be SSBs, even though they contain as much or more sugar per serving as most SSBs. Not surprisingly, SSB's have been found to constitute significant portions of individual energy consumption. Specifically, past research has indicated amounts as high as 10-15% of daily calories in youth (Wang, Bleich & Gortmaker, 2008) and about 7% of daily calories in adult samples (Kit, Fakhouri, Park, Nielson & Ogden, 2013).

It is encouraging that SSB consumption has demonstrated a modest decline from 1999-2010. Specifically, Kit et al. (2013) looked at NHANES data collected from 1999-2010 and found a 68-calorie reduction for children aged 2-19 over that 10 years and a 45-calorie reduction for adults over the age of 20. That said, there were still a large portion of average daily energy intake that was accounted for by the consumption of SSB's, 8% for children 2-19 and 6.9% for adults (Kit et al, 2013). Additionally, there is some evidence that these decreases in overall energy consumption from SSB's may be having some positive effects on population health. Data from a prospective study using NHANES datasets from 1999-2000 to 2009-2010 with over 62,160 representative US citizens found that along with reductions in SSB consumption, there were also significant improvements in markers for cardiovascular health, such as improvements in HDL to LDL ratios, fasting blood glucose levels and C-Reactive Protein levels (Hert, Fisk, Rhee & Brunt, 2014). Similarly, Hert et al., 2014 found that these trends in key biomarkers existed for those individuals consuming less than 20% of their overall daily calories from SSB and these improvements were not observed in individuals consuming more than 20% of their daily calories from SSB's (Hert et al., 2014).

Current Heavy Consumers – Adolescence and College Students. It is well known through a variety of epidemiological and cross-sectional studies that adolescents and college-aged men and women consume the largest portions of caloric sweeteners amongst any age group in the United States. Specifically, Marriott et al. (2009) found that men aged 15-18 and 19-22 had the highest consumption rates of fructose intake at around 75 g/day. Furthermore, among women, the highest consumers were 19-22-year-olds, averaging 61 g/day, followed by young women aged 15-18 with about 55 g/day (Marriott et al., 2009). Studies looking at the dietary components of college students also corroborate these findings, suggesting that college student sugar consumption can range from 15-25% of total daily caloric intake (Ervin & Ogden, 2013; Hirschberg, Fernandes, Melanson, Dwiggins, Diamond & Lofgren, 2011). Other research with adolescents and emerging adults has indicated that on average, men consume about 1 SSB per day and young women consume about .7 SSB per day, and higher levels of SSB intake have been related to adolescent weight gain and increased body fat percentage (Laska, Murray, Lytle & Harnack, 2012a).

Health Impact of Sugar Consumption

Considerable research has found a positive association between sugar consumption and weight gain as well as increased risk of cardiovascular, metabolic, hepatic and renal dysfunction later in life (Tappy & Le, 2015). This evidence tends to be even more pronounced when examining the impact of SSB consumption (Tappy & Le, 2015). Specifically, recent reviews and meta-analyses examining epidemiological, controlled feeding and prospective studies have consistently related high levels of sugar consumption to increased weight gain in children and adolescents (Malik et al., 2013), as well as in adults (Malik et al., 2006), as well as the increased incidence or risk of Type 2 Diabetes (Hu & Malik, 2011; Imamura et al., 2015; Malik, Popkin, Bray, Despres, Willett & Hu, 2010; Xi et al., 2014), hypertension (Jayalath et al., 2015), chronic kidney disease (Cheungpasitporn, Thongprayoon, O'Corragain, Edmonds, Kittanamongkolchai & Erickson, 2014) and cardiovascular disease (Huang, Huang, Tian, Yang & Gu, 2014; Te Morenga, Howatson, Jones & Mann, 2014). Overall the empirical support linking high levels of SSB and overall sugar consumption to negative health outcomes are robust, notable, and concerning. They are outlined in greater detail below.

Epidemiological and Cross-Sectional Studies

Weight Gain. Overweight and obesity remain one of the most expansive health problems in the United States today, with 33.8% of adults considered to be obese and 68% of adults considered to be either overweight or obese (Flegal, Carroll, Ogden & Curtin, 2010). Overweight and obesity are large contributing factors to national healthcare costs, costing an estimated $190 billion in 2005 alone (Cawley & Meyerhoefer, 2012; Withrow & Alter, 2010). Furthermore, the incidence of overweight and obesity have been pathophysiologically linked to other health conditions, including cardiovascular (Poirier et al., 2006), metabolic (de Ferranti & Mozaffarian, 2008) and other chronic diseases (Ma et al., 2015). What's more, abdominal adiposity seems to be a large contributing factor to overall national weight gain (Ford, Li, Zhao & Tsai, 2011) and this is concerning, given the health risks conferred by excess abdominal adiposity (de Ferranti & Mozaffarian, 2008).

While obesity is seen as being a combination of complex interactions between genetic, epigenetic, environmental, behavioral, endocrine, biological and neurological factors and there remains significant gaps in the literature addressing some of these more complex biological factors (Schwartz et al., 2017), it is clear that environmental factors play a prominent role. Similarly, there is significant evidence that current lifestyle interventions can be effective in facilitating weight loss and reducing both systolic and diastolic blood pressure and rates and severity of metabolic diseases such as Type II Diabetes (Galani & Schneider, 2007; Hartmann-Boyce, Johns, Jebb & Aveyard, 2014; Norris et al., 2004; Schwartz et al., 2017).

Increased sugar consumption is likely to be an important environmental factor associated with weight gain and obesity. Sugar consumption is associated with weight gain in both adolescents (Malik et al., 2006) and adults (Malik et al., 2013). Specifically, Malik et al. (2006) conducted a systematic review examining 15 cross-sectional, 10 prospective and 5 experimental studies from 1966 to 2005 examining the relationship between adult and child SSB consumption and weight gain. Authors found that among 13 cross-sectional studies examining the relationship between child SSB consumption and BMI, six found a significant positive relationship, 3 trended towards a positive association, 3 studies found no relationship and one was inconclusive. Malik et al. (2006) also found that the two studies examining adult obesity and SSB consumption demonstrated significant relationships. One study found that rates of obesity were roughly 1.5-2 times higher in age matched individuals that drank more than one soda per week (Liebman et al., 2003). Malik et al. (2006) also examined 6 prospective cohort studies with youth and adolescents. Four of the six studies in children found significant associations between high levels of SSB consumption and overweight or obesity at follow-up, with one study examining 11,654 children finding a .04 increase in BMI per year per daily SSB serving, and an increase of .14 BMI per year per 2 SSB servings for boys and a .10 increase in BMI per year per two daily servings of SSB's in girls (Berkey, Rockett, Field, Gillman & Colditz, 2004). Additionally, Laska et al (2012) also found that SSB consumption was related to adolescent weight gain and an increase in body fat percentage. Specifically, amongst a sample of 693 Minnesota adolescents, one serving of SSB's per day was related to a .7% increase in body fat percentage per year at 2 year follow up (Laska et al., 2012). Additionally, in a sample of 2,596 middle aged adults, SSB consumption was linked to higher levels of overall fat mass, as well as a higher ratio of visceral adipose tissue to subcutaneous adipose tissue relative to individuals that did not regularly consume SSB's (Ma et al., 2014).

In yet another meta-analytic study, Vartanian, Schwartz and Brownell (2007) examined 88 studies examining soft drink consumption, overall energy intake, body weight, other nutrient intake, as well as health outcomes. Of 12 cross sectional studies examining energy intake and soft drink consumption, 10 found a positive relationship, with a small effect size of r=.13. Perhaps more interestingly, among 5 longitudinal studies, all 5 showed positive associations between soft drink consumption and energy intake with a moderate effect size of r=.24. Among four long term studies with follow-ups between 3 and 10 weeks, all four showed a positive association between soft drink consumption and daily energy intake, with one study suggesting that participants who consumed soft drinks consumed 17% more daily calories than those who did not (DiMeglio & Mattes, 2002). Overall, Vartanian et al. (2007) speculated that it is likely that SSB consumption may contribute to weight gain by adding excess calories that are not compensated for by the drinker. Results demonstrating weight gain are less definitive as only 2 of 11 cross sectional studies finding positive associations. That said, an additional 4 cross sectional studies demonstrated risk of becoming overweight or obese among soda drinkers and another 2 studies revealed increased body fat, but not necessarily BMI. Overall, while Vartanian et al. (2007) found a weak association between soda consumption and weight gain within cross sectional studies, longitudinal studies revealed a significant albeit weak effect of r=.09 for soft drink consumption on weight gain.

Diabetes. The development of Type II Diabetes Mellitus is another complication that has been tied to excessive sugar consumption ((Hu & Malik, 2011; Imamura et al., 2015; Malik, et al., 2010; Xi et al., 2014). This is concerning as diabetes is a serious health condition that can lead to numerous peripheral vascular, cardiovascular and renal dysfunction and was associated with $245 billion in health care costs in 2012 alone (American Diabetes Association [ADA], 2013). Diabetes is a health condition marked by chronically high levels of hemoglobin A1c, which is a conduit measure of average blood glucose levels across the previous three months (Laville & Nazare, 2009). Specifically, individuals have been considered as having diabetes when they evidence HbA1c of above 6.5%, which equates to average blood glucose levels above 126 mg/dL (Menke, Casagrande, Geiss & Cowie, 2015; Selvin, Parrinello, Sacks & Coresh, 2014). Additionally, individuals have been considered pre-diabetic if they evidence HbA1c levels of 5.7-6.4% (Menke et al., 2015). Using data from the National Health and Nutrition Examination Survey, Selvin et al. (2014) examined 15,578 participants from NHANES III from 1988-1994, 12,726 from NHANES 1999-2004 and 15,135 from NHANES 2005-2010 and compared rates of both diabetes, prediabetes, and the proportion of diabetes that had been undiagnosed between these three nationally representative cohorts. Results indicated that rates of diabetes went from 6.2% prevalence in 1988-1994 to 8.8% prevalence from 1999-2004 and 9.9% prevalence from 2005-2010. Furthermore, amongst this subset of individuals diagnosed with diabetes, average HbA1c levels also rose from 7.3% from 1988-1994, 9.1% from 1999-2004 and 10.9% from 2005-2010. Once more, prevalence rates of prediabetes also increased with 5.8% from 1988-1994, 11.9% from 1999-2004 and 12.4% from 2005-2010 (Selvin et al., 2014). A recent paper using NHANES data found that rates of diabetes in the US continue to climb, finding a prevalence rate of 12-14% of US adults, with higher rates among African American, Asian and Hispanic populations (Menke et al., 2015).

Interestingly, many individuals have tied this increased prevalence of diabetes to high population levels of fructose consumption. Specifically, O'Conner, Imamura, Lentjes, Khaw, Wareham and Forohi (2015) found that SSB consumption alone was associated with increased risk (HR 1.2 per beverage per day) of Type II Diabetes in a prospective study of 25,639 adults in the United Kingdom. The authors concluded that reducing SSB consumption to less than 2% of overall energy intake may result in as much as a 15% decrease in the incidence of Type II diabetes (O'Connor et al., 2015). Additionally, in a large meta-analysis of 19 cross-sectional epidemiological studies, Imamura et al. (2015) found similar results, even with adjustment for adiposity and other related risk factors. Aggregated analysis indicated that one SSB serving per day can increase the incidence of Type II Diabetes by 28%. Interestingly, Imamura et al. (2015) also separated SSB's from traditional fruit juices and found that one serving of fruit juice also increased incidence of Type II Diabetes by 10%.

The mechanism behind the incidence of diabetes and SSB and sugar consumption is complicated and much remains to be discovered. That said, there do seem to be consistent experimental relationships with pancreatic dysfunction, insulin resistance, and the onset of diabetes. Laville and Nazare (2009) wrote a review of extent literature that elucidated some of the mechanisms that may be involved and link excess fructose consumption to pancreatic beta cell dysfunction, subsequent alterations in lipid metabolism and lipogenesis as well as pancreatic beta cell dysfunction, insulin resistance and thus the onset of prediabetes and eventually diabetes and related cardiovascular, neuropathic and renal dysfunction related to chronic hypertension (Laville & Nazare, 2009). Fructose in particular has come under immense scrutiny as it relates to insulin resistance and the onset of diabetes. Specifically, there has been accumulated evidence from animal and human models demonstrating that fructose ingestion does not produce the same effects on insulin as glucose and sucrose, and therefore does not produce as much of a leptin response (Elliot, Keim, Stern, Teff & Havel, 2002). Indeed, fructose does seem to stimulate differential metabolic processes, especially in the liver, and is not cleared out of blood stream at the same rate as sucrose (Elliot et al., 2002; Laville & Nazare, 2009). Further, consumption of fructose has increased along with the incidence of diabetes since the 1970's (Marriott et al., 2009; Menke et al., 2015; Selvin et al., 2014).

Taken together, epidemiological studies suggest that there is a positive association between fructose and SSB consumption and the incidence of diabetes and prediabetes.

Cardiovascular Disease. Another area of concern related to high levels of SSB and fructose consumption is the onset of risk factors for cardiovascular disease (Xi et al., 2015). This is notable, as cardiovascular related diseases cause roughly 800,000 deaths per year in the United States (Roger et al., 2011), and account for nearly $273 billion in direct care costs and $444 billion in total cost, including lost productivity (Heidenreich et al., 2011).

Indeed, there is active conjecture in the research literature that SSB consumption may be related to cardiovascular risk factors such as hypertension independent of weight gain (Shay & Dennison-Farris, 2013). In in a landmark study among 810 adults participating in a behavioral nutrition modification study, Shen et al. (2010) found that reductions in 1 SSB per day over 18 months lead to a 1.8 mm Hg reduction in systolic and a 1.1 mm Hg diastolic blood pressure. Importantly, these results remained significant after adjusting for weight loss. In another large prospective study of 42,883 male health professionals in the United States, Koning, Malik, Kellogg, Rimm, Willett and Hu (2012) found that men in the top quartile of SSB consumption had a 20% higher relative risk of developing Coronary Heart Disease at 22-year follow-up. In a similar analysis of 42,400 Swedish men aged 45-79, Rahman, Wolk and Larsson (2015) found that individuals that consumed more than 2 servings of SSB's per day, were 23% more likely to experience heart failure by 11-year follow-up. Finally, Xi et al., 2015 conducted a meta-analysis examining 6 prospective studies looking at the relationship between the onset of hypertension and SSB consumption, 4 prospective studies examining the impact of SSB consumption on Coronary Heart Disease, and another 4 studies examining the relationship between SSB consumption and stroke risk published between 2007 and 2014. Authors found that there was an 8% increase in the risk of hypertension for every SSB consumed. Furthermore, they also found a 17% increase in risk of coronary heart disease per SSB serving per day, and no association between SSB consumption and risk of stroke (Xi et al., 2015).

Chronic Kidney Disease and Hepatic Dysfunction. In addition to Type 2 Diabetes, weight gain and cardiovascular disease, there is evidence that high levels of consuming sugar sweetened beverages are also related to the development of non-alcoholic fatty liver disease (NAFLD) (Abid, Taha, Nseir, Farah, Grosovski & Assy, 20009; Ma et al., 2015) as well as chronic kidney disease (CKD) (Cheungpasitporn, Thongprayoon, O'Corragain, Edmonds, Kittanamongkolchai & Erickson, 2014; Yuzbashian, Asghari, Mirmiran & Azizi, 2016).

More specifically, Abid et al. (2009) conducted a study with 31 middle aged patients with NAFLD and compared them to 30 age and gender matched controls. Eighty percent of participants with NAFLD consumed more than 500 ml of SSBs per day compared to 17% of health controls. Additionally, participants in the NAFLD group also consumed roughly 5 times the amount of beverage calories compared to age and gender matched controls. Finally, it was found that NAFLD occurred independent of metabolic syndrome (Abid et al., 2009).

Epidemiological evidence also suggests an association between consumption of SSBs and NAFLD. For instance, Ma et al. (2015) examined the soft drink consumption and alanine transaminase concentrations (a biomarker of NAFLD) in 2,634 participants taking part in the Framingham Heart Study. Amongst participants that consumed greater than one serving of SSB per day, there was a 1.61 odds ratio of having alanine transaminase concentrations suggestive of NAFLD (Ma et al., 2015).

Studies have also linked the consumption of SSB's and high levels of fructose consumption to CKD. For instance, Yuzbashian et al. (2016) examined the relationship between SSB consumption and CKD in a longitudinal prospective design with 2,382 participants older than 27. Results indicated that participants who consumed more than 4 SSBs per week were 1.96 times more likely to have a diagnosis of CKD at 3-year follow-up relative to participants consuming less than .5 SSB per week. For soda specifically, participants consuming more than 4 regular sodas per week were 2.45 times more likely to evidence CKD at 3-year follow-up relative to participants consuming less than .5 regular sodas per week. Evidence from meta-analytic studies also demonstrate the relationship between SSB and overall sugar consumption and the development of CKD. For example, Cheungpasitporn et al. (2014) examined five studies published prior to 2014 looking at the relationship between SSBs and the development of CKD. They found a 1.58 pooled risk ratio for participants consuming SSBs relative to those not consuming SSBs.

Controlled Feeding and Experimental Studies.

While prospective cohort and cross sectional epidemiological studies provide strong evidence for the association between sugar consumption, weight gain and health problems, experimental and controlled feeding studies may begin to elucidate some of the mechanisms of these effects, while controlling for additional variance that can be problematic when looking at large datasets (Tappy & Le, 2015). Some of these mechanisms may be related to a failure to compensate for calories taken in the form of SSB's through either reductions in satiety cues (Sherrer et al., 2016), or due to cognitive distortions related to the way products are marketed, such as perceiving a high-sugar beverage to be healthy and subsequently failing to account for these calories (Mandel & Brannon, 2017). These cognitive distortions may be an especially important relative to fruit juices that share the perception of being universally healthy. Regardless, there is good evidence that consumption of SSB's seems to be related to weight gain and other health impacts due to excess caloric consumption (DeallaValle, Roe & Rolls, 2005; Gombi-Vaca et al., 2016; Vartanian et al., 2007).

Sherrer et al. (2016) examined the impact of habitual SSB consumption in adolescents on perceptions of fullness and satiety, as well as blood concentrations of ghrelin, an important hormone thought to be released to stimulate feelings of satiety during an ad libitum standardized meal. They found that participants consuming less than 1 SSB per day reported greater feelings of satiety. Furthermore, they found that participants consuming greater than 1 SSB per day also had lower levels of ghrelin circulating 30 minutes post meal relative to participants consuming less than 1 SSB per day (Sherrer et al., 2016). In addition to habitual SSB consumption, acute consumption of SSBs may also influence the amount of energy consumed during a meal. For instance, using a within-subjects design, DellaValle et al. (2005) brought 44 female subjects into a laboratory to consume an ad libitum lunch for 6 straight weeks. Women consumed either nothing, water, diet cola, regular cola, orange juice or 1% milk prior to consuming lunch. When participants consumed beverages containing sugar (regular cola, orange juice or milk), they consumed 104 calories more during the meal on average with no differences in perceived satiety. Importantly, the average caloric content of the beverages were 156 calories. So technically, while participants consuming SSBs consumed less food overall during the ad libitum meal, they did not fully account for all the calories that they consumed via the beverage, supporting the idea that people may not account for beverage calories the same way we might with solid foods (DellaValle et al., 2005).

Finally, there may be additional cognitive distortions that contribute to excess caloric intake after consuming SSBs. For instance, Mandel and Brannon (2017) conducted a two-part study examining the impact of consuming a high sugar or low sugar protein shake, as well as how perceptions of healthfulness related to consumption of subsequently presented ad libitum snacks. In study one, 76 participants were randomized to consume a high or low sugar protein shake. There were no differences in perceptions related to the healthfulness of the shake. That said, participants who were given the high sugar shake consumed 5.4 more grams of potato chips during the ad libitum snacking period. In the second portion of the two-part study, Mandel and Brannon ran a 2x2 study in which the factors were high sugar versus low sugar protein shakes and a label that read healthy versus indulgent. Results showed an interaction effect such that participants who consumed the high sugar shake labelled healthy consumed 3.3 grams more potato chips than those consuming the low sugar healthy labeled shake. To contrast that, participants consuming the high sugar shake labeled indulgent consumed about 3.2 grams less ad libitum potato chips than participants consuming the indulgent low sugar shake. This may reflect an interaction between perceived sweetness and indulgence, especially when primed to do so. Specifically, Mandel and Brannon (2017) speculate that the presence of sugar naturally stimulates biologically based distortions in experienced satiety cues to calories consumed and thus leads to higher caloric intake subsequent to ingestion of a sugary substance relative to other nutrients of similar caloric content. That said, they also state that participant perceptions of healthfulness of the shake acted as a moderator in study 2. They hypothesize that people utilize post-oral or more cognitive cues when perceiving the shake as indulgent as opposed to healthy, and thus compensated for it during the ad-libitum snacking experiment. Finally, Gombi-Vaca et al. (2015) examined the effects of SSB consumption on food intake amongst 34,003 Brazilian citizens participating in the 2008-2009 National Dietary Survey. The authors found that individuals consuming SSBs during the day consumed roughly 400 more calories per day than those individuals not reporting any consumption of SSBs. The authors then used multilevel modelling to detect the specific differences in consumed calories during meals absent SSB calories. Only 42% of SSB calories from breakfast were compensated for, 0% compensation for calories at lunch and 0-22% compensation for calories at dinner. This suggests that excess weight gain from SSB consumption is likely due to a lack of change in meal sizes relative to those who do not consume SSBs, and this subsequently contributes to excess energy intake among those individuals that regularly consume SSBs (Gombi-Vaca et al., 2015). More evidence from Anton et al. (2010) also indicates that individuals do not possess natural mechanisms that allow them to compensate for calories from sugar in beverages. Specifically, Anton et al. (2010) used a within subject design with 19 normal weight (BMI=20-25) and 12 obese (BMI=30-40) individuals to consume a preload pre meal beverage containing sucrose, aspartame or stevia before consuming an ad libitum meal. Participants consumed statistically equivalent calories in all three conditions, despite the fact that the sucrose loaded beverage contained roughly 200 more calories than the aspartame or stevia loaded beverage. This led to statistically significant differences in total calories consumed, such that participants consumed significantly more calories when fed the sucrose containing pre-load (Anoton et al., 2010).

Taken together, acute, as well as habitual SSB consumption seems to lead to higher levels of energy consumption in laboratory-based studies (Anton et al., 2010; DellaVella et al., 2005; Mandel & Brannon, 2017; Sherrer et al., 2016) and statistically controlled observational studies (Gombi-Vaca et al., 2015). This dynamic over time may contribute to excess weight gain that is subsequently related to the development of metabolic, cardiovascular, pancreatic, renal and hepatic dysfunction.

Psychosocial Factors Related to Sugar Consumption

Due to the negative health impact related to excessive sugar consumption (Malik et al., 2013; Tappy & Le, 2015), there have been many investigations into psychosocial factors that may contribute to high levels of sugar consumption. These factors range from attitudes and preferences of consumers, including readiness to make changes (Block, Gillman, Linakis & Goldman, 2013; Graham & Laska, 2012; Huffman & West,2007) to the built environment (Byrd-Bredbenner et al., 2012; Nelson & Story, 2009) and individual differences in hedonic hunger (Lowe et al., 2009), health literacy (Dingman, Schulz, Wyrick, Bibeau & Gupta, 2014), health orientation (Dutta-Bergman, 2009), and norm perceptions.

Attitudes and Preferences. Qualitative data from Block et al. (2013) may elucidate some of the specific perceptions and values of college students that lead to high consumption rates of SSB's. Specifically, they assembled 12 focus groups with 90 students at 6 colleges in Louisiana and Massachusetts. Several important themes emerged. First, there appeared to be a "health halo" regarding fruit juice, which may account for the high caloric intake from fruit juice in college men and women found by other researchers attempting to quantify the amount of SSBs that are generally consumed in a college population such as Smith West et al. (2006). Specifically, Smith West et al. (2006) found that undergraduate men reported consuming an average of 267 calories/day in fruit juices and 187 calories/day in soda among college men. In women, Smith West et al. (2006) found similar patterns with college women reporting that they consume an average of 241 calories/day from fruit drinks and 150 calories/day from soda. Secondly, Block et al. (2013) found that students saw water as being solely for hydration, which is not seen as a primary factor in drink selection for the majority of their focus group-based sample. Finally, and perhaps most importantly, price and taste were the most important factors relating to decisions regarding beverage consumption with 93% of the sample reporting taste as being important and 58% of the sample reporting price is important. Conversely, only 30% of participants reported that they consider the caloric content of beverages. Further, college students who value healthy eating are more likely to read nutrition labels and reading labels is associated with consumed more servings of fruits and vegetables, less added sugar and less fast food (Graham & Laska, 2012). Furthermore, label reading mediated the relationship between dietary attitudes (importance of healthy eating) and overall diet quality.

In addition to self-reported dietary attitudes and consumption of SSB's, research has also examined readiness to change as an indicator for intention to reduce overall SSB intake. Huffman and West (2007) examined readiness to reduce SSB intake in a sample of 201 students at a southern university. Participants were asked to indicate their readiness to change from pre-contemplation "*I have not thought about decreasing the amount of regular soft drinks and other high calorie, high sugar beverage that I drink."* (Huffman & West, 2007, pg.11) to contemplation/planning "*I have thought about decreasing the amount of regular soft drinks and other high calorie, high sugar beverage that I drink, but I have not yet taken any action to make this change. I plan to make this change in the next 3 months"* to action "*I have thought about decreasing the amount of regular soft drinks and other high calorie, high sugar beverages that I drink and am currently beginning to take action to make this change*" and finally to maintenance, "*I have made a change to decrease the amount of regular soft drinks and other high calorie, high sugar beverages that I drink and I have been following this change for at least six months*" (Huffman & West, 2007, pg.11). Researchers then took responses to the readiness to change question and correlated them with SSB intake, knowledge of the risks of sugar, and BMI. Thirty-four percent of the sample was in the action stage, 35% of the sample was in maintenance, 17% in the contemplation stage, and 13% were in pre-contemplation. Students in the action and maintenance phase reported consuming about 7.6 SSB's per week (SSB's defined as a serving of 12 ounces of a SSB). Students in the contemplation and pre-contemplation group reported consuming 10.4 and 12.6 SSB's per week respectively. All groups significantly differed from one and other in SSB consumption. Additionally, students in the action, maintenance and contemplation stages demonstrated significantly more knowledge of the risks of consuming SSB's. Women demonstrated greater nutritional knowledge than males across the groups and were more likely to be in action or maintenance stages compared to males. Additionally, Caucasian students were also disproportionately represented in the action and maintenance stages (75% compared with 54%). Notably, even students in action and maintenance phase reported consuming more than one SSB per day, indicating that they might continue to benefit from reducing SSB consumption, despite having taken action to reduce SSB consumption already. These individuals may be the most amenable to interventions designed to provide actionable ways to do so.

Built Environment. One factor potentially making it more difficult for students to reduce SSB consumption and influencing overall sugar consumption behaviors is the food environments often encountered on college campuses in the United States. This may explain why living off campus appears to be a protective factor on weight gain for first year university students (Vella-Zarb & Elgar, 2010). On average, college students appear to be exposed to campus food environments in which a vast variety of sugary convenience snacks and sugar sweetened beverages are widely available. For instance, Byrd-Bredbenner et al. (2012) conducted a study examining the contents of 1,650 beverage and 2,607 snack vending machines at 11 post-secondary institutions in the American South, Midwest and Northeast. Results indicated that nearly 58% percent of drinks in beverage vending machines were sugar sweetened beverages (soda, juice, energy drinks and sports drinks). Similarly, nearly 50% of snacks in vending machines featured snacks that were high in sugar (candy, cookies, pastries, fruit snacks, granola and cereal bars). More recent research using electronic monitoring of 61 vending machines on college campuses added further corroboration to this literature, indicating that roughly 95% of snacks and 49% of drinks in vending machines confer less healthy options according to the Australian Guide to Healthy Eating (AGHE) (Grech, Hebden, Roy & Allman-Farinelli, 2017). Additionally, Grech et al. (2017) found that there was a strong correlation between availability and purchases, indicating that students tend to purchase what is available to them.

Other research also points to a poor dietary environment for college students. For instance, there is evidence that college students also have large quantities of snack and convenience food in their dormitories. Specifically, Nelson and Story (2009) examined the food contents in the dorm rooms of 100 students at a large Midwestern university. The average dorm room featured 47 food items totaling 22,888 calories. More specifically, 71% of rooms contained SSB's, 75% of rooms contained candy or deserts of some kind, 23% contained some kind of juice and 78% of rooms contained breakfast cereal or granola bars. Furthermore, roughly half of these items were purchased by the students themselves with the other half purchased by their parents. That said, students purchased more candy and deserts than their parents did as well as more cereal or granola bars. Notably, parents purchased more fruits and vegetables than their college children did (Nelson & Story, 2009).

Additionally, students face barriers to healthy eating within campus dining institutions as well (Horacek et al., 2013). It is common that campus dining halls do not display specific nutrition information and feature an all-you-can eat environment. Furthermore, campus convenience stores and student unions feature advantageous pricing for foods and snacks that are high in sugar or sodium relative to other healthier options (Horacek et al., 2013). This is notable given that price is a commonly cited barrier to healthy eating among college populations (Block et al., 2013).

Health Literacy. Another important factor impacting sugar consumption is health literacy. There have been many different measures of health literacy over the past 25 years as well as a shift towards a more comprehensive definition. Health literacy can be broadly defined as functional literacy (able to read and write), basic numeracy, factual or procedural knowledge, awareness and affective and attitudinal components that mediate the successful navigation of both the preventative, secondary and territory health domains (Frisch, Camerini, Diviani & Schulz, 2011). The US Department of Health and Human Services [USDHS] defines health literacy similarly, stating that health literacy is the degree to which an individual has the capacity to obtain, process and comprehend information that directly contributes to one's ability to make optimal decisions related to one's health (USDHS, 2000).

Health literacy has been related to higher levels of sugar consumption. Specifically, Zoellner et al. (2011) conducted a cross-sectional study with 376 rural residents living in the lower Mississippi delta. The majority of the sample was African American and earned less than $20,000 per year. Zoellner et al. (2011) used the Newest Vital Sign (Weiss et al., 2005) as a measure of health literacy and compared scores on this measure to a 158-item food frequency questionnaire. Authors found that health literacy was inversely associated with SSB intake, explaining 15% of the total variance in SSB consumption while controlling for other factors. In a broader sample of 3,926 adults from the representative 2010 Health Styles Survey, Park, Onufrak, Sherry, and Blanck (2014) found that roughly 31% of adults consumed at least one SSB per day with 20% consuming 2 or more per day. While 80% of participants agreed that SSB consumption could lead to weight gain, 80% of the sample also was unaware of the caloric content of a 24 oz. fountain drink. Furthermore, Park et al. (2014) also found that those drinking soda 2 or more times per day were more 1.6 times more likely to disagree that SSB consumption could contribute to weight gain. Additionally, it appears that those that are low in health literacy may be more susceptible to media marketing campaigns for SSB’s. For example, Chen, Porter, Estabrooks and Zoellner (2014) conducted a study in which they categorized 224 individuals based on health literacy as defined by scores on the Newest Vital Sign (NVS). Those individuals who scored below a 4 on the NVS (likely low health literacy) were less likely to think that health information was omitted or pick up on marketing strategies from subsequently viewed soda advertisements relative to those who scored higher than a 4 (Chen et al., 2014). In practical purposes this means that individuals with lower health literacy are more likely to believe the validity of advertising and marketing claims related to the nutrition of a product and were less likely to feel as if any information has been omitted. Thus, those who score low in health literacy not only consume more SSB’s, but also may be more influenced by advertisements and marketing campaigns designed to increase consumption of SSB’s.

That said, individuals low in health literacy may benefit most from educational interventions and the use of alternative labelling techniques to help them make more nutritional decisions. For instance, Ellison, Lusk and Davis (2013) conducted a study examining the interaction of health literacy with nutrition labels and with nutrition labels augmented with stop-light guides for specific restaurant items within a campus restaurant. They used a 3-item measure of health literacy. Participants were also asked whether they try to monitor the calories they consume on a daily basis, to what extent they attempt to avoid high levels of fat in their diet, and whether or not they spend time looking at nutrition labels. Ellison, Lusk, and Davis (2013) found that students that were lower in health literacy were more likely to order lower calorie, more nutritious meals when presented calorie counts in addition to stop-light guide augmentation. They found no effect for nutrition labels or augmentation with the stop light guide for students that were in the medium to high ranges of health literacy. These findings suggest that educational approaches and menu labelling may be more effective for those individuals that are low in health literacy within a college population.

Thus, health literacy appears to be predictive of overall sugar consumption, especially when it comes to SSB's (Park et al., 2014; Zoellner et al., 2011). Furthermore, individuals that are low in health literacy are also more susceptible to advertisements and marketing campaigns designed to promote SSB consumption (Chen et al., 2014). However, individuals that are low in health literacy may also be the most responsive to basic interventions designed to increase their awareness of specific health or nutrition information (Ellison et al., 2013). Thus, it seems to be important for individuals to possess or be taught basic computational and literacy skills related to label reading and calorie counting in order to facilitate the consumption of a healthy diet. Along with this functional knowledge, it may also be important to consider the extent to which an individual identifies themselves as a healthy or health-oriented person.

Health Orientation or Health Consciousness. Health orientation is a construct that refers to the extent to which an individual identifies themselves as a healthy person and strives to make healthy decisions in their day-to-day life. There is a paucity of research connecting health orientation to sugar consumption specifically. Nevertheless, health orientation has been related to many different domains of health behavior, such as nutrition (Baiocchi-Wagner & Talley, 2012; Hwang & Cranage, 2015; Wang, Worsely & Cunningham, 2008), condom use (Stegar et al., 2015) as well as general tendencies to search for health related information (Dutta-Bergman, 2005). For instance, Dutta-Bergman (2005) was interested in the extent to which health consciousness mediated relationships between interpersonal communication styles and community participation and willingness to seek out health related information outside of their doctor's office on their own. Dutta-Bergman (2005) found significant associations with health consciousness and willingness to seek out health information autonomously, community participation, newspaper and magazine readership and internet usage. Most importantly, health consciousness mediated the relationship between community participation, newspaper and magazine readership and willingness to seek out health information autonomously. This suggests an individual's concern about their health drives an individual's willingness to seek out health information autonomously from a variety of sources. Additionally, Stegar, Fitch-Martin, Donnelly, and Rickard (2015) were interested in the relationship between health orientation, meaning in life, and alcohol and condom use behaviors. After conducting an exploratory factor analysis on a 27-item novel measure of health orientation a 2-factor solution emerged: 1) a Proactive Health Orientation factor and a 2) Heath Information Discounting factor. The

Proactive Health Orientation factor reflects the extent to which participants watch what they eat, are self-reliant in their day-to-day health, confident that they understand what is in the best interests of their health, and the overall importance of their physical health to achieving a happy and meaningful life. Conversely, the Health Information Discounting factor reflects the extent to which students find health guidelines too restrictive, do not think it is important to watch what one eats, and do not need to listen to health advice from medical professionals. Results indicated that health orientation mediated the relationship between self-reported condom use and meaning in life in the 571 undergraduate student sample, suggesting that those who evidence greater life satisfaction may engage in protective health behavior through the mechanism of valuing their health (Stegar et al., 2015).

More closely related to food and sugar consumption, other research has demonstrated relationships between dietary decision making and health orientation. For instance, in a sample of 175 undergraduates, Hwang and Cranage examined college student perceptions of the healthfulness of popular menu items from fast food restaurants based on their reported health consciousness and nutritional knowledge. Hwang and Cranage (2015) found that college students high in health consciousness and nutritional knowledge were significantly more critical of fast food menu items from popular fast food restaurants than those scoring low in health consciousness in a sample or roughly 1,300 college students. In a similar study, Wang et al. (2008) examined the relationship between ideological beliefs, health behaviors, heath attitudes and food consumption in a sample of 410 Australian adults. Wang et al. (2008) found that perceptions of the importance of health behaviors was positively related to fruit and vegetable consumption. Finally, Baiocchi-Wagner and Talley (2013) found health orientation was associated with communication about diet and exercise in the home (Baiocchi-Wagner & Talley, 2013). Baiocchi-Wagner and Talley (2013) found that health orientation was related to health behaviors operationalized as a combination of consuming less dietary fat, less fast food and more fruit and vegetable intake, as well as engaging in high levels of moderate or vigorous physical activity at r=.58.

Although there has not been a direct study linking sugar consumption to health orientation, it is plausible that those that care about what they eat, and strive to make nutritious dietary decisions would be less likely to consume high amounts of sugar, and may be more amenable to dietary intervention. Previous literature has shown that a positive relationship between health orientation and health behaviors exist in other significant health domains (Stegar et al., 2015) and has shown to be predictive of specific dietary behaviors or attitudes as well (Baiocchi-Wagner & Talley, 2013; Hwang & Cranage, 2015; Wang et al., 2008).

Norm Perception*.* Another potentially important factor related to individual sugar consumption is the perception of peer behavior or social norms regarding sugar consumption. Briefly, norms can be broken down into descriptive or injunctive norms. Descriptive norms are defined as an individual's perception of the quantity or frequency of a specified behavior, in this case sugar consumption. Injunctive norms refer to an individuals' perceptions of attitudes related to specific behaviors. Research looking at descriptive social norms has found that individuals overestimate the sugar consumption of their peers (Lally, Bartle & Wardle, 2011; Perkins, Perkins & Craig, 2010), as well as overestimate the extent to which their peers possess favorable attitudes towards sugar consumption (Lally et al., 2011) and these perceptions are positively correlated with individual sugar consumption (Robinson, Otten & Hermans, 2016). Furthermore, much of this research has examined young adult and adolescent perceived social norms (Lally et al., 2011; Perkins et al., 2010; Robinson et al., 2016). Overall, this research demonstrates that individuals' perceptions of what their peers are doing in terms of sugar consumption is an important predictor in individuals' own consumption patterns.

Studies assessing social norms typically ask participants to estimate how much of a specific food item their peers are eating. This number is then taken and compared to median or mean self-reported intake of specific food items. For instance, Lally et al., (2011) examined 264 secondary students in the UK between the ages of 16-19 years by asking them to estimate the total portions of snacks, SSBs, fruits and vegetables (descriptive norms) and then compared these to the median intake of each of these food items. They also inquired about attitudes related to consuming these products as well as perceptions of peer attitudes (injunctive norms). Results were such that participants overestimated the intake of peer snacks by 1.8 portions per week as well as overestimated peer consumption of SSBs by 5.2 portions per week. Furthermore, participants also overestimated peer favorability of consuming these foods. In contrast, participants underestimated peer consumption of fruits and vegetables by 3.2 portions per week. Additionally, peer descriptive norm perception around consumption of SSBs and unhealthy snacks explained 17% and 22% of the variance in self-reported consumption of these items (Lally et al., 2011). In a similar study, Perkins et al., (2010) looked at descriptive norms of SSB consumption specifically in a sample of 3,831 6th through 12th grade students and compared these to self-reported SSB consumption levels. Most of the sample (76%) overestimated consumption levels of their peers, and perhaps more alarmingly, 24% of participants rated their peer consumption to be at 3 or more SSBs per day. Furthermore, Perkins et al. (2010) also found that perceived descriptive norms were more predictive of personal consumption relative to utilizing actual descriptive consumption data based on grade level. These findings have been replicated amongst young adults as well. Specifically, Robinson et al. (2016) examined consumption of SSBs and sweet pastries as well as perceived social acceptance (injunctive norms) surrounding the consumption of these products amongst 1,056 young adults in the United Kingdom. They found that frequency of consumption of both of these products were significantly and positively related to perceptions of injunctive norms regarding the acceptability of the consumption of these foods (Robinson et al., 2016).

Finally, research has also demonstrated that providing a correction to perceived descriptive norms (or indirect corrections of perceived injunctive norms) may be successful in reducing sugar consumption overall. For instance, a review of 15 empirical experimental studies examining norm correction, or personalized normative feedback (PNF) on specific dietary behaviors found that social norm manipulations seem to consistently produce moderate effects on actual consumption patterns (Robinson, Thomas, Aveyard & Higgs, 2014). Thus, it seems reasonable to assume that perceived descriptive and injunctive norms have an influence on one's consumption behaviors and that manipulating these perceptions by providing lower or more accurate information may be a promising component of an intervention aimed at changing dietary behavior, in this case reducing sugar intake in college students.

Hedonic Hunger. A final construct plausibly associated with sugar consumption is hedonic hunger. Hedonic hunger or non-homeostatic hunger reflects an individual's tendency in a variety of food related settings (food not-present, food present, during eating) towards cravings of particularly palatable food, preoccupation with particularly palatable food and behavioral responses to particularly palatable food (Mela, 2006). Importantly hedonic hunger captures the extent to which an individual eats for pleasure as opposed to eating to satisfy nutritional needs. Individuals high in hedonic hunger have been found to consume higher amounts of dietary fat (Hunt, Nespola, Tapper & Kagee, 2016), tend to gain weight faster than those that score lower in hedonic hunger, despite a higher likelihood of engaging in dieting behaviors (Lipsky, Nansel, Haynie, Liu, Eisenberg & Morton, 2016), and have difficulty resisting temptations of palatable food when present (Forman, Hoffman, McGrath, Herbert, Brandsma & Lowe, 2007).

In some cases, sugar consumption has also been tied to hedonic hunger. For instance, Naughton, McCarthy and McCarthy (2015) conducted a study examining the impact of habit and hedonic hunger on sugar consumption in a sample of 500 Irish adults. They found that habit, as indicated by confirming statements such as "I would find it difficult to not eat sugar foods" (Naughton et al., 2015, pg. 174) and hedonic hunger to be related to sugar consumption. In a mediational analysis, they found that habit mediated the relationship between hedonic hunger and sugar consumption. This may indicate that those scoring higher in hedonic hunger are more likely to be consuming sugary foods more often than those lower in hedonic hunger. Implications of this research suggest that those high in hedonic hunger are likely to be consuming more sugar and may find it more difficult to make changes to reduce their sugar consumption.

Interventions to Reduce Sugar Consumption

Given the negative health impacts related to high levels of sugar consumption, there has been a concerted effort to produce interventions designed to reduce the intake of SSBs, as well as sugar in general in various populations (Ames et al., 2016; Avery, Bostock & McCullough, 2014; Ebbeling et al., 2012; Hedrick, Davy, You, Porter, Estabrooks & Zoellner, 2017; Rosas et al., 2017; Smith & Holloman, 2014; van de Gaar, Jansen, van Grieken, Borsboom, Kremers & Raat, 2014; Zoellner et al., 2016). Notably, many of these interventions have been conducted amongst adolescents (Ames et al., 2016; Ebbeling et al., 2012; Smith & Holloman, 2014) and young adults (Hedrick et al., 2017; Rosas et al., 2017; Zoellner et al., 2016). They have also featured brief, one contact interventions (Ames et al., 2016; Smith & Holloman, 2014) as well as extended interventions lasting up to a year (Ebbeling et al., 2012; Hedrick et al., 2017; Rosas et al., 2017; Zoellner et al., 2016).

Long term interventions to reduce sugar consumption have been shown to be effective both directly after an intervention and at follow-up. For instance, a landmark study by Ebbeling et al. (2012) randomly assigned 224 adolescents with overweight or obesity who regularly consumed SSBs to either a one-year multi-faceted intervention or a contact control group. The intervention featured an emphasis on replacing SSBs with non-caloric alternatives, such as diet beverages or water by providing participants with a year's supply of these alternatives. Additionally, interventionists would also conduct monthly 30-minute phone calls as well as three in-person check in visits within participants' homes. Participants from both the control group, as well as the intervention group were then followed for one-year post intervention and were assessed for changes in BMI and SSB consumption. Overall, the intervention group showed significant within-group reductions in SSB consumption directly post intervention, as well as at one-year follow up. Furthermore, the intervention group also reported consuming less SSB's relative to the control group at post intervention and one year follow up. Importantly, participants in the intervention group also reduced their overall sugar intake, going from an average of 133 grams per day at baseline to 57 grams per day post intervention to 71 grams per day at one-year follow-up (Ebbeling et al., 2012). Other longer-term studies have been conducted with adults. For instance, Zoellner et al. (2016) piloted an intervention they called SIP*smart*ER randomizing 296 participants to the intervention or physical activity control group in a rural and medically underserved area of Virginia. Outcomes were changes in BMI, as well as SSB consumption following the intervention. SIP*smarter*ER was a six-month long intervention that was designed to reduce SSB consumption to under 8 ounces per day. Primary modalities of this intervention included psychoeducation around SSB consumption and information about alternative beverages through 3, 90-120-minute interactive group classes, one live teach-back phone call towards the end of the intervention and 11 interactive voice response calls. At the end of 6 months, participants in the SIP*smart*ER trial decreased their SSB consumption from an average of 43 ounces per day to an average of 24 ounces per day, while participants in the physical activity control condition reduced their SSB consumption from an average of 33 ounces per day to 28 ounces per day. This represents a significant treatment effect favoring the SIP*smarter*ER intervention over the physical activity intervention (Zoellner et al., 2016). Similar research examining this RCT found that participants in the SIP*smart*ER group also made spontaneous and beneficial changes to their diets as well, such as increasing the amounts of fruits and vegetables they consumed, as well as reducing other sugary, empty calorie snacks relative to the physical activity control group (Hedrick et al., 2017).

In a different intervention that promoted increasing water consumption rather than decreasing SSB consumption, van de Gaar et al. (2014) studied the impact of a water promotion program amongst 4 elementary schools and 1,288 children in grades 2-7 from an underserved immigrant population in the Netherlands. They compared a water promotion condition to a treatment as usual control (regularly provided health education). The water campaign involved installing new drinking fountains as well as an educational emphasis on consuming more water. Outcome measures included SSB consumption at one-year post intervention. Results indicated that the water promotion campaign was successful in reducing the consumption of SSBs from an average of 2.7 servings per day to 2.3 servings per day at one-year follow-up, while the control group went from 3.1 servings of SSBs per day to 2.9 servings. This constituted a statistically significant albeit small difference in reductions favoring the intervention group. Importantly, these results were attained by simply promoting water, which in theory displaced the amount of SSBs individuals in the intervention group consumed regularly (van de Gaar et al., 2014).

In addition to long-term environmental change interventions, brief interventions have also shown efficacy in reducing overall sugar intake as well. For instance, Ames et al. (2016) conducted a study with 168 adolescents that possessed self-reported impulse control issues around consuming SSBs. Participants were randomized to one of three conditions that featured response inhibition training (go no-go task), as well as completing implementation intentions. The groups were as follows 1) Homework specific (control) implementation intention with a drink specific go no-go task training, 2) A drink specific implementation intention with a homework specific go no-go task and 3) A drink specific implementation intention with a drink specific go no-go task. Participants were then placed in an ad-libitum SSB consumption experiment whereby they were told to wait 10 minutes while experimenters prepared the next part of the study and were observed in a waiting room with different selections of SSBs and water available to them. Ames observed and recorded the amount of specific liquids that each participant drank. Results indicated that groups that featured the drink specific implementation intentions were more effective relative to control implementation intentions regarding homework in reducing the number of calories and sugar consumed during the ad libitum observation of SSB consumption. It was also determined that training participants in a go no-go task was less effective, as participants who were randomized to the drink specific go no-go task performed equally as well as participants assigned to the control condition featuring a homework specific go no-go task. That said, participants receiving both the drink specific implementation intentions as well as the drink specific go no-go task consumed significantly less sugar than groups that featured a control intervention (homework specific go no-go or homework specific implementation intention). Furthermore, participants that received both drink-specific interventions were more likely to make an option to consume a healthy drink (water or zero calories) relative to those who featured any portion of the homework-specific implementation intentions or go no-go task (Ames et al., 2016). In sum, Ames et al. (2016) demonstrated that a brief behavioral intervention aimed at increasing inhibitory control of SSB consumption can have impacts on subsequent behavior, even if the results of this study were indeed short-term.

Yet another short-term, yet multi-faceted intervention was conducted by Rosas et al. (2017). Specifically, Rosas et al. (2017) conducted an intervention designed to raise behavioral intentions to reduce sugar-sweetened beverage (SSB) consumption as well as to reduce SSB consumption among 143 college students (86% female) from the University of California San Marcos participating for intro psychology course credit. Specifically, Rosas and colleagues (2017) were interested in exploring a brief intervention that utilized corrections to social norms, psychoeducation around the risks of consuming SSBs and a self-affirmation of values and strengths component. Participants were run individually through a 3x2 randomization procedure. Specifically, participants were randomized to one of three social norms and risk conditions (control vs. social norms adjustment OR psychoeducation of risks vs. social norms adjustment AND psychoeducation regarding risk) and one of two conditions regarding self-affirmations (self-affirmation vs control). Experimenters were specifically interested in assessing participant's perceptions of subjective norms of their social circle (expectations of friends and family's support of reducing SSB consumption), injunctive norms (peers' perception of what individuals should do regarding SSB consumption), and descriptive norms (peers' behaviors regarding SSB consumption). They then would intervene on these by providing actual data of injunctive and descriptive norms specifically. Experimenters were interested in these constructs given research suggesting that adolescents and college students typically hold misperceptions regarding higher perceived acceptability and frequency of consumption of SSBs among their peers (Lally, Bartle & Wardle, 2011; Perkins, Perkins & Craig, 2010; Perkins, Perkins & Craig, 2015). They were also interested in adding a self-affirmation element to reduce reactance and increase receptivity to information regarding norms and risks.

Results from the intervention indicated that participants who received the risk information were more accurate in their assessment of health risks regarding SSB consumption, including estimates of energy density (time spent jogging to burn off SSB calories), quantities of sugar in SSBs (in teaspoons), and SSB's association with weight gain than those who received the control. Additionally, Rosas et al. (2017) found that those in the social norms condition were 3 to 4 standard deviations higher in their estimates of how many of their peers attempted to avoid high levels of SSB consumption relative to those who did not receive social norms feedback. Furthermore, participants receiving social norms feedback also were three quarters of a standard deviation higher in their perceptions of their peers' perceptions of SSB consumption risks. Participants receiving social norms feedback also reported higher levels of support from their friends for reducing their own SSB consumption (subjective norms). The affirmation activity by itself did not appear to have a significant impact on participant intentions to reduce SSB consumption. That said, participants who received both risk information and participated in the affirmation tasks were nearly a half a standard deviation unit higher in their intentions to reduce SSB consumption relative to those that received risk information alone.

Rosas et al. (2017) also conducted a follow-up study to examine the overall efficacy of their intervention versus a control group. In this investigation, they augmented both information conditions with a behavioral task involving estimating the sugar of specific beverages by using sugar cubes. They randomized 149 participants from UC San Marcos using a 4x2 design. Specifically, there were 4 information conditions (no information vs. SSB risk information vs. social norms information vs SSB risks and social norms information) and 2 self-affirmation conditions (self-affirmation versus control). This time participants came into a lab that was decorated as if a party had just occurred, with beverages sitting on a table. Participants were led into the lab and either completed the self-affirmation task (if they were randomized) or did not. They then would be given content regarding their specific information assignment. Following completion of the test battery (assessing perceptions of norms and intentions), participants were given the opportunity to grab a beverage of their choice without the experimenter in the room (water, tea, soda, diet soda, sports drinks and energy drinks were available). Finally, a two-week follow-up phone call with a 24-hour beverage recall was completed, though participants were not aware that this would occur. While there were no differences between receiving information about risks versus norms or receiving both norms and risk information in intentions, participants who received any kind of information reported half a standard deviation higher in their perceptions of SSB risk and intentions to reduce their own levels of SSB consumption. There were no effects on intentions regarding self-affirmations. Behaviorally, participants who were exposed to both risks and norms were significantly less likely to take a soda from the lab than those participants that received no information on risks or norms. Furthermore, participants who received both social normative information and risk information were the least likely to take a soda.

Results from Rosas et al. (2017) indicate that both normative and risk information are sufficient to alter behavioral intentions as well as behaviors regarding SSB consumption in college students. There seem to be marginal impacts regarding self-affirmations. While this study provides valuable insight into the feasibility and potential effective mechanisms of an intervention designed to reduce SSB consumption, it did not target additional sources of sugar frequently found on college campuses, and did not control for selection effects, such as overall motivation for health, previous SSB consumption patterns from adolescence and childhood or information regarding the built environment (vending machines, soda fountains etc.) that may contribute to differences in SSB consumption and intentions to reduce SSB consumption.

There has also been research on longer term outcomes with regards to SSB consumption using a briefer intervention model. For example, Beck, Fernandez, Rojina and Cabana (2017) randomized 82 Hispanic parents of children ages 6 months to 5 years at the Zuckerberg San Francisco General Hospital to a short educational module about SSBs or a module providing education on another health topic. Participants were then followed and provided the estimated frequency and quantity of SSB consumption in their children at 2 weeks, 2 months and 3 months. Participants in the SSB education intervention reduced their children's SSB consumption from 31 oz at baseline to 12.4 oz at 2 weeks to 6.9 ounces at 2 months and 11.4 ounces at 3 months. Participants in the control condition reported that their children consumed 40 ounces of SSBs at baseline, 38.8 ounces at 2 weeks, 23.1 ounces at 2 months and 21.3 at 3 months. These numbers reflected statistically significant differences between the control group and the intervention group at 2-week as well as at 2- and 3-month follow-up (Beck et al., 2017).

Thus, it is conceivable to think that a short-term intervention may produce long term effects on SSB and indeed overall sugar consumption.

While there have been extensive and effective interventions designed at reducing SSB and sugar consumption amongst children and adolescents (Ames et al., 2016; Ebbeling et al., 2012; Smith & Holloman, 2014; van de Gaar et al., 2014;) and adults (Hedrick et al., 2017; Rosas et al., 2017; Zoellner et al., 2016), to my knowledge, there has yet to be data published establishing the success of a brief intervention to reduce sugar consumption amongst college students administered in a group setting. This is important to note, given the high frequency of SSB consumption (Smith West et al., 2006) and the readiness to change amongst the college student population (Huffman & West, 2007). That said, preliminary findings on a brief Sugar Busters workshop have shown promise at being effective in doing so (Taylor et al., 2015).

Sugar Busters

"Sugar Busters" was designed by Taylor and colleagues (2015) and is a one day, one-and-a-half-hour workshop designed to assist college students in reducing the overall amount of sugar they consume in the form of sugary snacks, candy, cereals and SSB's. This study produced an unpublished manuscript in addition to a poster that was presented at the Society for Behavioral Medicine in 2014. Weaknesses in this study included a limited amount of participants completing the one month follow up, as well as a lack of a control group. Notably, it differs in that it is far briefer than Zoellner et al.'s (2016) SipSmartER campaign and does not feature individual health coaching like that of Rosas et al.'s (2017) intervention, making it possible to run in groups. The workshop was developed at a large Midwestern University and was piloted amongst 84 undergraduates by Taylor et al. (2015). The sample was 63% female, 73% Caucasian with M_{BMI}=24.3. Overall the workshop resulted in significant reductions in sugar consumption at one-week and one-month follow-up. Furthermore, there were also significant decreases in SSB consumption at one-week follow-up and one-month follow-up. However, only a small sub-section (n=20) of the sample was contacted for follow up at one month, and the initial pilot study also lacked a control group. Specifically, the intervention produced an overall decrease of 18.4 grams of sugar per day at one-week follow-up, with an average reduction of 17.4 grams of sugar from SSBs alone (Taylor et al., 2015).

The composition of the intervention included interactive psychoeducation regarding the effects of sugar on metabolic processes, the quantity of sugar in typical items found on a typical college campus, items that could be used to displace more sugary items, as well as introducing the concept of implementation intentions to make better decisions under specific and difficult contingencies. Notably, the psychoeducation component was designed to be interactive and visually appealing The components of this particular intervention have been previously utilized in a variety of health behavior domains including, but not limited to improving glycemic control (Norris, Lau, Smith, Schmid & Engelgau, 2002), increasing physical activity (Bélanger-Gravel, Godin & Amireault, 2013) and improving dietary control (Hendrickson & Rasmussen, 2017) but were combined in this workshop for full effect. The background on specific components of this intervention follows.

Interactive Psychoeducation Sugar Busters utilizes an interactive psychoeducation model. Specifically, participants are taught about short- and long-term effects of high levels of sugar consumption, including insulin release and effects on satiety, as well as long term effects of consuming high levels of sugar, such as the development of insulin resistance and the development of diabetes. Additionally, Sugar Busters also features a segment that asks participants to place the amount of sugar into baggies that represent the actual amount of sugar listed on nutrition labels of items commonly found on college campuses. Finally, Sugar Busters features a segment called “Swaportunities” in which participants are taught about potential items that are lower in sugar that could take the place of many of these commonly found sugary items. For instance, participants are taught about specific sugar content in commonly purchased sweetened coffee drinks (such as a Frappucino with 2% milk and whipped cream from Starbucks – 41 grams of sugar) and are then advised about incrementally better alternatives, such as a light coffee Frappuccino with whipped cream that has 18 grams of sugar, or even better a tall iced coffee with 2% milk and a tsp of sugar with only 6.2 grams of sugar. Thus, participants are provided information regarding the short- and long-term effects of sugar consumption, knowledge about how much sugar is contained in readily available campus food items and are then provided with a litany of incremental options to reduce their overall sugar intake.

Psychoeducation is a frequently featured portion of most behavioral interventions and is designed to orient participants to the conceptualization and rationale for specific behavioral changes that are targeted by the intervention itself. Though not as powerful or effective when delivered as a standalone intervention, psychoeducational interventions have been found to be successful in some cases. For instance, Norris, Lau, Smith, Schmid and Engelgau (2002) conducted a meta-analysis of 31 studies examining the impact of education alone on glycemic control amongst diabetics. Overall, they found an average decrease in HbA1c of .76% relative to matched control groups at immediate follow up and .26% at 1-3-month follow-up. Educational interventions have also been proven to be effective in increasing physical activity amongst patients who recently underwent coronary artery bypass grafting (CABG) (Aldcroft, Taylor, Blackstock & O'Halloran, 2011).

Amongst undergraduate students, Kingson and Coumaravelou (2014) found that a psychoeducational intervention addressing test-anxiety amongst 42 randomly assigned pharmacy students with high levels of test anxiety reduced overall lack of motivation and psychological distress and improved grade-point average. Overall, psychoeducation is an important component of most behavioral interventions and alone may produce small effect sizes relative to a no education control group. For the Sugar Busters Workshop, psychoeducation provides the rational for reducing overall sugar intake, and provides concrete examples of how to go about doing that on a college campus. The intervention is augmented with the following empirically-supported components including mindful eating (Hendrickson & Rasmussen, 2017), the use of implementation intentions to plan for specific future goal directed behaviors (Gollwitzer, 1999) and the use of personalized normative feedback to adjust perceptions of average peer sugar consumption (Robinson et al., 2014).

Mindful Eating. Mindful eating interventions or exercises are commonly narrated meditations that ask participants to slow down their regular eating speed and take time to notice the visual, aromatic, textural, and specific taste qualities of a food as they eat it. Brief one session interventions featuring mindful eating have been found to reduce impulsivity in food decision making and to reduce the overall net energy intake (Allirot, Cebolla, Perdices, Oliver & Urdaneta, 2016; Hendrickson & Rasmussen, 2017). Additionally, mindful eating interventions have been shown to reduce the consumption of salty snacks in habitual snackers regardless of baseline levels of emotional eating (Forman et al., 2016). Furthermore, brief mindful eating interventions have also been found to reduce the intake of high fat foods, SSBs, and snack food, as well as overall caloric intake in college student samples (Anderson, Caine-Bish, Gordon & Falcone, 2015a; Anderson, Caine-Bish, Gordon & Falcone, 2015b; Arch, Brown, Goodman, Della Porta, Kiken & Tillman, 2016).

Allirot et al. (2016) conducted a study in which they randomized 70 women to a brief mindful eating intervention and a control group that received a psychoeducational contact control intervention. Participants were then presented with 4 finger foods that were comprised of 1 savory high caloric density food, 1 savory low caloric density food, 1 sweet high caloric density food and 1 sweet low caloric density food. Participants in the mindfulness-based group consumed less energy dense foods, while reporting the same levels of satiety as participants in the control group who consumed more energy dense food options (Allriot et al., 2016). Similarly, Hendrickson and Rasumussen (2017) randomized 172 adolescents and 176 adults to a brief mindful eating intervention, a psychoeducational control group or a no contact control group after measuring levels of trait mindfulness and percentage body fat. Participants also completed a pre and post delayed discounting task for money and food. They could opt to receive less food earlier or more food if they waited longer, similarly for money. Results suggested that adults with higher body fat percentages evidenced less trait mindfulness and were more likely to make impulsive decisions with both food and money. For adolescents, there was no relationship between body fat and trait mindfulness, however, adolescents with higher body fat percentages were more likely to make impulsive decisions regarding food and money. Results also demonstrated that individuals receiving a mindful eating intervention made significantly less impulsive food decisions in the follow-up delayed discounting task relative to both control groups. Overall, results show that trait mindfulness may play an impact on weight gain through adolescence into young adulthood through impulsive food decision making. Additionally, results demonstrate that a brief mindfulness-based intervention may act to curb impulsive food related decision making and therefore have a protective influence on adolescent and young adult weight gain (Hendrickson & Rasmussen, 2017).

Additional studies conducted by Anderson et al. (2015a; 2015b) also demonstrated the effectiveness of mindful eating interventions on ad libitum food intake. Specifically, they randomized 28 participants from a college sample to a control condition or a brief 15-minute mindful eating intervention. Participants were under the impression that they were to be testing and rating movie theatre food and watched a movie after selecting specific movie theatre food. Food selection and quantity was measured by researchers for analyses. Results found that participants in the mindful eating group consumed fewer overall calories, dietary fat, dietary protein and dietary carbohydrates (Anderson et al., 2015b), as well as less overall quantities of high fat dips, SSB’s and chips and pretzels (Anderson et al., 2015a).

Though mindful eating interventions have been found to be successful, Arch et al. (2016) sought to discover the mechanisms associated with mindful eating.

Specifically, they conducted 3 separate experiments with 319 undergraduate students. For the first study, they randomized 81 participants to either a distraction control condition or a mindful eating intervention. Participants were then given 5 chocolate chips and were instructed to only eat one chip per trial. Participants in the mindful eating condition were instructed to explore the sensory sensations related to consuming the chocolate chips prior to completing word puzzles, while participants in the distraction condition were simply instructed to complete word puzzles while eating the chocolate chips. Results indicated that participants in the mindful eating condition were more adherent to mindful eating, but solved fewer puzzles. Additionally, participants in the mindful eating condition reported significantly more enjoyment of the chocolate chips than participants in the distraction control condition.

The second study replicated these findings, only using raisins instead of chocolate chips among 136 undergraduate students. A third study featured both a mindfulness and distraction condition, as well as a no-instruction control group for 102 participants. Following the experimental trials with the raisins, participants were then asked to enter a subject room where they were presented with 6 oz. samples of sweet, salty, high saturated fat and healthy foods. Results showed that individuals in the mindfulness group consumed significantly fewer calories from sweet foods than the two control conditions, as well as less fat, but did not differ from either control conditions in terms of calories from healthy foods. Results also indicated that participants in the mindfulness intervention consumed fewer overall calories than participants in either control conditions (Arch et al., 2016). Overall, these results indicate that mindful eating may exert its influence on reducing overall caloric consumption by instructing participants to focus on their enjoyment of specific food items and this may ultimately have the effect of reducing overall caloric consumption due to decreased speed of eating, as well as more deliberate decision making regarding food related decisions.

Sugar Busters utilizes a brief narrated mindful eating exercise using a raisin. Participants are encouraged to consume high sugar foods that they regularly consume mindfully when they leave the workshop. Research suggests that this may slow the overall rate of eating sugary foods, reduce overall caloric consumption from those sugary foods and, paradoxically, may actually increase actual enjoyment of eating sugar foods (Arch et al., 2016).

Implementation Intentions*.* Implementation intentions are goal directed, explicit, and often written behavioral intentions related to specific and expected internal or external situational contingencies, which can often be barriers (Gollwitzer, 1999). They serve to assist individuals in adhering to a goal, by specifying an action when confronted with a specific contingency. Implementation intentions often take the form of "when situation *x* happens, I will do *y*." For example, an individual that frequently puts a lot of sugar in their coffee, but has a desire to reduce the amount of overall sugar that they consume can specify, "when I order a coffee from the coffee shop I will use Splenda instead of putting 4 teaspoons of sugar in my coffee." Implementation intentions have been found to be effective and produce a medium to large effect size on a wide variety of health behaviors (Gollwitzer & Sheeran, 2006). Specifically implementation intentions are successful in helping individuals to reduce their fat consumption (Vilá, Carrero & Redondo, 2017), increase their physical activity (Bélanger-Gravel et al., 2013), include more healthy foods (fruits and vegetables) in their diets, and to a lesser extent reducing consumption of unhealthy foods in their diet (Adriaanse, Vinkers, De Ridder, Hox & De Wit, 2011). Furthermore, implementation intentions have been found to be effective amongst college students to make behavioral changes related to increasing physical activity and increasing healthy eating behavior (increased fruit and vegetable consumption) (Bélanger-Gravel et al., 2013; Chapman, Armitage & Norman, 2009). Additionally, enhancements of implementation intentions, such as augmenting implementation intentions with visual imagery regarding the specified goal behavior and situation have also been found to enhance the effectiveness of intentions amongst college students (Knäuper, McCollam, Rosen-Brown, Lacaille, Kelso & Roseman, 2011). Thus, implementation intentions are widely used, effective and potentially powerful interventions to increase specific health behaviors, especially among college students.

One specific example regarding implementation intentions was utilized to increase fruit and vegetable consumption. Specifically, Chapman et al. (2009) conducted a study in which they sought to increase fruit and vegetable consumption amongst 557 undergraduates (92% female) from the United Kingdom. They utilized a 3x2 repeated measures design with a one-week follow-up in which participants were randomized to a no treatment control group, a global goal setting group, and a group that utilized implementation intentions. Results found that both the global goal setting group, as well as the implementation intention group were successful relative to the control group in increasing their fruit and vegetable consumption. That said, the implementation intention group that specified exactly which situations and how in those situations they would consume additional fruits and vegetables was significantly more effective than the global goal group, with the implementation group consuming an additional .5 servings of vegetables per day at follow up and the global goal group consuming an additional .31 servings per day at follow up (Chapman et al., 2009).

Recent meta-analyses also affirm the effectiveness of implementation intentions. For instance, Vilá et al. (2017) conducted a meta-analysis examining 12 studies with a total of 3,323 participants published between 2004 and 2013 in which participants were attempting to reduce the amount of fat in their diets. Overall, 9 of 12 studies found significant reductions in fat consumption amongst participants. Pooled effect size analysis found that interventions featuring implementation intentions yielded a medium effect size of d=.49 (Vilá et al., 2017). Additionally, Adriaanse et al. (2011) also conducted a meta-analysis among 23 empirical studies published prior to 2009 examining healthy dietary change. Of those studies, 14 were examining the effectiveness of implementation intentions on increasing the consumption of healthy foods (fruits and vegetables) and increasing healthy eating behaviors, while 8 studies examined the effectiveness of implementation intentions on reducing unhealthy eating behaviors. There was one additional study that targeted both. Adriaanse et al. (2011) found a medium effect size of d=.43 of what on what. Additionally, they found significant differences between intervention type, with interventions targeting an increase in consumption of healthy foods or healthy eating behaviors to be more effective (d=.51) than interventions designed to reduce unhealthy eating behaviors (d=.29).

Sugar Busters utilizes psychoeducation to inform participants of specific high sugar foods that are commonly found on college campuses. It then provides alternative options in an incremental fashion such that participants can make a choice that has less sugar but may fit many of the tactile or taste qualities of foods that are being swapped. Participants then use implementation intentions to visualize and directly state clear behavioral objectives in order to enact these changes. Participants are asked to list 3 specific changes they would like to make regarding their sugar consumption and are then asked to think about the situation that they typically order or consume that food item or beverage. They are then asked to think about making a swap or reduction in that food item or beverage, and then asked to utilize implementation intentions to specify the precise behavior that they will engage in given the specific situation. Furthermore, participants are asked to write these down and share at least one of them with the group. This is designed to go beyond making a global goal regarding reducing sugar consumption, as well as address barriers that may preclude participants from enacting their desired goal behavior. That is to say that participants go beyond stating that they would like to reduce their sugar consumption, and instead provide discrete, situation dependent actions that are designed to push them towards a global goal of reducing overall sugar consumption. This is consistent with Chapman et al.'s (2009) finding, suggesting increased efficacy when specific situations and behaviors are listed by participants. Additionally, to increase the efficacy of the intervention, participants will be asked to visualize themselves engaging in one of their behaviors specified by their implementation intention, as this has been found in similar samples to augment the effectiveness of the implementation intention itself (Knäuper et al., 2011).

Personalized Normative Feedback. Personalized normative feedback is a type of intervention whereby one receives feedback on the accuracy of their perceived notions of what is typical behavior. Regarding diet, this usually refers to individuals' conceptualizations of the frequency or quantity individuals in one's peer group consume of specific food or beverage items. Personalized normative feedback has been utilized to improve people's diets (Robinson et al., 2014), reduce alcohol consumption (Neighbors, Larimer & Lewis, 2004), reduce smoking (Balvig & Holmberg, 2011), as well as used as a component of an intervention designed to reduce SSB consumption among college students (Rosas et al., 2017).

Personalized normative feedback has been shown to improve dietary behavior. Specifically, in a review article, Robinson et al. (2014) found that adjusting perceived norms by either providing accurate information or lower prevalence of consuming unhealthy foods or higher prevalence of peer consumption of healthy foods, typically produced a moderate impact on consumption patterns (more healthy or less unhealthy foods) relative to control conditions at follow up. Furthermore, Rosas et al. (2017) found that participants receiving PNF for their beliefs about their peers' attitudes regarding consumption of SSB's were effective in changing personal attitudes towards consuming SSBs. Specifically, individuals assigned to the normative feedback component of the intervention reported that they thought that roughly 91% of their peers try to avoid or reduce SSB consumption relative to the groups not receiving this feedback who estimated that 36% and 41% of their peers possess similar attitudes regarding SSB consumption.

Personalized Normative Feedback has also been found to be effective for reducing alcohol consumption. Specifically, Neighbors et al. (2004) used computerized normative feedback amongst 252 college students who were randomly assigned to the

PNF intervention or a control group. Participants in the intervention group were provided feedback on their personal alcohol consumption patterns, as well as feedback on their perceptions of peer attitudes regarding drinking (injunctive norms). Participants in the intervention group demonstrated a reliable drop in their perceptions of acceptability of alcohol use among their peers as well as a reliable and statistically significant drop in their perceptions of descriptive norms. Participants in the intervention group also evidenced a within subjects decline of .18 standard deviations in alcohol consumption from baseline at three months and .16 at 6 months relative to the control, who evidenced a .08 standard deviation drop from baseline at both 3 and 6 months (Neighbors et al., 2004). Personalized normative feedback has also been found to be effective in reducing adolescent attitudes regarding smoking as well. For instance, Balvig and Holmberg (2011) conducted a study amongst 349 Danish fifth and sixth graders by randomizing some to an intervention in which students received personalized normative feedback about their own perceptions of their peers' attitudes, followed by a group discussion about these misperceptions. Results demonstrated that students receiving this intervention had significantly less favorable attitudes regarding smoking at follow-up (Balvig and Holmberg, 2011).

Personalized normative feedback seems to be an effective tool at influencing perceptions of social norms (Balvig & Holmberg, 2011; Rosas et al., 2017), as well as potentially contributing to improving specific target behaviors (Neighbors et al., 2004; Robinson et al., 2014). The current iteration of Sugar Busters differs from Taylor et al. (2015) in that it featured a component of the intervention in which participants estimated the amount of average cubes (4 grams each) of sugar individuals in their peer group consume on an average day. They were shown gram of sugar looks like. Participants in the workshop then were shown both the numerical figure (sugar consumed in grams) as well as a visual representation of this sugar (a clear plastic bag filled with the respective average amount of sugar consumed by their peer group). It was expected that all participants would overestimate these figures, as previous literature has consistently found this to be the case (Lally et al., 2011; Perkins et al., 2010; Robinson et al., 2015) and corrections to these misperceptions seemed likely to increase motivation to reduce overall sugar intake amongst workshop participants.

Purpose of Current Study

The current study sought to extend our understanding of Taylor et al.'s (2015) findings regarding of the effectiveness of reducing overall sugar intake within a college population by using a modified Sugar Busters workshop in a college population. It further explored these findings by including a wait-list control group and extended follow-up. The workshop also featured a social norms component based on findings from Rosas et al. (2017). Additionally, this study explored moderating factors that could have contributed to the variance in outcomes within the experimental group itself. For instance, this study examined the extent to which health literacy, health orientation, as well as differences in hedonic hunger explain the variability in workshop outcomes at one month. Given relationships found in previous literature, the current study specifically sought to investigate the extent to which health literacy, health orientation and hedonic hunger moderate treatment effects. I also sought to understand how potential changes in health literacy and in perceived peer sugar consumption from baseline to one-month follow-up mediate decreases in sugar consumption at one month follow up. Specific hypotheses and aims, study methods and measures are subsequently listed below.

Study Aims and Hypothesis and Proposed Statistical Analyses

Aim 1. The first aim was to determine both within and between subject effectiveness of the modified Sugar Busters Workshop at one month as determined by measures of self-reported sugar consumption at baseline and 9 subsequent follow-up assessment points.

Hypothesis 1. It was hypothesized that participants in the experimental condition receiving the Sugar Busters intervention would demonstrate significant within-subject reductions in overall sugar consumption at one-month follow-up.

Hypothesis 2. It was hypothesized that participants receiving the Sugar Busters intervention would evidence significantly lower levels of self-reported sugar consumption throughout the course of the month following the intervention and at one-month follow-up compared to the control group.

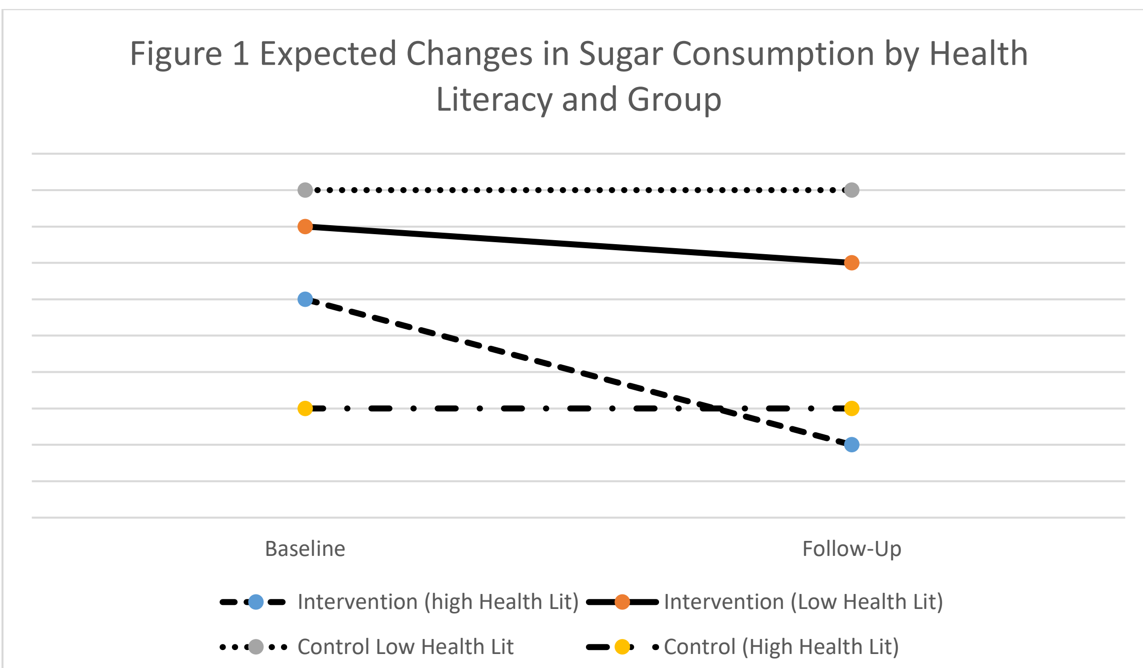
Aim 2. Aim 2 examined relationships between baseline variables and baseline sugar consumption.

Hypothesis 3. It was hypothesized that health literacy and health orientation would be inversely correlated with baseline levels of sugar consumption.

Hypothesis 4. It was hypothesized that hedonic hunger and higher levels of perceived peer sugar consumption would be positively associated with self-reported sugar intake.

Aim 3. Aim 3 sought to determine whether specific moderators impact differential trajectories in sugar consumption from baseline to one month. They were determined by observing significant interactions between conditional assignment and moderating variables. I expected that health literacy, health orientation and hedonic hunger would moderate the impact of the workshop.

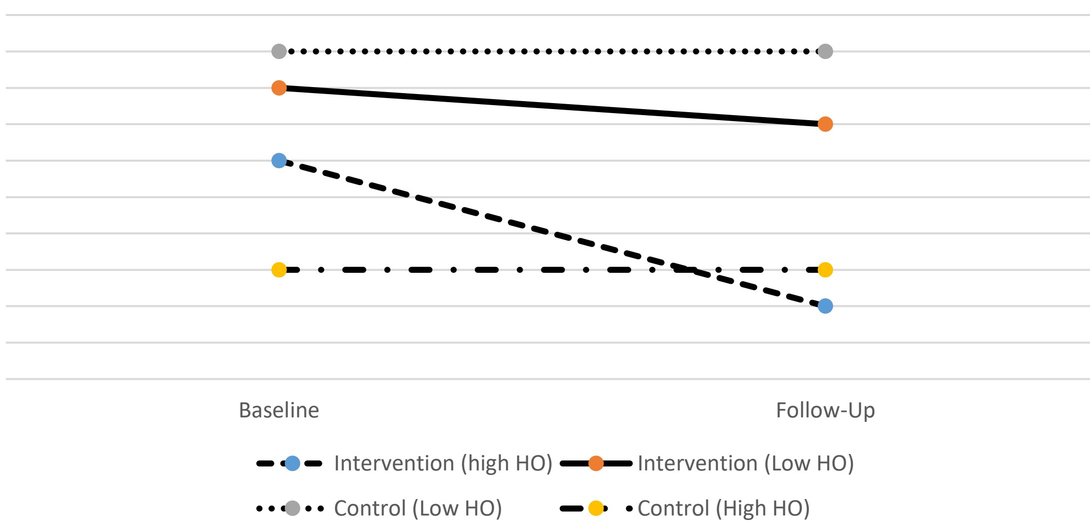
Hypothesis 5. It was hypothesized that health literacy would moderate the reductions in sugar consumption within the intervention group. Specifically, I expected that those lower in health literacy would show greater reductions in their overall sugar consumption from baseline to one month when compared to individuals high in health literacy within the intervention group. Conversely, I did not anticipate any differences from baseline to one month follow up in sugar consumption between those low or high in health literacy that are placed in the control group. Depiction of expected moderation effect can be seen in Figure 1.



Hypothesis 6.   It was hypothesized that health orientation will moderate treatment effects in the intervention group such that those individuals scoring higher in

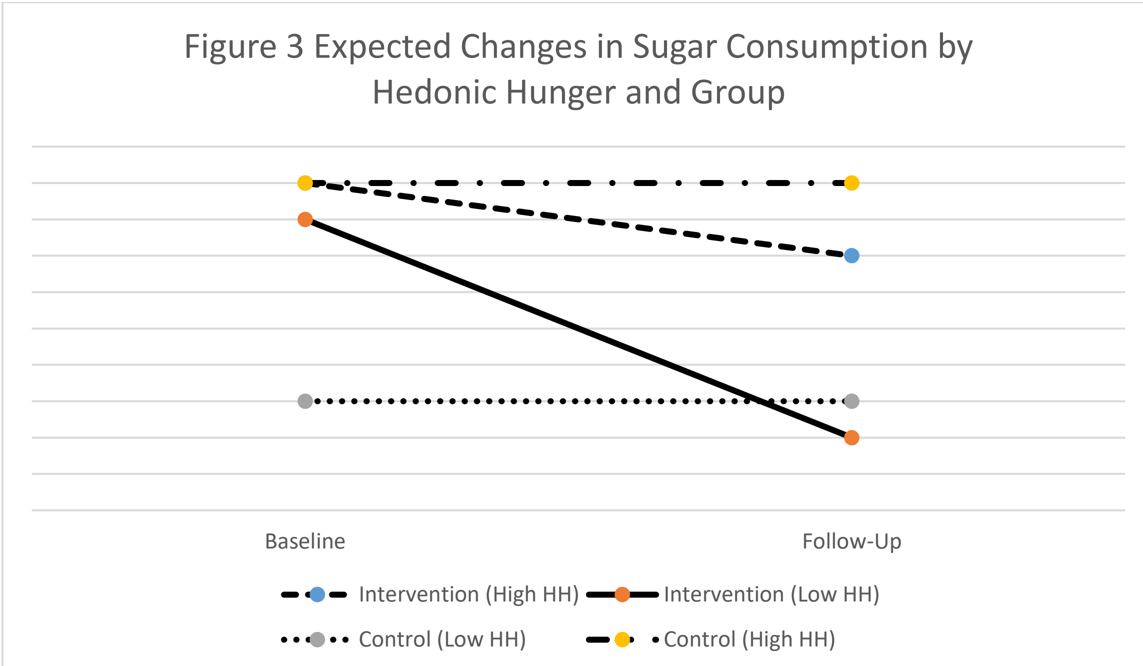
health orientation will show greater reductions in sugar consumption at one-month follow-up than those low in health orientation within the intervention group. Underlying this hypothesis was data from Huffman and West (2007) that demonstrated that college students who were actively attempting to reduce their SSB consumption were still consuming an average of 7.6 SSBs per week, thus I hypothesized that that there may be room to change among individuals who are more motivated or oriented to change, whereas those that are not high in health consciousness or health orientation may be less likely to pursue recommendations to pursue the goals related to the intervention. Conversely, I did not anticipate any differences in sugar consumption between those high or low in health orientation that are randomized to the control group. Depiction of expected moderation effect can be seen in Figure 2.

Figure 2 Expected Changes in Sugar Consumption by Health Orientation and Group



Hypothesis 7. It was hypothesized that hedonic hunger would also moderate treatment effects such that those that scored higher in hedonic hunger within the intervention group would show smaller reductions in sugar consumption at follow-up

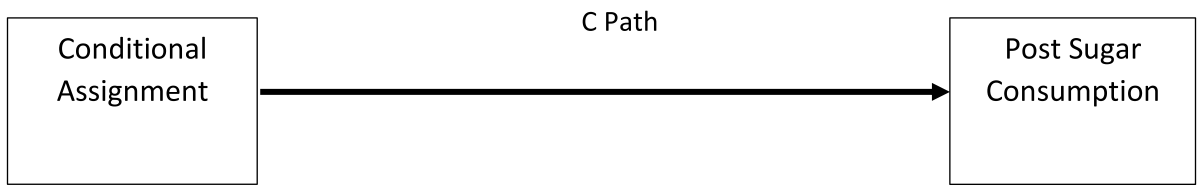
relative to those individuals scoring lower in hedonic hunger. Depiction of expected moderation effect can be seen in Figure 3.

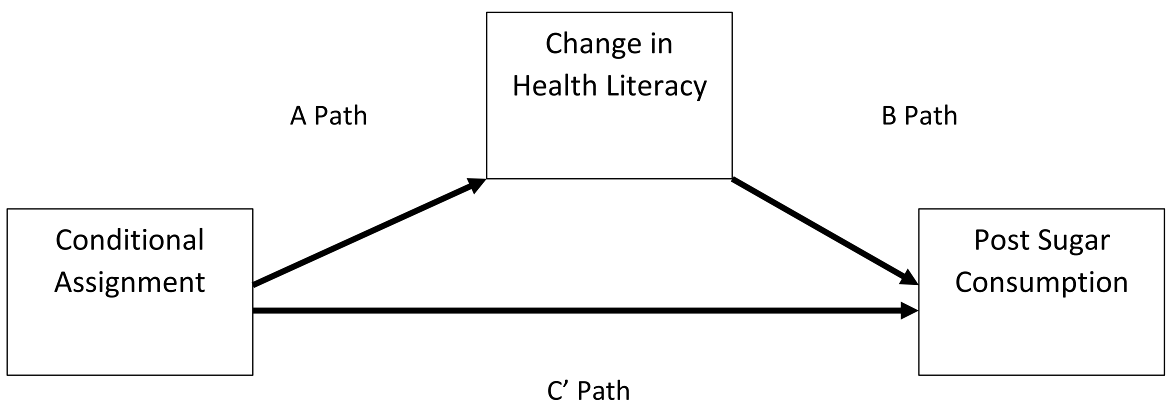


Aim 4: Aim 4 sought to determine factors that partially or fully mediate the impact of the intervention. I expected that health literacy and changes in perceptions of normative or average peer sugar consumption would partially mediate the relationship between treatment assignment and reduced sugar consumption at one month.

Hypothesis 8. It was hypothesized that gains in health literacy from pre to post intervention would at least partially mediate the reductions in sugar consumption from baseline to one month. See Figure 4 for a depiction of expected mediation.

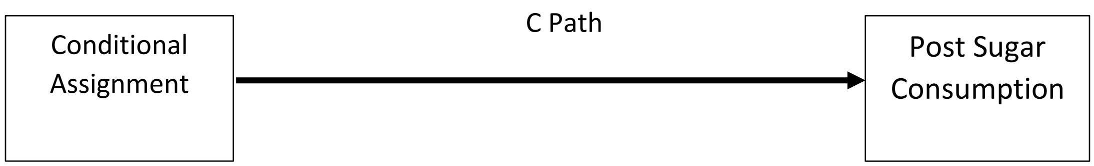
Figure 4 Graphic Depiction of Expected Mediation of Reduced Sugar Consumption by Changes in Health Literacy

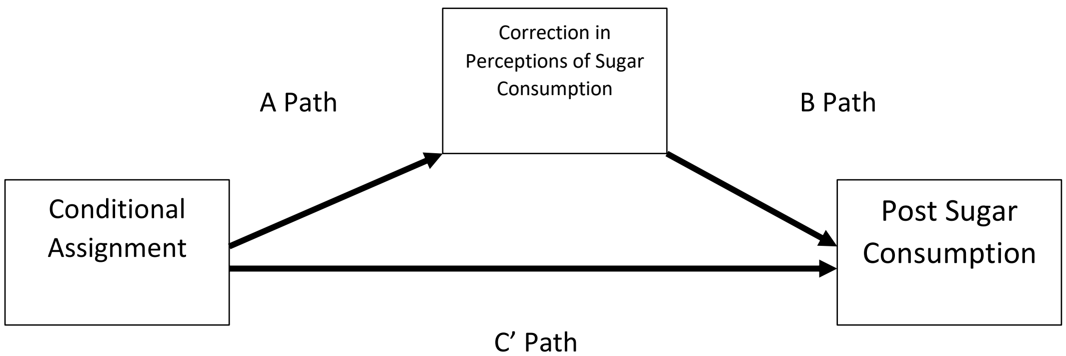




*Hypothesis 9***.** It was hypothesized that individuals in the intervention group getting personalized normative feedback would see changes in their perceptions of average sugar intake of their peers via personalized normative feedback. I expected that a shift from initial perceptions to corrected perceptions based on consumption data from Marriot et al. (2009) would mediate the relationship between group assignment and sugar consumed at one-month follow up as measured by the DSQ, and the BEVQ-15. See Figure 5 for a graphic depiction of mediation of reduced sugar consumption by changes in perceived norms.

Figure 5 Graphic Depiction of Expected Mediation of Reduced Sugar Consumption by Changes in Perceived Peer Sugar Consumption





CHAPTER III: METHODS

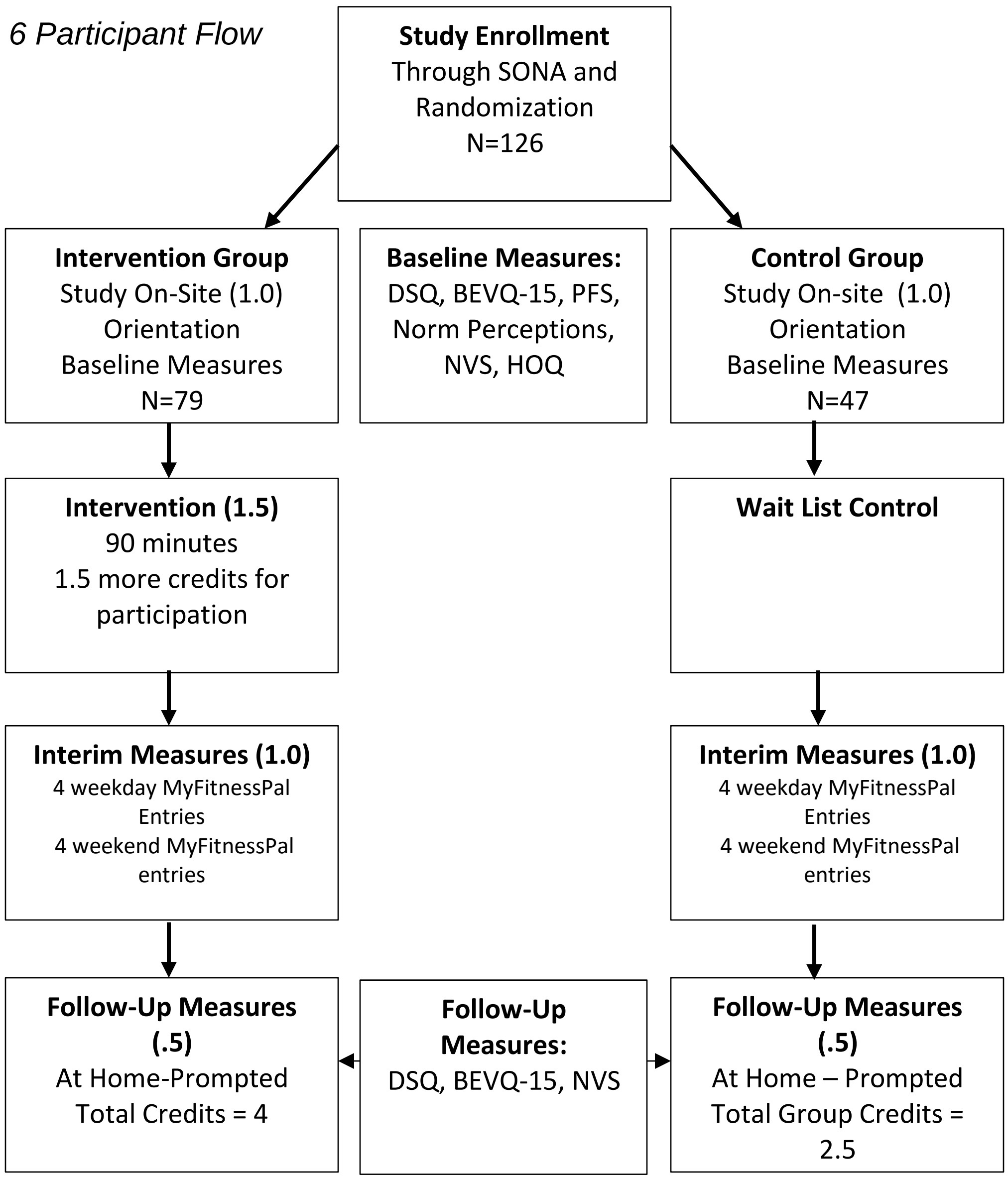
Participants and Sample Size Determination

Given the relatively high effect sizes from pre-intervention to post-intervention detected by Taylor et al. (2015) (all greater than d=1.0), it was determined that it would be likely that even a very modest sample size will be able to detect within and between group differences in sugar consumption. However, the detection of moderational and some mediational variables underlaid most of the need for statistical power for this study. According to Shieh (2011), a sample size of 78 is enough to detect small interaction effects on an independent variable assuming random distribution of the new interaction variable when the moderator is multiplied by the independent variable that is supposedly moderated. Additionally, according to assumptions by Fritz and McKinnon (2007), it seems that a sample of greater than 100 participants would be necessary to detect a small mediational effect regarding changes in health literacy on changes in sugar consumption. Given the fact that I expected moderation effects to be small to moderate based on literature regarding the association between health literacy and dietary choice (Ellison et al., 2013) as well as a somewhat less direct association between hedonic hunger and food consumption in general, and that I assumed 80% study retention, I anticipated that 125 total randomized participants would be adequate to detect mediation and moderation effects with study attrition.

Study Design

Participants were randomly assigned to the Sugar Busters intervention or wait list control group via computer randomization following enrollment in the study. See Figure 6 for flow-chart of assessment points and randomization. Randomization was also conducted via block randomization such that “blocks” of participants were randomized together based on the night and time that they signed up for the study. Students in both the intervention and wait-list control group met on the campus of East Carolina University to complete baseline questionnaires. See Figure 6 for participant flow through study protocol.

Figure 6 Participant Flow



Participants that were assigned to the intervention group then attended the Sugar Busters workshop held on campus that day, while students in the control group were dismissed and informed that they would be able to participate in the workshop after the one-month follow-up period if they would like. For participants in the intervention group, the workshop lasted approximately 90-minutes and students were awarded course credit based on their participation in the intervention and the completion of subsequent follow-up measures. Following the completion of baseline questionnaires, participants were instructed to complete one weekday and one weekend food diary per week using MyFitnessPal. These days were determined via computer run random number generation and were assigned to both groups of during orientation. Students in the intervention and wait list control group were both asked to complete a final assessment online approximately one month following their completion of the workshop. Information on specific measures utilized, as well as their timing within the study are listed below.

Procedure

Permission to recruit participants for the study on the campus of East Carolina University was approved by ECU IRB in February of 2018. See Appendix A for approval letter. Students were randomized after entry into the study to either the wait list control group or the Sugar Busters intervention group. Both groups were randomly assigned based on specific days and times that they signed up for prior to block randomization. Participants in both groups also completed baseline questionnaires on site. During orientation, participants were also given their randomized days to complete MyFitnessPal entries. Randomization occurred such that a random number generator drew a number 1-5 to determine the weekday entry, and 1-2 to determine weekend entries for specific weeks. Participants were asked to complete 4 weekday and 4 weekend entries (one of each per week) specified by randomization over the course of the one month follow up. Participants were provided hard copies of these dates along with passwords to their designated MyFitnessPal accounts for the study. Participants were told that if they missed a day, they could make up an entry on the next subsequent weekend or weekday. Those that were randomized to the intervention group were then able to participate in the Sugar Busters workshop after completing their baseline measures, and receiving instruction on completing the required MyFitnessPal entries, while participants in the wait-list control group were dismissed. Finally, both groups were sent follow-up measures via email at roughly 4 weeks post intervention. Students were then awarded course credit based on their participation.

Addition of a Peer Facilitator

In order to complete data collection, a peer facilitator was trained in both the background of the workshop and in delivering the intervention itself by the author as well as graduate students and was provided supervisory support throughout. The peer facilitator led the workshop in the Spring of 2019, towards the end of data collection. While not part of the original hypotheses, exploratory analyses were conducted to look at differences between groups led by an undergraduate (peer) versus graduate student facilitators. Undergraduate facilitators have been found to be effective in helping other college students reduce their smoking behavior (Ramsay & Hoffman, 2004) and reduce harmful binge drinking behavior (Masteroleo, Oakley, Eaton & Bosari, 2014). Additionally, peer led interventions have been found to contribute to lower BMI's at year follow-up in an intervention addressing body image satisfaction among high-school students (Sweat et al., 2015).

Modified Sugar Busters Intervention

Students participated in groups of 4-20 individuals in the Sugar Busters workshop described above. The 90-minute modified Sugar Busters intervention (Taylor et al., 2015) featured components of empirically supported interventions in aggregate format. Participants were provided with a participant manual and followed along with a designed PowerPoint presentation outlining the structure of the intervention. Specifically, Sugar Busters featured interactive psychoeducation that addressed short- and long-term effects of sugar consumption, the amount of sugar in commonly consumed high sugar food items, and information regarding similar food choices that feature less sugar ("Swaportunities"). Psychoeducation has been shown to be an efficacious intervention with regards to changing specific health behaviors, including improving glycemic control amongst individuals with diabetes (Norris et al., 2002). Participants also produced their own implementation intentions regarding specific food items or behaviors that they want to change within the context in which that change will take place in. Implementation intentions have been found to be effective in a variety of areas regarding health behavior change, including improving one's diet (Adriaanse et al., 2011). In addition to psychoeducation and implementation intentions, Sugar Busters also featured a mindful eating component (Allriot et al., 2014), that has also previously been shown to improve dietary habits among participants. Finally, Sugar Busters added a new component, which differed from the (Taylor et al., 2015) version, which featured normative feedback, which has also been found to be effective in improving dietary patterns in participants (Robinson et al., 2014; Rosas et al., 2017).

Baseline Measures

Demographics. Demographic information was collected including age, sex, race, self-reported height, self-reported weight, year in college, and estimates of their parent(s)' household income.

Dietary Screening Screener Questionnaire. (DSQ: Thompson et al., 2005) The DSQ is a 26-item food frequency questionnaire that has been developed for the National Health and Nutrition Examination Survey (NHANES) 2009-2010. It provides estimates of average daily intake of fruits and vegetables, dairy, added sugar, whole grains, fiber and calcium that one consumes by utilizing regression coefficients based on normative data regarding regular portion sizes by age and sex for each specific food item. The DSQ has been compared and found to be highly correlated with 24-hour food recalls, which are considered the gold standard in dietary research (Thompson et al., 2005). Specifically, an early evaluation study of the DSQ found that 24 hour food recalls correlated with the DSQ from .5 to .7 for servings for fruits and vegetables, dietary fiber intake and percentage of calories from fat intake in early measure evaluation and development work (Thompson, Midthune, Subar, Kahle, Schatzkin & Kipnis, 2004). Other extensive evaluation work has been conducted on the DSQ, and the DSQ has been used to assess racial and socioeconomic differences in sugar consumption (Thompson, McNeel, Dowling, Midthune, Morrissette & Zeruto, 2009). Questions and key output variables from the DSQ can be seen in Appendix B.

BEV-Q 15. (Hendrick et al., 2012) The BEV-Q 15 is a 30-item measure that asks participants to rate how often they consume specific beverages on a 7-point Likert scale from never or less than one time per week to 3 or more times per day. The BEV-Q 15 also asks participants to assess the average quantity of the specific beverage that is consumed each time on a 5-point Likert scale ranging from less than 6 fl oz. to more than 20 oz. The BEV-Q 15 provides estimates of total ounces of specific beverages that are consumed, as well as specific calorie estimates. The BEVQ-15 then uses raw responses from participants to estimate overall ounces of beverages consumed, calories from those beverages, and the ounces of SSB (which the BEVQ-15 considers sweetened fruit juice, full calorie soda, energy drinks, sweetened coffee, and sweetened tea) and calories from SSB's consumed. The scale has good internal consistency for both total beverage intake α=.99 and for SSB intake α=.99 (Hendrick et al., 2012). Additionally, the BEV-Q 15 has been shown to detect small to moderate changes in beverage consumption when given at multiple time points (Hendrick et al., 2013). Reliability for the current study for total beverage intake was The BEV-Q 15 can be seen in Appendix C.

Health Orientation Questionnaire. (HOQ: Stegar et al., 2015) The HOQ is a 13-item 4-point Likert scale measure comprised of two subscales. One subscale is the 8-item proactive health orientation subscale, which assessed the extent to which an individual considers themselves to value and be committed to making decisions in the best interests of their overall health. This subscale produced good internal reliability at α=.90. The second subscale is known as the health information discounting subscale and features 5 items. The health information discounting subscale measures the extent to which individuals discount well-established health guidelines including physician recommendations. The internal consistency of this subscale was also adequate at α=.73 (Stegar et al., 2015). The reliability for the 8-item Health Orientation scale for the current study was α=.89 and for the 5-item Health Information Discounting scale the reliability was α=.61. The HOQ can be seen in Appendix D.

Newest Vital Sign*.* (NVS; Weiss et al., 2005) The Newest Vital Sign is a 6-item measure of Health Literacy designed to assess participants' capabilities to make health, and specifically nutritional decisions based on the reading of a nutrition label. The NVS has adequate reliability with α=.76 and demonstrates good validity correlating at r=.59 with the much longer Test of Functional Health Literacy in Adults (TOFHLA) (Weiss et al., 2005). The NVS is scored by assessing the number of correct responses out of 6 items that participants provide. Items assess knowledge and ability to read and understand an ingredient and nutrition label for a fictional container of ice cream and then assess how participants make functional decisions based on this information. The NVS also assess participants' abilities to make specific calculations based on nutrition facts and serving sizes. Reliability for the NVS for the current study was calculated by coding responses into correct or incorrect responses using dummy codes 0 and 1. Reliability for the current study was α=.57. The NVS can be seen in Appendix E.

Power of Food Scale. (PFS: Lowe et al., 2009) The PFS is a 15-item likert scale designed to measure Hedonic Hunger. The measure is subdivided into 3 subscales that relate to specific reactions when food is not directly available, available and present, or actively tasted or consumed by the participant. Overall, the scale measures the participants' perceptions of their own reactions to food related stimuli. For instance, on the food available subscale one item reads "I find myself thinking about food even when I'm not hungry." An example of an item on the food present subscale is, "If I see or smell a food I like, I get a powerful urge to have some." Finally, an example of an item on the food tasted subscale is, “When I eat a delicious food, I focus a lot on how good it tastes.” The PFS three-factor structure was suggested by Cappelleri et al. (2009) and confirmed by Lowe et al. (2009). Furthermore, the PFS evidences good reliability with α=.91, and it is considered acceptable to utilize the average item response based on the total score on all 15 items (Lowe et al., 2009). The reliability for the current study was α=.89, which is considered reliable. The PFS can be seen in Appendix F.

Norm Perception Measure. The norm perception measure consisted of providing students with a visual image of a sugar cube that they were informed was 4 grams. Students then were asked to estimate the number of sugar cubes they thought the average person their age and gender consumed daily. Students receiving the Sugar Busters intervention were provided individualized feedback as to the accuracy of their guess during the workshop with both specific numerical figures based on sex, as well as a visual representation of the average sugar consumed. Visual representation was based on the average amount of sugar consumed for males and females being placed into a baggy along with other food items that participants were viewing visual representations of quantities of sugar in common food items during the workshop. Data on normative sugar consumption within this age group was based on nationally representative data from Mariott et al., (2009).

MyFitnessPal*.* MyFitnessPal is a free self-monitoring application that can be accessed via computer, smartphone or tablet. Users are asked to input all daily food items consumed into the application before, during or after the food is consumed. The application then provides users with estimates of daily calories consumed as well as other key variables, such as grams of macronutrients, as well as some micronutrients such as sugar and sodium consumption. MyFitnessPal has become increasingly popular as a tool amongst dieticians, with a recent study suggesting that roughly 60% of polled dieticians utilize the tool in order to help clients track their calories and 62% of dieticians polled stated that they would recommend the use of MyFitnessPal over any other self-monitoring application (Chen, Lieffers, Bauan, Hanning & Allman-Farinelli, 2017).

Follow-Up Measures

Participants were then asked to complete two complete entries in MyFitnessPal per week following the intervention. They were asked to complete one weekend and one weekday entry with specific dates randomly selected by the study team. The final calculations regarding average daily calories as well as grams of sugar will be included in the final analysis. Participants also were asked to complete the BEVQ-15 and the DSQ at the end of one-month follow-up. Additionally, all participants were also asked to complete the NVS one more time in order to detect any differences in health literacy or that occurred over the month assessment and follow-up period. For norm perceptions, it was assumed that only the intervention group would evidence shifts in their perceptions of peer sugar consumption, thus conditional assignment and participants' estimates of peer sugar consumption at baseline were deemed sufficient to assess for mediation effects.

Data Analytic Plan

Aim 1 Statistical Analyses

Hypothesis 1. Hypothesis 1 was tested using a repeated measures Analysis of Variance (ANOVA) with just participants from the intervention group. The paired variables were scored based on baseline and one month follow up variables from the DSQ and BEVQ-15 that reflected estimates of daily average sugar consumption and daily average sugar consumption from SSB's from the DSQ (Thompson et al., 2005) as well as ounces and calories from SSBs from the BEVQ-15 (Hendrick et al., 2015). Significant reductions in sugar consumption within the intervention group on the specific variables in the DSQ and BEVQ-15 would be confirmatory of hypothesis one.

Hypothesis 2. Hypothesis 2 was also tested using split-plot repeated measures ANOVAs with conditional assignment as a between subject factor. Scores that reflected the total average of sugar consumed per day and sugars form SSBs consumed per day as measured by the DSQ (Thompson et al., 2005) and estimates of ounces and calories from SSB as measured by the BEVQ-15 (Hendrick et al., 2012) were the repeated measure variables. Significance was contingent on the detection of a significant between x within subject interaction effects that would reflect greater reductions in sugar consumption within the intervention group as opposed to the control group.

For the second part of hypothesis 2, aggregated food records from MyFitnessPal were entered and averaged based upon number of entries completed. Food records from the 4 weekdays and 4 weekends provided by participants in both groups were aggregated and averaged for calories and dietary sugar. These calculated variables were then compared using an independent samples t-test with group assignment as the independent variable. The dependent variable was average sugar consumed per entry day. Significant differences such that the intervention group reflects lower average sugar consumption across the month following intervention were considered confirmatory of hypothesis 2.

Aim 2 Statistical Analyses

Hypothesis 3. Hypothesis 3 was using Pearson regression coefficients. Significant inverse correlation coefficients between baseline estimated average daily sugar consumption, and estimated sugar from SSB's from the DSQ (Thompson et al., 2005) and baseline estimates of total ounces of SSBs and total calories form SSBs from the BEVQ-15 (Hendrick et al., 2012) were correlated with Stegar et al., (2015)'s measure of health orientation and health literacy as measured by the NVS (Weiss et al., 2005). Significant inverse correlations between baseline sugar consumption and SSB consumption with health literacy and health orientation were considered confirmatory of hypothesis 3.

Hypothesis 4. Hypothesis 4 was tested by conducting a Pearson correlation between hedonic hunger as measured by the PFS and estimates of average daily sugar consumed, and average daily sugar from SSB's from the DSQ (Thompson et al., 2005) and total ounces of SSBs and total calories from SSBs from the BEVQ-15 (Hendrick et al., 2012). A positive and significant correlation was considered confirmatory of hypothesis 4.

Aim 3 Statistical Analyses

Hypothesis 5. Moderation was determined using moderated multiple regression (MMR) with simultaneous entry predicting follow up sugar consumption as measured by the DSQ and BEVQ-15. Predictors were entered including conditional assignment, the variable proposed to moderate workshop effectiveness (in this case health literacy), and baseline sugar consumption in order to account for baseline differences in sugar consumption. Finally, in order to determine a significant moderation effect, an interaction term by multiplying the dummy coding for treatment assignment (1 or 2) by health literacy scores were entered as the third predictor variable. Significance of this interactive variable when simultaneously entered with the other three independent variables would be considered confirmatory of a significant moderation effect (Shieh, 2011).

Hypothesis 6. Much like hypothesis 5, I created an interaction term using group assignment and health orientation scores from Stegar et al.'s (2015) measure of health orientation. Health orientation scores were calculated by subtracting the health discounting information subscale from the health orientation subscale of the Stegar et al. (2015) measure. Significance of this interaction variable when entered with group assignment, health orientation score, and baseline sugar consumption as measured by the DSQ and BEVQ-15 respectively would denote significant moderation.

Hypothesis 7. Like hypotheses 5 and 6, hypothesis 7 will be detected by examining the interaction term within the MMR model. The dependent or criterion variables will be measures of follow-up sugar and SSB consumption at follow up as measured by the DSQ and BEVQ-15. Predictor variables were group assignment, hedonic hunger, corresponding baseline measures of sugar and SSB consumption (DSQ and BEVQ-15 respectively), and the interaction term. Hedonic hunger as measured by total scores from the PFS (Lowe et al., 2009) were multiplied by group assignment to produce this interaction term. A significant interaction would indicate a significant moderation effect.

Aim 4 Statistical Analyses

Hypothesis 8. Hypothesis 8 was tested using mediational analysis. Mediational analysis specifies several paths that are conduits for statistically significant relationships between variables (Preacher & Hayes, 2008). Something is considered a mediator variable when variance within that variable renders a relationship between two other associated variables to be less related. Thus, mediation is viewed as a conduit for underlying mechanisms partially accounting for the relationship between two variables (Kazdin, 2007). Mediation specifies that the effect of a direct relationship is rendered insignificant or will evidence significant reductions in its significance when accounting for variance through a mediator. For hypothesis 8 regarding health literacy scores, the direct path was expected to demonstrate that conditional assignment would be predict sugar and SSB consumption at follow up, such that those participants in the workshop would report lower levels of sugar and SSB consumption. This is considered the direct, or C path. I also expected conditional assignment would be predictive of changes in health literacy at follow up (A path). This predicted change in health literacy then should predict sugar and SSB consumption at one month follow-up (B path). Thus, the indirect path would be looking at changes in the relationship between conditional assignment and follow up sugar and SSB consumption scores after accounting for variance related to changes in health literacy. This would create the indirect or C' path. Mediation would be indicated should the relationship in the indirect path be considerably weaker or insignificant when compared to the direct path. Thus, I expect that the projected relationship between conditional assignment and follow up sugar and SSB consumption (direct path) will be significantly stronger than the indirect path. Specifically, mediational testing would be carried out using a bias-corrected bootstrapping model using Preacher

& Hayes (2008) available macro for SPSS. According to Fritz & McKinnon (2007), when expecting a large direct A path (conditional assignment and changes in health literacy) and a small B path (changes in health literacy and sugar consumption at one month), a sample of between 54 and 115 participants would be needed to detect a weakened relationship in the indirect (C') path. See Figure 4 for depiction of mediation effect.

Hypothesis 9. Like hypothesis 8, hypothesis 9 was tested using a mediational model (Preacher & Hayes, 2008). Once again, the direct C path would be the relationship between conditional assignment and sugar consumption at one month follow up. The A path will be the relationship between conditional assignment and changes in perceptions of peer sugar consumption (only the intervention group will receive normative feedback) and the B path will be changes in perceptions of peer sugar consumption and sugar and SSB consumption at one month. The C' path will be the indirect path between group assignment and sugar and SSB consumption at one month follow up after accounting for the variance between changes in perceptions of peer sugar consumption and sugar consumption at one-month follow-up. Mediation would be demonstrated assuming the relationship between conditional assignment and follow up sugar and SSB consumption is significantly weaker than the direct path after accounting for the variance related to changes in perceptions of peer sugar consumption.

CHAPTER IV RESULTS

Sample Characteristics

Participants were 126 undergraduate students (67% male) from a large southeastern university. A total of 79 students were randomized to the intervention and 47 participants were randomized to the control group. Groups were unbalanced in order to address mediation and moderation hypotheses (more power was needed in the intervention group). There were no significant proportional differences in sex by random group assignment $\chi^2(1)=2.87$, $p=.09$. Seventy-six participants (60.3%) identified as Caucasian, 33 (26.2%) as African American, 8 (6.3%) as Latinx, 5 (4.0%) as Asian or Pacific Islander, and 4 (3.2%) identified as other or multi-racial. There were no proportional differences in racial identity of participants by group assignment $\chi^2(4)=3.34$, $p=.50$. Furthermore, 96 (76.2%) of participants identified as freshman, 22 (17.5%) as sophomores, 7 (5.6%) as juniors, and 1 (.8%) participant identified as a senior. There were no proportional differences in self-identified class standing of participants by group assignment $\chi^2(3)=.70$, $p=.87$. Finally, 9 students (7.1%) identified as having parents that earned under $30k per year, 16 (12.7%) reported that their parents earned between $30-45k per year, 15 (11.9%) between $45k-$60k per year, 16 (12.7%) between $60k-$75k per year, 20 (15.9%) between $75k-$90k per year, 16 (12.7%) between $90k-$105k per year, and 34 (27.0%) participants reported that their parents made more than $105k per year. There were no proportional differences in reported parental income and random group assignment $\chi^2(6)=4.75$, $p=.58$.

Attrition

Overall, 73 (57.9%) participants completed baseline measures, MyFitnessPal entries, and the follow up survey, while 53 (42.1%) of the sample only completed baseline measures and did not complete MyFitnessPal or follow-up measures. Importantly, there were no significant differences in study attrition by condition $\chi^2(1)=.01$, $p=.93$. See Table 1 for a breakdown of attrition by study condition.

Table 1, Attrition by Condition

Condition	Completed Study	Lost to Follow-Up	Total
Workshop	46	33	79
Control	27	20	47
Total	73	53	126

Exploration of differences on key baseline variables between participants lost to follow-up and participants who completed the study was conducted. Table 2 lists means, standard deviations, and statistical differences of participants on key variables based on attrition status. Statistical differences were computed using independent samples t-tests. Participants lost to follow up evidenced significantly lower health literacy at baseline. There were no other significant differences on key variables by attrition status.

Table 2 Differences in Key Baseline Variables Based on Attrition

Baseline Variables	Completed Study M(*SD*) *n*=73	Lost to Follow-Up M(*SD*) *n*=53	Statistical Difference
Age	18.9 (*1.4*)	18.8 (*1.1*)	$t(124)=.62$, $p=.53$
BMI	25.6 (*5.7*)	24.3 (*4.5*)	$t(124)=1.37$, $p=.17$
Estimated Peer Sugar Consumption (grams)	66.8 (*21.7*)	70.3 (*22.8*)	$t(122)=.86$, $p=.39$
Proactive Health Orientation	27.5 (*3.6*)	27.1 (*3.6*)	$t(119)=.69$, $p=.49$
Health Information Discounting	7.5 (*2.1*)	8.0 (*2.2*)	$t(123)=1.41$, $p=.16$

Health Literacy	5.1 (*1.2*)	4.2 (*1.4*)	$t(124)=3.57$, $p<.01$**
Hedonic Hunger[A]	2.4 (*.8*)	2.3 (*.8*)	$t(119)=.48$, $p=.52$
BEVQ-15 SSB Ounces Consumed	17.4 (*20.1*)	19.1 (*18.1*)	$t(122)=.48$, $p=.63$
BEVQ-15 SSB Calories Consumed	233.5 (*229.0*)	205.9 (*235.8*)	$t(122)=.65$, $p=.52$
DSQ-Sugar (tsp)	14.8 (*8.8*)	16.0 (*9.3*)	$t(120)=.75$, $p=.45$
DSQ-Sugar from SSB (tsp)	7.7 (*9.2*)	9.3 (*9.6*)	$t(121)=.91$, $p=.36$

*Note, **denotes significance at the p<.01 level. [A]denotes that Hedonic Hunger was measured with the Power of Food Scale*

Power Analysis Following Attrition

Given that attrition exceeded the expected 20%, a power analysis was conducted to determine the ability of the study to test key proposed hypotheses. Specifically, hypotheses 1,2,5,6,7,8 and 9 were susceptible to reduced power due to reliance on follow up measures and higher than expected attrition. A total of 73 participants completed the study, and thus was the assumed sample size for post-hoc power analyses. Power analyses were conducted with *G Power version 3.1.9.2* (Faul, 2014).

First, power analysis examining key hypothesis related to within and within*between subject changes for hypotheses 1 and 2. Assuming a medium effect size ($f^2=.25$ or $\eta^2=.06$) and the sample of 73 with 2 groups, power analyses suggests that the current sample is powered at 98.8%, suggesting adequate power to detect medium within and within*between subject differences. Next, power analyses were conducted to determine the power of detecting medium sized correlations that are relevant to hypotheses 5,6, and 7 as these hypotheses rely on some form of linear regression with a moderation interaction term predicting follow-up sugar consumption. With moderation hypotheses, there would be four predictor variables (baseline sugar consumption, proposed moderating variable, condition, and the condition*moderating variable interaction term) predicting sugar consumption at follow up. Assuming a medium effect size (f^2=.15 or total R^2=.13) with a final sample of 73 participants who completed all relevant study measures with four predictor variables the sample is powered at 72.6%, which is somewhat below the ideal 80% power that is typically desired for hypothesis testing. This is consistent with Sheih (2011) that stated that a total sample of 78 participants would be adequate to detect small to medium effect sizes in a moderation model. For mediation hypotheses (Fritz & MacKinnon, 2007) suggested that a sample of greater than 100 participants would be required, which suggests that the final sample falls short of the required power to detect mediational effects. Thus, the sample retained should be adequate to find statistically significant differences between groups and to test moderation hypotheses, though may be inadequate to detect small to medium mediation effects.

Differences in Baseline Variables by Condition

In order to examine differences in baseline variables by randomized condition, independent samples t-tests were conducted. Overall there were no statistical differences between participants in the workshop and control conditions with regards to age, BMI, health literacy, proactive health orientation, discounting health orientation, hedonic hunger, estimated ounces and calories of sugar sweetened beverages, estimated daily averages of total sugar consumed, sugar consumed through SSB's, dietary fiber, whole grains, and fruits and vegetables. There was a significant difference regarding normative perceptions of sugar consumption, such that the intervention group estimated higher daily sugar consumption for their peers than did participants in the control condition. See Table 3 for means, standard deviations, and significant differences for baseline variables by group. Additionally, see Table 4 for a correlation matrix of key variables that are not compared in Hypotheses 3 and 4 (Health Orientation, Health Information Discounting, Health Literacy, Perceptions of Peer Sugar Consumption, and Hedonic Hunger). Notably, there was a significant and inverse relationship between Health Orientation and Health Information Discounting. There was also a positive relationship between estimates of peer sugar consumption and Health Information Discounting, meaning that the more participants discounted information from health professionals or from dietary guidelines, the more sugar they assumed their peers were consuming. There were no other significant relationships between key predictors of sugar consumption. Note that correlations with variables measuring sugar consumption are covered in Tables X and X. .

Table 3, Means, Standard Deviations, and Statistical Differences on Key Variables Between Groups at Baseline

Key Variables	Workshop M(*SD*) *n*=79	Control M(*SD*) *n*=47	Statistical Difference
Age	19.1 (*1.5*)	18.6 (*.9*)	*t*(124)=.89, *p*=.38
BMI	24.7 (*4.5*)	25.6 (*6.4*)	*t*(124)=1.73, *p*=.09
Estimated Peer Sugar Consumption (grams)	71.2 (*21.1*)	63.1 (*23.1*)	*t*(122)=1.99, *p*=.05*
Baseline Health Literacy	4.8 (*1.4*)	4.6 (*1.4*)	*t*(124)=.48, *p*=.63
Proactive Health Orientation	27.4 (*3.7*)	27.3 (*3.6*)	*t*(119)=.08, *p*=.94
Health Information Discounting	7.7 (*2.1*)	7.7 (*2.3*)	*t*(123)=.25, *p*=.80
Hedonic Hunger[A]	2.3 (*.8*)	2.3 (*1.0*)	*t*(119)=.06, *p*=.95
Baseline BEVQ-SSB (ounces)	16.8 (*17.6*)	20.4 (*21.7*)	*t*(122)=1.01, *p*=.31
Baseline BEVQ-SSB (calories)	201.2 (*210.1*)	245.7 (*266.0*)	*t*(122)=1.03, *p*=.31

Baseline DSQ Sugar (teaspoons)	14.4 (*8.4*)	16.8 (*9.9*)	*t*(121)=1.42, *p*=.16
Baseline DSQ Sugar from SSB (teaspoons)	7.4 (*8.5*)	10.0 (*10.6*)	*t*(121)=1.48, *p*=.14
Baseline DSQ Fiber (grams)	14.8 (*5.6*)	13.1 (*7.1*)	*t*(116)=1.44, *p*=.15
Baseline DSQ Whole Grains (ounces)	1.0 (*1.6*)	.8 (*2.7*)	*t*(123)=.44, *p*=.66
Baseline DSQ Fruits and Vegetables (cups)	2.2 (*.9*)	1.9 (*.9*)	*t*(122)=1.66, *p*=.10

*Note, * denotes significance at the p<.05 level. [A]denotes that Hedonic Hunger was measured with the overall average item score from the Power of Food Scale*

Table 4 Correlations of Key Variables Other than Sugar Consumption

Variables	(1)	(2)	(3)	(4)	(5)
Health Orientation (1)	1.0	*r*(120)=-.38 *p*<.01**	*r*(120)=-.07, *p=.45*	*r*(117)=-.17, *p*=.08	*r*(119)=-.03, *p*=.78
Health Information Discounting (2)	-	1.0	*r*(125)=.09, *p*=.31	*r*(120)=-.06, *p*=.52	*r*(123)=.24, *p*=.01**
Health Literacy (3)	-	-	1.0	*r*(121)=-.11, *p*=.25	*r*(124)=.06, *p*=.53
Hedonic Hunger (4)	-	-	-	1.0	*r*(119)=-.01, *p*=.94
Estimated Peer Sugar Consumption (5)	-	-	-	-	1.0

*Note, all correlations were calculated using Pearson correlations. * denotes significance at the p<.05 level and ** denotes significance at the p<.01 level.*

Aim 1

Hypothesis 1. Participants in the workshop group completed the DSQ and the BEVQ-15 at baseline and at one-month follow-up. Repeated Measures ANOVA's were conducted to determine within subject changes in estimated average daily sugar consumption and estimated daily average sugar consumption from SSB's from the DSQ and estimated ounces of SSB's and calories from SSB's from the BEVQ-15. Results can be seen in Table 5. There were no within subject changes in any key variable tracking sugar consumption within the intervention group, thus hypothesis 1 is rejected.

Table 5 Workshop Within Subject Changes in Sugar Consumption

	Baseline M(*SD*)	Follow-Up M(*SD*)	Statistical Difference
Sugar Consumed (tsp)	14.4 (*8.5*)	14.5 (*9.5*)	$F(1,42)=.01$, $p=.94$ with partial $\eta^2=.00$
Sugar Consumed from SSB's (tsp)	7.0 (*8.3*)	6.8 (*9.4*)	$F(1,43)=.02$, $p=.88$ with partial $\eta^2=.00$
Daily SSB Consumption (oz)	15.7 (*20.0*)	12.2 (*15.4*)	$F(1,39)=1.76$, $p=.19$ with partial $\eta^2=.04$
Daily SSB Consumption (Calories)	193.5 (*241.0*)	149.6 (*203.3*)	$F(1,39)=1.76$, $p=.19$ with partial $\eta^2=.04$

Note, Analyses conducted using Repeated Measures ANOVA

Hypothesis 2. Hypothesis 2 proposed that participants in the intervention group would see greater reductions in sugar consumption as compared to the control group at one month follow up. This was tested using a Mixed Measures ANOVA, with the within subject variables being within subject changes in sugar consumption from key variables from the DSQ and BEVQ-15 and the between*within subject variable being the interaction between these changes and conditional assignment. Significant interaction effects would suggest differential changes from baseline to follow up by group assignment. See Table 6 for results. Overall, there were no significant within subject or within*between subject changes from baseline to follow up. Interestingly, though not reaching statistical significance, both the intervention and control group trended toward reduced SSB consumption at one month follow up as measured by the DSQ. Importantly, group assignment had no impact on changes in SSB consumption from pre-post.

Table 6 Changes in Sugar Consumption in Intervention and Control Groups Between Baseline and Follow Up

Variables	Intervention Group M(*SD*)	Control Group M(*SD*)	Within Subjects Effect	Within*Between Subjects Effect
DSQ Sugar Consumed Baseline (tsp)	14.4 (*8.5*)	13.8 (*7.8*)	F(1,64)=.30, *p*=.58	F(1,64)=.41, *p*=.52
DSQ Sugar Consumed Follow-up (tsp)	14.5 (*9.5*)	12.7 (*7.5*)		
DSQ Sugar Consumed SSB's Baseline (tsp)	7.0 (*8.3*)	6.8 (*7.9*)	F(1,66)=.54, *p*=.47	F(1,66)=.29, *p*=.59
DSQ Sugar Consumed SSB's Follow-Up (tsp)	6.8 (*9.4*)	5.5 (*5.7*)		
BEVQ-15 SSB Ounces Consumed Baseline	15.7 (*20.0*)	16.9 (*20.7*)	F(1,64)=3.33, *p*=.07 with partial η^2=.05	F(1,64)=.04, *p*=.84
BEVQ-15 SSB Ounces Consumed Follow-up	12.2 (*15.4*)	12.4 (*13.0*)		
BEVQ-15 SSB Calories Consumed Baseline	193.5 (*241.0*)	189.7 (*230.9*)	F(1,64)=2.52, *p*=.12 with partial η^2=.03	F(1,64)=.00, *p*=.99
BEVQ-15 SSB Calories Consumed Follow-Up	149.6 (*203.3*)	146.4 (*157.9*)		

Note, Effect sizes added for insignificant, though trending statistical differences

Additionally, hypothesis 2 set out to determine differences in sugar consumption as measured by MyFitnessPal entries by group assignment. These differences were determined using independent samples t-tests. Results are shown in Table 7. There were no differences in the number of entries completed, the average calories recorded, or the average amount of sugar recorded between the control and intervention groups. Thus hypothesis 2 is broadly rejected.

Table 7 Differences in MyFitnessPal Entries by Group Assignment

MFP Variables	Intervention Group M(*SD*) *n*=34[A]	Control Group M(*SD*) *n*=18[A]	Statistical Differences
MyFitnessPal Entries	3.9 (*2.7*)	3.6 (*2.8*)	*t*(96)=.57 *p*=.60
MyFitnessPal Average Calories	1690.3 (*473.6*)	1621.1 (*375.5*)	*t*(50)=.50, *p*=.62
MyFitnessPal Average Sugar Consumed (g)	56.9 (*32.1*)	55.7 (*28.2*)	*t*(51)=.14, *p*=.89

Note, Entries were measured using participants who did not record any entries to account for attrition. Calories and sugar consumed were calculated using only participants who provided MFP data. [A]denotes the number of participants who submitted completed MFP data.

Aim 2

Aim 2 was to explore relationships between health literacy, health orientation, health information discounting, hedonic hunger, and estimated peer sugar consumption with baseline estimates of daily average sugar consumption and estimated average daily sugar consumption from SSB's on the DSQ and estimated daily ounces of SSB's and calories from SSB's on the BEVQ-15.

Hypothesis 3. Hypothesis three was that health literacy and health orientation would be inversely correlated with estimated reports of sugar consumption from the DSQ and BEVQ-15 at baseline. Hypothesis 3 was tested with Pearson correlations. Results can be seen in Table 8. Measures of sugar consumption at baseline were significantly and positively correlated with one and other. Interestingly, there were significant inverse correlations between health literacy and sugar consumption as measured by the DSQ (overall sugar consumption and sugar consumption from SSB's). Health literacy was not significantly correlated with estimates of SSB consumption from the BEVQ-15. Conversely, proactive health orientation was not significantly correlated with measures of baseline sugar consumption from both the DSQ and BEVQ-15. There was a slight trend towards an inverse correlation between health orientation and overall estimates of participant sugar and SSB consumption as measured by the DSQ and BEVQ-15 respectively, though these relationships did not reach statistical significance. Taken together, this data suggests that hypothesis 3 should be rejected.

Table 8 Correlation Matrix of Baseline Sugar Consumption with Proactive Health Orientation and Health Literacy

Variables	(1)	(2)	(3)	(4)	(5)	(6)
DSQ Sugar Consumed (tsp) (1)	1.0	$r(122)=.96$, $p<.01$**	$r(120)=.53$, $p<.01$**	$r(120)=.55$, $p<.01$**	$r(122)=.21$, $p=.02$*	$r(117)=-.17$, $p=.08$
DSQ Sugar from SSB's (tsp) (2)	-	1.0	$r(121)=.48$, $p<.01$**	$r(121)=.49$, $p<.01$**	$r(123)=.20$, $p=.02$*	$r(122)=-.12$, $p=.20$
BEVQ-15 Ounces of SSBs (3)	-	-	1.0	$r(124)=.98$, $p<.01$**	$r(124)=.07$, $p=.42$	$r(119)=-.12$, $p=.19$
BEVQ-15 Calories from SSB's (4)	-	-	-	1.0	$r(124)=.04$, $p=.69$	$r(122)=-.12$, $p=.21$
Health Literacy (5)	-	-	-	-	1.0	$r(121)=-.07$, $p=.45$
Proactive Health Orientation (6)	-	-	-	-	-	1.0

*Note, All correlations are Pearson correlations. * denotes significance at the p<.05 level, and ** denotes significance at the p<.01 level.*

Hypothesis 4. Hypothesis 4 stated that hedonic hunger and higher perceived levels of peer sugar consumption would be positively related to measures of sugar consumption from the DSQ (total estimated daily average sugar consumed, and daily sugar consumed from SSB's) and SSB consumption the BEVQ-15 (total estimated daily average of ounces of SSB's consumed and total calories from SSB's). Results can be seen in Table 9. Perceptions of peer sugar consumption were positively related to self-reported SSB consumption in ounces and calories as measured by the BEVQ-15. There was no significant relationship with perceptions of average peer sugar consumption and self-reported daily sugar consumed or sugar consumed through SSB's as measured by the DSQ. There was no significant relationship between hedonic hunger and any baseline measures of SSB or sugar consumption. Thus, hypothesis 4 is partially supported in that higher estimates of average peer sugar consumption seem to be related to higher self-reported SSB consumption, though not of overall estimated sugar consumption.

Table 9 Correlation Matrix of Baseline Sugar Consumption with Perceived Norms of Peer Sugar Consumption and Hedonic Hunger

Variables	(1)	(2)	(3)	(4)	(5)	(6)
DSQ Sugar Consumed (tsp) (1)	1.0	*r*(122)=.96, *p*<.01**	*r*(120)=.53, *p*<.01**	*r*(120)=.55, *p*<.01**	*r*(120)=.11, *p*=.22	*r*(117)=-.01, *p*=.90
DSQ Sugar from SSB's (tsp) (2)	-	1.0	*r*(121)=.48, *p*<.01**	*r*(121)=.49, *p*<.01**	*r*(121)=.13, *p*=.16	*r*(118)=-.02, *p*=.81
BEVQ-15 Ounces of SSBs (3)	-	-	1.0	*r*(124)=.98, *p*<.01**	*r*(123)=.34, *p*<.01**	*r*(119)=.12, *p*=.20
BEVQ-15 Calories from SSB's (4)	-	-	-	1.0	*r*(123)=.34, *p*<.01**	*r*(119)=.09 *p*=.31

Estimates of Peer Sugar Consumption (5)	-	-	-	-	1.0	*r*(119)=-.01, *p*=.94
Hedonic Hunger (6)	-	-	-	-	-	1.0

Note, All correlations are Pearson correlations.

Aim 3

Aim 3 was to examine the impact of hypothesized moderating factors on reduced sugar consumption from baseline to follow up within the intervention group relative to the control group.

Hypothesis 5. It was hypothesized that health literacy would moderate the impact of the workshop (reduced sugar consumption at follow-up), such that those scoring higher in health literacy would see greater reductions in estimated daily sugar consumption as measured by the DSQ's and estimated daily SSB consumption as measured by the BEVQ-15. In order to test this hypothesis, a linear regression was modelled predicting sugar and SSB consumption as measured by the DSQ and BEVQ-15 respectively, using the respective measure of baseline sugar or SSB consumption, conditional assignment, health literacy, and the moderation variable of condition*health literacy as predictors entered simultaneously. A significant beta weight for the moderation variable in either regression equations would indicate a significant moderation effect. The overall regression significantly predicted the estimate of daily average sugar consumed as measured by the DSQ $F(4,61)=12.68$, $p<.01$** and predicted 45% of the variance of daily average sugar consumption at follow-up. Regression coefficients can be seen in Table 10. Overall, the only significant predictor of follow-up daily average sugar consumption as estimated by the DSQ was baseline sugar consumption as measured by the DSQ, suggesting that health literacy did not moderate the impact of the workshop on reduced sugar consumption as measured by the DSQ at follow-up.

*Table 10 Prediction of Follow-Up Average Daily Sugar Consumption as Measured by the DSQ by Baseline Sugar Consumption as measured by the DSQ, Health Literacy, Condition, and Condition*Health Literacy*

Predictor Variable	β (*standard error*)	Standardized β	*t*	*p*
Intercept	4.55 (*11.09*)	-	.41	.68
Baseline Sugar Consumption (DSQ)	.72 (*.10*)	.67	7.01	<.01**
Condition	2.20 (*6.92*)	.12	.32	.75
Health Literacy	.23 (*2.09*)	.03	.11	.91
Condition*Health Literacy	-.74 (*1.34*)	-.25	-.56	.58

*Note, **denotes significance at the p<.01 level. Linear Regression was used to predict Sugar Consumption at follow-up.*

Similarly, a linear regression was modelled predicting SSB consumption in average daily ounces consumed as measured by the BEVQ-15 using baseline SSB consumption as measured by baseline BEVQ-15 data, conditional assignment, health literacy, and the moderation variable of condition*health literacy entered simultaneously to test the second portion of hypothesis 5. Overall, baseline daily average ounces of SSB's consumed as measured by the BEVQ-15, conditional assignment, health literacy, and the moderation variable of health literacy*conditional assignment significantly predicted daily average SSB consumption in ounces as measured by the BEVQ-15 at follow up $F(4,61)=7.41$, $p<.01$** and specifically predicted 31% of the variance in SSB consumption at follow up. Regression coefficients can be seen in Table 11. Overall, higher baseline daily SSB calorie consumption and lower health literacy scores predicted higher levels of average daily SSB calorie consumption as measured by the BEVQ-15 at follow up. The beta weight on the interaction term of health literacy*conditional assignment was not significant, suggesting that health literacy did not moderate the impact of the workshop on reducing sugar consumption. Taken together, hypothesis 5 is rejected. It appears that health literacy significantly predicted lower SSB consumption at follow-up, such that those scoring higher in health literacy reported lower SSB consumption at follow-up, but did not predict lower overall sugar consumption and did not moderate the impact of the workshop on either overall daily average sugar consumption as measured by the DSQ or SSB consumption as measured by the BEVQ-15.

*Table 11 Prediction of Follow-Up Average Daily SSB Consumption (in calories) as Measured by the BEVQ-15 by Baseline SSB consumption measured by the BEVQ-15 Health Literacy, Condition, and Condition*Health Literacy*

Predictor Variable	β (*standard error*)	Standardized β	*t*	*p*
Intercept	596.38 (*262.41*)	-	2.27	.03*
Baseline SSB Consumption (BEVQ-15)	.40 (*.08*)	.51	4.83	<.01**
Condition	-215.63 (158.74)	-.57	-1.36	.18
Health Literacy	-100.58 (*50.61*)	-.70	-1.99	.05*
Condition*Health Literacy	40.35 (*30.93*)	.65	1.31	.20

*Note, * denotes significance at the p<.05 level, **denotes significance at the p<.01 level. Linear Regression was used to predict SSB Consumption at follow-up.*

Hypothesis 6. It was hypothesized that health orientation would moderate the impact of the intervention, such that those scoring higher in health orientation would show greater reductions in sugar consumption when in the intervention group than those low in health orientation. Sugar and SSB consumption were measured with the

DSQ and BEVQ-15 respectively. Two linear regressions were set up in a similar fashion to hypothesis 6 predicting both average daily sugar consumption at follow-up as measured by the DSQ (in teaspoons) and average daily SSB consumption at follow-up as measured by the BEVQ-15 in calories. For the first regression, average daily sugar consumption at follow-up as measured by the DSQ was predicted from baseline sugar consumption as measured by the DSQ, the conditional assignment, health orientation, and the moderation interaction term of health orientation*conditional assignment. Results and regression coefficients can be seen in Table 12. Overall, the total regression significantly predicted estimates of average daily sugar consumption at follow up $F(4,60)=12.21$, $p<.01$** predicting 45% of the total variance. That said, the only significant predictor of sugar consumption at follow-up was estimated daily average baseline sugar consumption as measured by the DSQ.

*Table 12 Prediction of Follow-Up Average Daily Sugar Consumption as Measured by the DSQ by Baseline Sugar Consumption measured by DSQ, Health Orientation, Condition, and Condition*Health Orientation*

Predictor Variable	β (*standard error*)	Standardized β	*t*	*p*
Intercept	11.92 (*11.29*)	-	1.06	.29
Baseline Sugar Consumption (DSQ)	.69 (*.10*)	.64	6.62	<.01**
Condition	-2.74 (*8.15*)	-.15	-.34	.74
Health Orientation	-.29 (*.54*)	-.16	-.55	.59
Condition*Health Orientation	.07 (*.39*)	.09	.17	.87

*Note, **denotes significance at the p<.01 level. Linear Regression was used to predict Sugar Consumption at follow-up.*

For the second regression, follow up total daily average SSB consumption as measured by the BEVQ-15 in estimated daily SSB calories was predicted from baseline SSB consumption as measured by the BEVQ-15, condition, health orientation, and health orientation*condition. Results can be seen in Table 13. Overall, the regression significantly predicted daily average SSB calorie consumption at follow-up as measured by the BEVQ-15 $F(4,60)=5.10$, $p<.01$** explaining 25% of the variance. The only significant predictor was baseline average SSB calories consumed as measured by the BEVQ-15. Overall, both regressions suggest that hypothesis 6 should be rejected, therefore suggesting that health orientation did not moderate the impact of the intervention on follow-up measures of sugar consumption and that the only significant predictor of sugar consumption at follow up, were measures of sugar consumption at baseline.

*Table 13 Prediction of Follow-Up Average Daily SSB Consumption (in calories) as Measured by the BEVQ-15 by Baseline SSB consumption from the BEVQ-15, Health Orientation, Condition, and Condition*Health Orientation*

Predictor Variable	β (*standard error*)	Standardized β	*t*	*p*
Intercept	-53.39 (*279.32*)	-	-.19	.85
Baseline SSB Consumption (BEVQ-15)	.37 (*.09*)	.47	4.11	<.01**
Condition	137.22 (*192.20*)	.36	.71	.48
Health Orientation	6.71 (*13.32*)	.17	.50	.62
Condition*Health Orientation	-6.98 (*9.23*)	-.44	-.76	.45

*Note, * denotes significance at the p<.05 level, **denotes significance at the p<.01 level. Linear Regression was used to predict SSB Consumption at follow-up.*

Hypothesis 7. It was hypothesized that hedonic hunger as measured by the power of food scale would moderate intervention effects, such that those high in hedonic hunger within the workshop would evidence higher levels (lower reductions in sugar consumption) of sugar consumption at follow up as measured by the DSQ and BEVQ-15 at follow-up. In the first regression, follow up estimates of daily average sugar consumption as measured by the DSQ were predicted from baseline average daily sugar estimates from the DSQ, conditional assignment, hedonic hunger, and hedonic hunger*conditional assignment as the moderation term. Overall, the regression significantly predicted follow up estimates of daily sugar consumption as measured by the DSQ $F(4,61)=12.04$, $p<.01$** and explained 44% of the variance. Regression coefficients can be seen in Table 14. The only significant predictor of daily average sugar consumption at follow up as measured by the DSQ was daily average sugar consumption at baseline as measured by the DSQ.

*Table 14 Prediction of Follow-Up Average Daily Sugar Consumption as Measured by the DSQ by Baseline Sugar Consumption from the DSQ, Hedonic Hunger, Condition, and Condition*Hedonic Hunger*

Predictor Variable	β (*standard error*)	Standardized β	*t*	*p*
Intercept	8.66 (*7.97*)	-	1.09	.28
Baseline Sugar Consumption (DSQ)	.70 (*.10*)	.65	6.81	<.01**
Condition	-2.23 (*4.95*)	-.12	-.45	.65
Hedonic Hunger	-1.26 (*3.09*)	-.13	-.41	.68
Condition*Hedonic Hunger	.38 (*1.94*)	.08	.20	.85

*Note, **denotes significance at the p<.01 level. Linear Regression was used to predict Sugar Consumption at follow-up.*

Similarly, the second regression set out to predict average daily calories of SSB's consumed at follow up as measured by the BEVQ-15 using baseline levels of average daily SSB consumption as measured by the BEVQ-15 at baseline, conditional assignment, hedonic hunger, and hedonic hunger*conditional assignment. Overall, the regression significantly predicted follow up SSB consumption (in ounces) as measured by the BEVQ-15 $F(4,65)=4.93$, $p<.01$** and explained 24% of the variance. Regression coefficients can be seen in Table 15. The only significant predictor of average daily SSB consumption (in calories) as measured by the BEVQ-15 at follow up was daily average SSB consumption (in ounces) as measured by the BEVQ-15 at baseline. This suggests that hedonic hunger did not significantly moderate the impact of the intervention on follow-up SSB consumption.

*Table 15 Prediction of Follow-Up Average Daily SSB Consumption (in calories) as Measured by the BEVQ-15 by Baseline SSB consumption (in calories), Hedonic Hunger, Condition, and Condition*Hedonic Hunger*

Predictor Variable	β (*standard error*)	Standardized β	*t*	*p*
Intercept	129.01 (*209.97*)	-	.61	.54
Baseline SSB Consumption (BEVQ-15)	.39 (*.09*)	.49	4.25	<.01**
Condition	-19.02 (*129.05*)	-.05	-.15	.88
Hedonic Hunger	-22.77 (*83.39*)	-.10	-.27	.79
Condition*Hedonic Hunger	7.52 (*51.56*)	.07	.15	.89

*Note, * denotes significance at the p<.05 level, **denotes significance at the p<.01 level. Linear Regression was used to predict SSB Consumption at follow-up.*

Taken together, hedonic hunger did not moderate the impact of the workshop on either overall estimates of daily average sugar consumed at follow-up or daily average SSB consumption at follow-up. This suggests that hypothesis 7, that hedonic hunger would moderate the relationship between conditional assignment and follow-up sugar consumption, should be rejected.

Aim 4

Hypotheses 8 It was hypothesized that changes in health literacy would mediate the relationship between conditional assignment and sugar consumption at follow-up. In order to conduct mediation analysis, it is necessary to demonstrate a statistically significant relationship between conditional assignment and sugar consumption at follow up (Kazdin, 2007). There was no statistically significant effect of treatment (see hypothesis 1 and 2), therefore rendering mediation analysis unwarranted.

Hypothesis 9. Hypothesis 9 posited that changes in perceptions of peer sugar consumption would mediate the relationship between conditional assignment and sugar consumption and SSB consumption at follow up. Like hypothesis 8, in order to test a mediation effect, there must be a significant relationship between conditional assignment and sugar consumption at follow-up. Given that there was no treatment effect (see hypotheses 1 and 2), Kazdin (2007) suggests that further investigation of mediation effects is unwarranted.

Exploratory Analyses

Peer Versus Expert Led Intervention

Given the addition of a peer leader, additional exploratory analyses were conducted to examine the impact of having a peer educator lead workshops. Crosstabs of peer versus graduate student run interventions and conditional assignment can be seen in Table 16. Overall, a proportional amount of randomization to the control or workshop occurred between peer-lead and graduate student lead workshops $\chi^2(1)=1.75$, $p=.19$.

Table 16, Crosstabs of Conditional Assignment and Peer versus Graduate Student Led Workshops

	Peer-Led	Graduate Student Lead	Total
Workshop	53	26	79
Control	26	21	47
Total	79	47	126

There was, however, a significant relationship between attrition and peer-lead versus graduate student lead interventions $\chi^2(1)=6.38$, $p=.01$** such that more attrition occurred when interventions were peer-led. Crosstabs of this can be seen in Table 17. It should be noted that peer-led interventions also disproportionately took place in

March of 2018 and that there was a significant effect of time of year on attrition $\chi^2(3)=11.65$, $p=.01$** such that a disproportionate amount of attrition occurred in the months of March of 2018 and 2019. Crosstabs of time of year and attrition can be seen in Table 18.

Table 17, Crosstabs of Attrition and Peer versus Graduate Student Led Workshops

	Peer-Led	Graduate Student Lead	Total
Completed Study	39	34	73
Lost to Follow-Up	40	13	53
Total	79	47	126

Table 18 Crosstabs of Attrition by Time of Study Participation

Status	March 2018	October 2018	February 2019	March 2019	Total
Completed Study	6	23	20	24	73
Lost to Follow Up	5	6	10	32	53
Total	11	29	30	56	126

Additionally, differences in participants' self-reported levels of sugar consumption at follow-up, estimates of peer levels of sugar consumption, health literacy at follow-up, MyFitnessPal entries, and average levels of calories and sugar reported in MyFitnessPal entries were examined based on whether or not participants completed the study with a peer or graduate student leader. Results from this analysis can be seen in Table 19. There were no statistically significant differences in baseline or follow up measures of sugar consumption or SSB consumption as estimated by the DSQ (Thompson et al., 2005) and BEVQ-15 (Hendrick et al., 2012) respectively. Interestingly, there did seem to be a trend for participants in the peer led condition who received the workshop to report less SSB consumption at one month follow up compared to those who completed the study and participated in the graduate student led workshops. This trend may be due to attrition, as peer lead workshop and control groups experienced significantly higher attrition, and thus may have lost a disproportionate amount of high SSB consumers relative to graduate student led workshops and control groups, which did not experience as much attrition. Interestingly, there were relationships with attrition and health literacy, which will be discussed below. These relationships existed such that higher levels of health literacy were related to study completion and may have also led to more accurate reporting by those participating in the workshop, and thus higher reported estimates of sugar and SSB's consumed.

Table 19, Mean Comparisons between Peer-Lead and Graduate Student Lead Participants on Baseline and Follow-up Sugar and SSB Consumption and Health Literacy, and MyFitnessPal entries

Variable	Peer Led M(*SD*)	Graduate Student Led M(*SD*)	Mean Difference
Baseline Sugar Consumption (tsp/day) DSQ	14.9 (*9.2*)	16.0 (*8.7*)	$t(120)=.66$, $p=.51$
Follow-Up Sugar Consumption (tsp/day) DSQ	13.2 (*8.2*)	14.5 (*9.5*)	$t(65)=.61$, $p=.55$
Follow-Up Sugar Consumption (tsp/day) DSQ^{A}	12.7 (*8.2*)	17.5 (*11.0*)	$t(41)=1.63$, $p=.11$
Baseline SSB Consumption (calories/day) BEVQ-15	233.0 (*254.1*)	192.6 (*191.6*)	$t(122)=.94$, $p=.35$
Follow-Up SSB Consumption (calories/day) BEVQ-15	131.0 (*153.2*)	172.3 (*214.1*)	$t(66)=.93$, $p=.36$

Follow-Up SSB Consumption (calories/day) BEVQ-15[A]	104.9 (*115.0*)	225.8 (*285.6*)	$t(16.7)^B=1.57$, $p=.14$
Perceptions of Peer Sugar Consumption (tsp)	17.0 (*6.0*)	17.2 (*4.8*)	$t(122)=.25$, $p=.80$
MyFitnessPal Entries	3.8 (*2.7*)	3.7 (*2.7*)	$t(96)=-.18$, $p=.86$
MFP Average Calories	1710.4 (*452.9*)	1618.7 (*427.4*)	$t(50)=.75$, $p=.46$
MFP Average Sugar (g)	59.2 (*35.3*)	53.5 (*24.4*)	$t(51)=.67$, $p=.50$
Pre Health Literacy	4.7 (*1.4*)	4.8 (*1.4*)	$t(124)=.33$, $p=.75$
Post Health Literacy	4.9 (*1.4*)	4.9 (*1.4*)	$t(69)=.03$, $p=.97$
Post Health Literacy[A]	4.8 (*1.5*)	5.0 (*1.3*)	$t(43)=.39$, $p=.70$

Note, all analyses conducted with independent samples t-tests. [A]Denotes analyses that were conducted with participants in the workshop group only. [B]Denotes degrees of freedom adjustment due to violation of assumption of equal variances.

Relationship of Key Variables with Baseline Health Literacy

Another interesting finding discovered through exploratory analyses were relationships between health literacy and attrition, levels of sugar consumed at baseline as measured by the DSQ, MyFitnessPal entries, and calories recorded from MyFitnessPal entries. It should be noted that there was very little change in health literacy scores from baseline to follow up within the intervention group with $M_{change}=-.06$ $SD_{change}=.1$. In regards to attrition, disproportionately more participants who were low in health literacy were lost at follow-up $\chi^2(5)=16.5$, $p=.01$**. Crosstabs featuring health literacy scores and attrition status can be seen in Table 20.

Table 20, Crosstabs of Baseline Health Literacy Scores and Attrition Status

Attrition Status	NVS^A Score 1	NVS^A Score 2	NVS^A Score 3	NVS^A Score 4	NVS^A Score 5	NVS^A Score 6	Total
Completed Study	0	4	6	8	18	37	73
Lost to Follow-Up	2	5	8	16	8	14	53
Total	2	9	14	24	26	51	126

Note, ^A denotes that scores are reflective of baseline health literacy scores as indicated by scores on the NVS (Weiss et al., 2005).

Additionally, there were relationships with baseline health literacy and estimates of daily average sugar consumed both in general and of sugar consumed through SSB's as estimated by the DSQ (Thompson et al., 2005) at baseline $r(122)=.21$, $p=.02$* for overall sugar consumption and $r(123)=.20$, $p=.02$* for SSB consumption such that participants scoring higher in health literacy also had higher estimates of average daily baseline sugar consumption. Interestingly, this relationship was not found with the BEVQ-15 (Hendrick et al., 2012) in terms of health literacy scores with caloric intake of SSB's at baseline $r(124)=.04$, $p=.69$. There was also a positive relationship with baseline health literacy scores and the number of MyFitnessPal entries recorded $r(98)=.24$, $p.02$*, as well as average daily calories recorded from MyFitnessPal entries $r(52)=.36$, $p=.01$**, but not of average daily sugar recorded from MyFitnessPal entries $r(53)=.09$, $p=.52$. More on this will be addressed in the discussion.

CHAPTER V DISCUSSION

Summary and Context of Results

This study investigated the efficacy of a 90-minute sugar reduction workshop for college students based on Taylor et al. (2015) with the addition of peer normative feedback based on Rosas et al. (2017). In addition to peer normative feedback, the current study sought to build on Taylor et al.'s (2015) study with the inclusion of a control group, as well as a month long follow up period for all study participants. Taylor and colleague's (2015) original study examined sugar consumption at a one-week follow-up and only had a small portion of the sample complete a one-month follow-up period. Furthermore, Taylor and colleagues' (2015 study did not feature a control group.

Sugar Consumption Trends and Workshop Effectiveness

Overall, the workshop did not produce significant within-subject reductions in overall average daily sugar consumption as measured by the DSQ (Thompson et al., 2005) and overall average daily SSB ounces consumed or calories consumed from SSBs as measured by the BEVQ-15 (Hendrick et al., 2012) from baseline to one-month follow up. Further, the intervention group did not differ from the control group in sugar consumption at baseline and at one-month follow up. This suggests that the workshop was ineffective in reducing overall sugar consumption. This is surprising given that a similar workshop reported an average reduction in overall daily sugar consumption of 20 grams at one-week follow-up and an average reduction in daily SSB consumption of 167.7 calories (Taylor et al. 2015). Interestingly, estimates of average daily sugar consumption at baseline for the workshop group (M_{grams}=57.6, SD_{grams}=33.6) and the control group (M_{grams}=67.5, SD_{grams}=39.6) is lower than nationally representative data from Ervin and Ogden's (2013) data brief suggesting that similarly aged males consume about 99.3 grams of sugar per day and similarly aged women consume about 68.8 grams of sugar per day. Statistically speaking baseline estimates of male sugar consumption were significantly less than Ervin and Ogden's (2013) sample $t(82)=-7.10$, $p<.01$** with M_{males}=67.5g SD_{males}=40.3g using a one sample t test against test statistic 99.25 and female baseline sugar consumption was significantly less than Ervin and Ogden's sample $t(40)=-6.86$, $p<.01$** with $M_{females}$=48.1g, $SD_{females}$=19.1g using a one sample t test with test statistic 68.75. This may indicate a cohort effect, and signal changes in overall population level sugar consumption in the US. Similarly, this finding may also reflect a selection bias effect regarding this sample. Specifically, the study was advertised as the "College Student Healthy Living Study" and discussed dietary tracking in the study description. This could have disproportionately pulled health conscious individuals to participate. Indeed, the 67 participants whose DSQ at follow up could be calculated and who completed the study showed lower levels of sugar consumption relative to the age matched nationally representative Ervin and Ogden (2013) sample for female study completers $t(22)=-4.50$, $p<.01$** with $M_{females}$= 47.9g SD_{female}=32.6g using a single sample t test with test statistic of 68.75 and significantly lower levels of sugar consumption for male study completers $t(40)=-6.13$, $p<.01$** with M_{males}=60.2g SD_{males}=36.9g using a single sample t test with test statistic 99.25. The current numbers are encouraging as well if they are compared to the WHO (2015) recommendation that less than 10% of daily caloric intake come from added sugars. Specifically, if we hypothetically assume that young adult men (19-35) consume about

2,700 calories/day on average and age matched women consume about 1,800 calories per day on average based on nationally representative national data from Ladabaum, Mannalithara, Myer, and Singh (2014), male completers from the current sample would consume about 9% and female study completers about 11% of total daily caloric intake from added sugars. This would indicate that participants who completed the current study are consuming less added sugars than previously gathered nationally representative samples, such as Marriot et al. (2009) and Ervin and Ogden (2013). This is encouraging as the current reported estimates of sugar consumption as measured by the DSQ seem to be falling within, or very close to the WHO's (2015) guidelines.   That said, one should also take caution in interpreting these results as people tend to underreport dietary intake. Underreporting of caloric intake has been deemed common when estimating both fast food (Chandon & Wansink, 2007) and even of organic food (Besson, Lalot, Bochard, Flaudias & Zerhouni, 2019). In fact, some research has suggested that underreporting of dietary fat may have systematically contributed to over-estimating the impact that dietary fat plays in cardiovascular and metabolic risk factors in epidemiological studies (Heitmann & Lissner, 2005).

Trend Towards Within-Subject SSB Changes

One other finding was the trend towards reduced SSB consumption as measured by the BEVQ-15 (Hendrick et al., 2012) for both control and workshop groups. While this within-subject trend did not reach statistical significance, there were reductions from about 16 ounces or about 195 calories of SSB consumption/day to about 12 ounces or 150 calories of SSB beverage consumption per day. Importantly, however, there was no within*between subject reduction, indicating that both groups reported similar SSB consumption patterns from baseline to one-month follow up. Specifically the control group went from 16.9 ounces or 189.7 calories of SSB consumption per day to about 12.4 ounces or 146.4 calories per day of SSB consumption at one month follow up, and the group that participated in the workshop went from 15.7 ounces or 193.5 calories of SSB per day to 12.2 ounces of 149.6 calories per day of SSB consumption at one-month follow-up. One reason for this reduction may be that both participants in the control and intervention groups did make small reductions in their SSB consumption. Another possibility that is not mutually exclusive with actual reductions in SSB consumption is, once again, the idea of a selection effect such that participants opting to participate and complete the current study were on average more interested in tracking their own health behaviors and making positive changes in these behaviors relative to peers who opted not to participate. This is like findings from Enzenbach, Wicklein, Wirkner and Loeffler, 2019. Other research has found that participants begin either thinking about change when enrolling in a study targeting health behaviors, even in the absence of an intervention (MacNeill, Foley, Quirk & McCambridge, 2016), thus it is possible that participation in the control group and active enrollment in the study may have coincided with intended behavioral change with regards to SSB consumption That said, it should be noted that the study never directly stated that it was specifically looking at sugar consumption. It should also be noted that demand characteristics of the study may have also played a role and lead to under-reporting of sugar consumption as well. Underreporting is common in studies where participants are asked to track their diet and has been linked to social desirability (Herbert, Celmow, Pbert, Ockene & Ockene, 1995) and may have contributed to reductions in both the control and intervention group. Unfortunately, given time constraints, participants were not asked about their specific diet history or previous or current use of dietary self-monitoring.

Health Literacy's Positive Relationship to Reported Sugar Consumption

Further this study also examined relationships between sugar consumption and perceptions of peer sugar consumption, health literacy, health orientation, and hedonic hunger. One curious finding was the positive relationship between baseline health literacy scores and daily average sugar consumption at baseline. Looking at the current sample, participants scoring perfectly on the NVS measure of health literacy recorded significantly more MyFitnessPal calories ($M_{calories}$=1800.14, $SD_{calories}$=429.00) than participants scoring a 5 or lower on the NVS ($M_{calories}$=1514.02, $SD_{calories}$=407.59) with $t(50)=2.45$, $p=.02$*. This may be due to those higher in health literacy being better able to judge portion sizes or find more accurate representations of what they are consuming in online databases that MyFitnessPal uses to estimate calorie totals. Additionally, given health literacy's relationship to study retention (higher health literacy was predictive of study completion), follow-up estimates of SSB and sugar consumption may have been influenced by the selection and retention of a sample that was already aware of and possibly formally or informally monitoring their sugar intake, and were fairly accurate in their reporting of dietary intake, which contributed to both estimates of overall sugar and SSB consumption. There is some literature that has found that the accuracy, but not the completion of food records and food recall data are related to higher levels of health literacy amongst weight loss participants (Rosenbaum, Clark, Convertino, Call, Forman & Butryn, 2018). This may also account for the strong positive relationship between baseline health literacy scores and average recorded caloric consumption, but not sugar consumption in MyFitnessPal entries. As stated in the results, there was a positive correlation between health literacy scores and MyFitnessPal calories that were recorded, but not for daily sugar intake. That said, the average recorded daily caloric consumption in MyFitnessPal in this study (around 1,700 calories) is somewhat lower than recent national data suggests, which has found that the average daily caloric intake form women between ages 18-39 is around 1,873 and about 2,678 for men of the same age (Ladabaum et al., 2014). This may indicate that the current sample, on average, did not produce complete food records, and this in turn may have influenced these relationships such that individuals scoring lower in health literacy may have been more likely to provide incomplete or inaccurate food records. It should also be noted that caloric underestimation in studies examining dietary habits is common, particularly when recording large meals (Chandon & Wansink, 2007; Franckle, Block & Roberto, 2016), and may be related to social desirability in responding (Herbert et al., 2005).

Estimates of Peer Sugar Consumption

Findings from the current study suggested that one's own SSB consumption was positively associated with one's perceptions of the amount of sugar their peers consumed. This finding was expected and not surprising. Indeed, the relationship between one's own SSB consumption and perceptions of peer SSB has also been found in recent literature among a sample of 5,841 students in grades 6-12 (Perkins, Perkins & Craig, 2018). A key difference between the sample from Perkins et al.'s (2018) and the current sample though, was that the current sample was fairly accurate in their perceptions of peer sugar consumption, and in fact leaned towards underestimating levels of peer sugar consumption as measured by baseline DSQ (Thompson et al., 2005), while over half of Perkins et al.'s (2018) sample of adolescents overestimated levels of peer sugar consumption. Specifically, the current sample reported consuming an average daily total of M_{sugar}=61.2g, SD_{sugar}=35.9g and estimated that their peers consumed M_{sugar}=68.3g, SD_{sugar}=22.1g. This estimate is close to the actual average sugar consumption of participant's peers *in this study* and are significantly less than the consumption data found in Ervin and Ogden's (2013) sample. This seems important to consider, as peer normative feedback likely had little to no effect on consumption given that there was very little room for correction in these perceptions for participants in the workshop group. This could have been some of the reason that the normative feedback component of the intervention was less effective than its use in either the Perkins et al. (2018) or the Rosas et al. (2017) study. That said, caution should be expressed here, as there is no way in the current study to isolate the impact of peer-normative feedback. Another important difference between the Perkins et al. (2018) sample and the current sample is that participants in the Perkins et al. (2018) sample were estimating the amount of SSB's their peers consumed, while the current sample was estimating the amount of sugar cubes (4g each) that their peers consumed as a whole. This was done in order to provide participants with a visual representation of sugar, as it was assumed that many students would struggle to picture what a gram of sugar would look like, and therefore potentially lead to meaningless responses. This may underly the reason the Perkins et al. (2018) sample estimated something regularly visible and tangible to participants in the form of SSB servings. Thus, Perkins et al.'s (2018) sample was providing estimates of peer consumption in the same modality as consumption data was measured in the study, while the current study did not ask participants to estimate the level of peer SSB consumption. This is an important difference, and limitation to comparison, as it may be easier for participants to quantify their levels of SSB consumption and estimate the levels of peer SSB consumption. Indeed, it may be that SSB's are one of the most recognizable products containing high levels of sugar. In fact, in the current sample according to the DSQ, sugar from SSB consumption comprised a little under half of all sugar consumed by participants (refer to Table 5 on page 81). Perhaps lending additional credibility to this idea is the suggestion that reducing SSB intake in general may help to make significant dose-response reductions in weight gain and overall sugar consumption (Kaiser, Shikany, Keating & Allison, 2013).

Potential Population Level Attitude Shifts Regarding Sugar Consumption

Similarly, it is important to account for the potential of average attitude and behavioral changes regarding sugar consumption among college students that may be contributing to less overall sugar consumption than previously documented. These changes may reflect more awareness of sugar and its health effects, as well as knowledge of behavioral strategies that reduce sugar consumption within the college population. Other literature has consistently found significant overestimation in peer consumption of SSBs and sugary snacks as well (Lally et al., 2011; Perkins et al., 2010; Robinson et al., 2015), which would make the current sample's more accurate, and perhaps underestimated perceptions of peer sugar consumption a somewhat unique finding. More recent literature suggests that changes in population level attitudes, perceptions, and behaviors may in fact be underway, and would be considered a relatively positive development with regards to college student health (de Vlieger, Collins & Bucher, 2017; Fernandes, de Oliveira, Rodrigues, Fiates, da Costa Proenca, 2015; Howse, Freeman, Wu, Rooney, 2018; Vizireanu & Hruschka, 2018).

Moderation and Mediation Hypotheses

Additionally, this study examined hypothesized moderators of workshop effectiveness, which were perceptions of peer sugar consumption, health orientation, and hedonic hunger respectively. Analyses revealed that there was no moderating effect of health orientation, health literacy, and of hedonic hunger on the workshop effectiveness. Importantly, there were also no significant relationships established between conditional assignment and follow up reports of SSB or sugar consumption when examining hypothesized moderating variables. It should be noted that without an intervention effect, it is likely to be more difficult to assess the impact of moderating variables. That said, when examining moderation hypotheses, the only significant predictor of follow up SSB or sugar consumption outside of baseline sugar or SSB consumption was the impact of health literacy on SSB consumption at follow up such that participants reporting higher baseline health literacy scores also reported less SSB consumption at follow up. Once again, this may be due to sample selection bias, which will be discussed further below. With regards to health literacy, it is also possible that the relationship between health literacy and completion of the study may also have impacted the ability to determine a moderational effect of health literacy on workshop effectiveness. This is given that there were higher levels of attrition among participants lower in health literacy, and the moderation hypothesis was set up to predict sugar and SSB consumption at follow up. Thus, it may be that participants lower in health literacy did not complete follow-up measures, which could have lead to disproportionately more missing follow-up sugar consumption data for those same participants relative to participants scoring higher in health literacy. This would lead to reduced variability in health literacy scores amongst study completers. Regarding health orientation and hedonic hunger, there were no established relationships between these predictor variables and either baseline or follow-up sugar or SSB consumption in addition to no evidence of a moderating impact on the effectiveness of the workshop. This is a curious finding, as other studies have found relationships between sugar consumption and hedonic hunger (Naughton, McCarthy & McCarthy, 2015). That said, Naughton et al.'s sample was a sample of Irish adults, and data showed that habit was a mediator between sugar consumption and hedonic hunger. Thus, it may be that the current sample was not in a regular habit of high levels of sugar consumption, especially given that the current sample was comprised of predominantly college freshman. Indeed, recent research suggests that college students experience fluctuation in dietary habit and priority across their freshman year, as they begin to establish their own dietary habits separate from their families of origin (Vilaro et al., 2018). This is important research to note as the current sample was comprised of 76.2% freshman students.

Finally, this study was designed to examine the proposed mechanisms of workshop effectiveness through mediation analysis (i.e., whether gains in health literacy and corrections in perceptions of peer sugar consumption would mediate the relationships between conditional assignment and reported sugar consumption at follow-up). Unfortunately, there was also no way to test these mediation models, given that the workshop did not produce significant within*between subject effects that would indicate workshop effectiveness, and therefore a relationship between conditional assignment and follow-up sugar and SSB consumption. According to Kazdin (2007) there must be an established relationship between two variables, in this case conditional assignment and sugar consumption at follow-up, to establish a mediational model. Given that the workshop did not produce any significant reductions in sugar consumption, there is no way to determine whether gains in health literacy or corrections in perceptions of peer sugar consumption mediated the relationship between conditional assignment and sugar consumption at follow up.

Finally, exploratory analyses found that there were differences in attrition depending on whether the workshop was led by an undergraduate or “peer” facilitator or a graduate student. Despite this, there were no other significant differences found between graduate student led and undergraduate student led workshops. There were, however, significant differences in attrition such that nearly half of the participants in the peer led groups were lost to attrition, while this number was lower amongst participants that completed orientation and/or the workshop with graduate student facilitators.

Limitations

Attrition

Given the relatively high amount of attrition in this study (42%) caution should be exercised when interpreting results, especially those that were reliant on the completion of follow-up measures. Indeed, the relative burden of this study was high, as participants were required to complete roughly 4 hours of study related responding in the intervention group and 2.5 hours if participants were in the control group. One thing of note is that the current sample was recruited via the psychology student subject pool at East Carolina University. Participants completed the study for course credit, and there is no way of knowing the motivation for participation of some participants. It is possible that some portion of participants completed the study simply for course credit. This may have contributed to lower intrinsic motivation to complete the study, particularly given the demands of the current study on participants. Attrition may have impacted the results by further strengthening selection bias effects (participants who followed up may have been especially motivated to complete the study), as well as reducing the overall amount of power that this study had to examine hypothesized relationships, which would especially true in the case of hypotheses regarding moderation and mediation. That said, there should have remained adequate power to detect differences between intervention and control groups, even with attrition.

Selection Bias and Cohort Effects

As mentioned earlier, selection bias effects may have had a strong impact on the results of this study. This study was advertised as the “College Student Healthy Living Study” and mentioned the use of MyFitnessPal in the study description. It is possible that this study pulled for a sample that was already using MyFitnessPal, was aware of their own dietary intake, and/or were interested in a study that examined these behaviors. This would lead to a sample that had minimal room for change, which may lead to floor effects as well as the potential for underreporting of sugar consumption. In addition to selection effects, one must also entertain the possibility of cohort effects, such that there has been a decrease in population levels of sugar consumption over the past decade or so. Notably, this sample reported significantly less sugar consumption than in nationally representative samples of young adults drawn from before 2010 (Ervin and Ogden, 2013; Kit et al., 2013; Marriot et al., 2009; Welsh, Sharma, Cunningham & Vos, 2011). This is especially true of samples taken during periods in the early 2000's and late 1990's. Specifically, in the case of Welsh and colleagues (2011), a nationally representative sample of 2,157 adolescents participating in the larger National Health and Nutrition Examination Survey (NHANES) between 1999 and 2004 completed 24 hour food recalls that suggested the average daily sugar consumption was about 118.9 grams/day and represented 21.4% of total caloric intake. This sample and Marriot and colleagues' (2009) sample were both representative, nationally drawn samples in which there was no intervention or explicit description of attempting to improve specific health behaviors. This could point to selection sample bias, and/or cohort effects. With respect to cohort effects, Kit and colleagues (2013) found similar levels of SSB intake to the current sample with a nationally representative sample of 22,367 youth (under 18) and 29,133 adults in 2009-2010. Specifically, Kit et al. (2013) found a reduction amongst adult men aged 19-30 going from 362 calories per day of SSB's in 1999-2000 to 254 calories per day of SSB's in 2009-2010 and a similar trend in the same time period for adult women aged 19-30, going from 252 calories per day in 1999-2000 to 172 calories per day in 2009-2010. More will be discussed below on potential population level attitudinal and behavioral changes towards sugar and sugar consumption.

With regards to selection bias effects, previous research has indicated that there can be strong associations between voluntary participation in studies related to health and health behaviors (Cheung, ten Klooster, Smit, de Vries & Pieterse, 2017; Enzenbach et al., 2019). Specifically, Cheung et al. (2017) conducted a study examining differences in tobacco and alcohol consumption, as well as sexual intercourse frequency between two different samples of Dutch adolescents. One sample was comprised of 8,761 10th graders that were required to complete the survey as a part of their schooling. The other sample was comprised of 1,571 Dutch 10th graders that voluntarily participated in a study examining health behaviors. Results indicated that students that completed the survey as a part of their class work reported significantly higher levels of drinking, smoking, and sexual intercourse when compared to students who voluntarily participated in the study (Cheung et al., 2017). Enzenbach and colleagues (2019) also completed a study examining selection effects looking at a representative sample of 9,145 adults aged 40-79 in Germany. They split the sample into two categories, one in which participants voluntarily completed the full LIFE-Adult study, which was designed to examine the health of the German adult population, and another sample that after refusing to participate in the LIFE-Adult study, agreed to participate in a much shorter survey examining participant health and demographic factors such as age, sex, education, and income. Participants who refused to participate often cited lack of time, job-related reasons, or no interest. Results indicated that participants who opted to complete the full LIFE-Adult study were significantly more educated, earned more income, were more likely to be married, were current non-smokers, and reported better subjective health than participants who completed the short form of the questionnaire (Enzenbach et al., 2019). Thus, it seems possible that participants who voluntarily participate and complete research studies related to their health or health behaviors are likely to be engaged in more health related and less health averse behaviors than individuals who do not choose to participate. In addition, this could also create floor effects, such that it would be harder to see change in participants who are already actively engaged in some level of dietary monitoring of their sugar intake.

Time of Year and Peer Facilitation

Another limitation of this study would be the variable time of year that participants completed the study. Specifically, students participated throughout the spring semester of 2018, the fall semester of 2018, and the spring semester of 2019. This is important to note, as previous research has indicated that there are differences within university subject pools depending on the time of year, and nature of the study. For instance, Witt, Donnellan, and Orlando (2011) found that students choosing to participate in on-site studies versus online studies scored higher in extraversion than students opting for online studies. Additionally, students who participated in studies earlier in the semester scored higher in conscientiousness than students participating late in the semester (Witt et al., 2011). Given conscientiousness's tie to health behaviors within the college population (Raynor & Levine, 2009), and specifically with lower self-reported consumption of sugary snacks and drinks in adult samples (Keller & Siegrist, 2015) it is possible that students who participated early in the study had higher levels of conscientiousness, and thus may have also had lower levels of sugar consumption by proxy. This could have muddied the results, particularly since the randomization process led to a greater amount of interventions taking place towards the end of the Spring of 2019, which would have confounded the results of the study. This occurred as the study design called for a higher number of students to be randomized to the intervention condition (75) versus the control condition (50). As randomization was even (i.e. an odd or even random number was generated and designated the status of the block, the study had to finish with 4 blocks of intervention groups in the Spring of 2019.) Another piece of data that suggests this may be the case, is the higher level of attrition with the peer facilitator, which was utilized exclusively in the spring semester of 2019 towards the end of data collection. Perhaps corroborating this was the higher levels of attrition that occurred in March of 2018 and March of 2019, when students likely would have been more concerned about course credit. This confounds potential reasons for higher attrition towards the end of the study when a peer facilitator was primarily used. Specifically, there was a different type of facilitator, and potentially different motivations for participants, given the incentive of course credit to participate in the study. Academic motivations (completing course credit) may be more salient towards the end of semesters than in the beginning.

Current Attitudes of College Students Regarding Healthy Eating and Sugar Consumption

One issue that warrants further discussion is the possibility that there have been wide spread attitudinal and behavioral shifts within the United States, and particularly within the college population that have resulted in lower estimated average levels of sugar consumption (Christoph, Larson, Laska & Nuemark-Sztainer, 2018; Howse et al., 2017; Kit et al., 2013; Thiagarajah & Kay, 2015; Vilaro et al., 2018). In one instance, these reductions have even been tied to lower LDL and HgbA1c levels in a college population (Hert et al., 2014). Indeed, the current sample reported significantly less sugar consumption than estimates of sugar consumption that were drawn 10 years ago. Bleich, Cercammen, Koma and Li (2018) using nationally representative NHANES data featuring 18,600 children and 27,652 adults found that approximately half of all US adults reported consuming SSB's daily in 2014, which was down from 62% of US adults reporting daily SSB consumption in 2003. This decrease was even more significant for children who went from about 80% of children reporting daily SSB consumption to 61% of children reporting daily consumption of SSBs over the same period. Other recent data published from NHANES that looked at the food recalls of 12,378 children aged 4-19 years old found overall reductions in both SSB consumption and overall added sugar consumption ranging from 2003-2010 (Rehm & Drewnowski, 2016). Perhaps underlying these trends are changes in attitudes such that people are more aware of added sugars and may be engaged in some form of harm reduction to reduce their intake of added sugars, and especially SSB's. Some of this shift is evidenced in the literature, as many studies focusing on dietary variables in the late 1990's and mid 2000's were primarily focused on dietary fat intake with little mention of sugar (Bray et al., 1999; Pryer, Vrijheid, Nichols, Kiggins & Elliot, 1997; Yo-Poth, Zhao, Etherton, Naglak, Jonnalagadda & Kris-Etherton, 1999). Research from the mid-2000's suggested that relationships between dietary fat and cardiovascular risk factors may have been over-inflated (Heitmann & Lissner, 2005). Indeed, more recent research seems to focus on refined carbohydrates and sugar consumption as important variables that are related to cardiovascular and metabolic risk factors (Lustig, Schmidt & Brindis, 2012; Lustig, 2014). A recent review article has tentatively suggested that public health interventions seem to be having at least modest impacts on increasing US adults' perceptions of the health risks associated with excess sugar intake (Gupta, Smithers, Harford, Merlin & Braunack-Mayer, 2018). Specific studies have shown increased awareness of health risks of added sugars in the US lay population (Christoph et al., 2018) and in the college population (de Vliegar et al., 2017; Howse et al., 2018; Vilaro et al., 2018).

Within the US young adult population, Christoph and colleagues (2018) conducted a study using NHANES Project EAT-IV data featuring 1,817 US adults aged 25-36 years old examining the proportion of individuals that use nutrition labels when purchasing food items, what participants looks for when utilizing nutrition labels, and how this relates to subsequent dietary intake. Higher nutrition label use was associated with being a woman, having a higher level of educational attainment, having a higher income, being classified as overweight with a goal towards weight loss, and being younger. Regarding nutrition label use, 31.4% of the sample reported that they use nutrition labels when making food purchases “almost always” or “always”. Among this subsample of people, 74.1% of participants reported that they utilized grams of sugar in their decision making, which was the most commonly cited piece of information individuals looked for, ahead of total calories at 72.9% and saturated fat at 49.4% (Christoph et al., 2018). Once more, label users reported significantly lower levels of added sugar intake, reporting 8.2% of daily caloric intake from added sugars, while non label users reported 11.1% of daily caloric intake from added sugars. Importantly, there was no difference in caloric intake between label users and non-users (Christoph et al., 2018). This finding suggests that at least a subsample of the US young adult population is aware of and actively taking steps to reduce their overall added sugar intake, particularly among the college educated, younger, and women. Encouragingly, similar to the current sample, this finding also relates to estimates of overall added sugar consumption falling at below the WHO (2015) recommendations of 10% of total caloric intake from added sugars among the label users.

Within the college student population, there is evidence that students may also becoming more aware of sugar consumption and its potential health impacts when compared to samples from 5-10 years ago. For instance, in a sample of 118 college students in Australia, de Vliegar et al., (2017) found that 90% of participants cited sugar as the top nutrient they associated with “unhealthy” snacks when asked to classify 32 different snacks and beverages based on their perceived nutritional value. According to linear regression analysis, sugar was the most predictive of food classification as “unhealthy” and suggests that de Vliegar et al.’s (2017) sample was aware of health risks associated with excess sugar intake. In another study conducted by Howse and colleagues (2018), 913 US undergraduates were polled about their own SSB consumption, their attitudes and knowledge of health risks associated with SSB consumption, and their support for campus wide measures to assist in reducing SSB consumption. Results indicated that almost 75% of participants reported consuming 1 or less SSB every week. Once more, 95% of participants agreed that SSB consumption is tied to health risks. Furthermore, 85% of participants correctly associated excess SSB consumption with obesity and 83% of participants associated SSB consumption with higher risk of Type II Diabetes. Students also seemed to support the idea of making healthier beverages more available, but not necessarily restricting SSB sales on campus (Howse et al., 2018). In another study Vilaro and colleagues (2018) looked at dietary patterns, and rationale underlying these dietary patterns from the beginning of the first year to the end of the first year in 1,149 first year college students in the US.

Vilaro et al. (2018) found that only 7% of the current sample reported consuming greater than 10% of their daily caloric intake from added sugars. Once more, they found the consumption of added sugars was inversely associated with food selection motivated by healthy ascetic and lower peer sugar consumption. They found greater sugar intake to be associated with primary food selection factors including price, daily preferences, significant other's sugar consumption, and greater advertising for sugary snacks and beverages on campus (Vilaro et al., 2018). Overall, these studies seem to indicate that college students are evidencing lower levels of sugar consumption than in earlier studies (Ervin & Ogden, 2013; Hirschberg et al., 2011; Marriott et al., 2009), and this change may be tied to attitude shifts and dietary priorities in this population.

Overall, these findings are encouraging and suggest that sugar consumption may be decreasing, particularly within the young adult population in the United States (Kit et al., 2013). Additionally, recent data, as well as data from the current study seems to indicate that, at least among individuals participating in studies pertaining to health, young adults and college students are consuming approximately the amount of added sugar recommended by the WHO (2015) recommendations (Christoph et al., 2018; Vilaro et al., 2018). This may have presented a problem for the current study in that college student samples may not gain additional benefit from interventions targeting sugar consumption, and rather may benefit from more environmental shifts, such as increasing the availability of health alternative snacks and beverages on college campuses as students in Vilaro and colleagues' (2018) sample seemed to prefer.

Future Directions and Clinical Implications

The current research suggests that there may be limits to utilizing convenience samples when investigating health behaviors and conducting effectiveness studies or specific interventions. More research is needed on the impact of selection bias effects, especially as it pertains to college students. Selection effects seem to have a large impact on findings in health-related studies (Cheung et al., 2017; Enzenbach et al., 2019) and may lead to underestimation of aversive health behaviors or overestimation of beneficial health behaviors within a population. To this author's knowledge, there is no detailed study on differences in dietary behaviors or quality between individuals that willingly volunteer to participate in research opportunities examining health behaviors, versus individuals who would not choose to willingly participate in these studies. Once, more, it is important to note that both groups in the current study were asked to log entries in MyFitnessPal, as well as complete dietary recalls. Indeed, research has found that the act of self-monitoring alone can be sufficient to produce weight loss in individuals actively seeking to lose weight (Burke et al., 2011; Harvey, Krukowski, Priest & West, 2019), and thus we can infer dietary change. It is thus, perhaps curious that the current sample did not significantly change over time with regards to overall sugar consumption and only trended toward change with regards to SSB consumption. This may speak more to floor effects given selection bias of the current sample. Additionally, more research towards intervention with participants low in health literacy and in the precontemplative to contemplative stages of behavioral change seem important. This is especially true given health literacy's relationship to study retention in the current sample.

In addition to looking at selection bias effects, future research examining the current needs and health deficits of college students may also be helpful. While there have been large scale studies examining dietary behaviors within the US population such as the use of iterations of NHANES and Project EAT data collection, there does not seem to be very much research looking into specific trends in sugar consumption or other specific dietary behaviors amongst college students. Longitudinal or cohort-based research may be helpful in assessing attitudinal and behavioral shifts occurring within specific populations with more detailed topographical information. This would be helpful in tailoring interventions to the specific needs of those populations. Indeed, it might be argued that the current study may have implemented an intervention that would have been especially effective 5 or 10 years ago, but was limited in its effectiveness now, which may have been due to growing popular understanding of the health risks associated with sugar intake (Christoph et al., 2018; Howse et al., 2018; Vilaro et al., 2018). Importantly, this may especially be the case in health literate samples. If indeed it is the case that population level sugar consumption has peaked and is now on the decline, it would be beneficial to also begin to examine population level health impacts. Indeed, early studies have found significant inverse relationships between SSB consumption and HbaA1c and LDL (Hert et al., 2014).

Overall, the current research adds to the understanding of dietary habits in a small sample of college students. The current research also examined the impact of health literacy on sugar consumption and study completion and may suggest that individuals lower in health literacy may benefit from additional attention or alternative forms of intervention to improve compliance and overall intervention effectiveness. The current study also adds to the growing evidence which suggests population level reductions in sugar consumption are underway in the US (Kit et al., 2013), and the potential health impacts of this trend would also be important to examine.

Clinically, this study suggests that a needs assessment may be a valuable tool in determining what types of interventions may benefit the population of interest the most. Conducting such actions as needs assessments allows for more real-time understanding of the current population, which can be helpful when local and population specific trends may outpace the national picture from large epidemiological studies, such as NHANES. Additionally, practitioners should be mindful of the health literacy of the populations and individuals with which they work. Conducting more formative evaluations during the intervention, or assessing the reason for attrition from an intervention may allow practitioners to be more mindful of accounting for and attempting to eliminate barriers to those individuals and populations that face barriers to implementing the use of new knowledge or behavioral strategies to improve their health.

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Appendix A IRB Approval

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board
4N-64 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284** · **www.ecu.edu/ORIC/irb**

Notification of Initial Approval: Expedited

From: Social/Behavioral IRB

To: James Rossi

CC:
Robert Carels
James Rossi

Date: 2/19/2018

Re: UMCIRB 18-000016
College Healthy Living Study

I am pleased to inform you that your Expedited Application was approved. Approval of the study and any consent form(s) is for the period of 2/19/2018 to 2/18/2019. The research study is eligible for review under expedited category #7. The Chairperson (or designee) deemed this study no more than minimal risk.

Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The Investigator must adhere to all reporting requirements for this study.

Approved consent documents with the IRB approval date stamped on the document should be used to consent participants (consent documents with the IRB approval date stamp are found under the Documents tab in the study workspace).

The approval includes the following items:

Name	Description
Consent Form	Consent Forms

Measures	Surveys and Questionnaires
Rossi_Dissertation	Study Protocol or Grant Application
SONA paragraph	Recruitment Documents/Scripts

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

Appendix B The Dietary Screener Questionnaire (DSQ)

Key Output Variables – Daily Estimates (units) of the following:

- Fruits (daily cup equivalents), vegetables (daily cup equivalents), dairy (cup equivalents), added sugars (tsp), sugar from SSBs (tsp), whole grains (ounce equivalents), fiber (g) and calcium (mg).

List of variables used to determine regression coefficients:

- Age and Sex

FFQ Anchors for frequency:

- Never, one time per month, 2-3 times last month, 1 time per week, 2 times per week, 3-4 times per week, 5-6 times per week, 1 time per day, 2-3 times per day, 4-5 times per day, 6 or more times per day.

FFQ Food items Assessed:

- **STEM:** "During the past month, how often did you eat/drink…"
- Hot or cold cereal and specific type of cereal
- Milk and specific type of milk
- Regular soda or pop that contains sugar (NOT including diet soda)
- 100% pure fruit juice (NOT including juice made at home that you have added sugar to)
- Coffee or tea that had sugar or hooney added to it. Include coffee that you sweetened yourself and presweetened tea and coffee drinks such as Arizona Iced Tea and Frappuccino. (NOT including artificially sweetened coffee or diet tea).

- Sweetened fruit drinks, sports or energy drinks, such as Kool-Aid, lemonade, Hi-C, cranberry drink, Gatorade, Red Bull or Vitamin Water. Include fruit juices that you made at home and added sugar to. (NOT including diet or artificially sweetened drinks).
- Fruit, including fresh, frozen or canned. NOT including fruit juices.
- Leafy greens or lettuce salad with or without other vegetables.
- Fried potatoes, including French fries, home fries or hash brown potatoes.
- Other kinds of potatoes, such as baked, boiled, mashed, sweet potatoes or potato salad.
- Refried beans, baked beans, beans in soup, pork and beans or any other type of cooked dried beans. Do NOT include green beans.
- Tomato Sauces such as with spaghetti or noodles or mixed into foods such as lasagna. NOT including tomato sauce on pizza.
- Cheese including cheese as a snack, cheese on burgers, sandwiches and cheese in foods such as lasagna, quesadillas, or casseroles. NOT including cheese on pizza.
- Red meat such as beef, pork, ham or sausage. NOT including chicken turkey or seafood. Include meat you had in sandwiches, lasagna, stew and other mixtures. Red meats would also include lamb, veal and any lunch meat made with these meats.
- Processed meat, such as bacon, lunch meats or hot dogs. Include processed meats you had in sandwiches, soups, pizza, casseroles and other mixtures. Processed meats are those preserved by smoking, curing or salting, or by the

addition of preservatives. Examples are ham, bacon, pastrami, salami, sausages, bratwursts, frankfurters, hot dogs and spam.

- Popcorn

Appendix C BEVQ-15

	How Often (Mark One)							How Much Each Time				
Beverage	Never of less than one time per week	1 Time per Week	2-3 Times per Week	4-6 Times per Week	1 Time per Day	2+ Times per Day	3+ Times per day	Less than 6 fl oz (3/4 cup)	8 fl oz. (1cup)	12 fl oz (1 ½ cup)	16 fl oz (2cups)	20+ fl oz (2 ½ cups)
Water												
Fruit Juice												
Sweetened Juice Beverage Drink (fruit ades, lemonade, punch, Sunny D)												
Whole Milk												
Reduced fat milk (2%)												
Low fat/Fat free milk (Skim, 1%, buttermilk, soymilk)												
Soft Drinks, Regular												
Diet Soft Drinks/Artificially sweetened drinks (crystal light)												
Sweetened Tea												
Tea or Coffee, with cream and/or sugar (includes non-dairy creamer)												
Tea or coffee, black with/without artificial sweetener (no cream or sugar)												
Beer, Ales, Wine Coolers, Non-alcoholic or Light Beer												
Hard Liquor (shots, rum, tequila, etc.)												
Wine (red or white)												
Energy or sports drinks (RedBull, Rockstar, Gatorade, Powerade, etc.)												
Other:												

Appendix D Health Orientation Questionnaire

Please state the extent to which you agree or disagree with the following statements:				
Item	Strongly Disagree	Disagree	Agree	Strongly Agree
Maintaining a healthy lifestyle is important to me.				
It is important to me to stay healthy all of my life				
Staying healthy helps me pursue important life goals				
Living life in the best possible health is very important to me				
Eating right, exercising and taking preventative measures will keep me healthy for life				
I watch what I eat because it helps me stay healthy				
My health depends on how well I take care of myself				
I feel confident that I can access the health care I need				
I don’t believe my health is affected by what I eat				
I think it is probably okay to smoke cigarettes every day as long as its less than a pack per day				
A lot of the guidelines about smoking, alcohol and drugs are too protective				
A lot of what doctors say about how to stay healthy is not worth listening to				
Often doctors tell you things that you actually don’t need to listen to.				

Appendix E Newest Vital Sign

The following is a nutrition label on a pint of ice cream. Please look at the label and answer the following questions to the best of your ability.

1. If you eat the entire container, how many calories will you consume?
2. If you are allowed to eat 60 grams of carbohydrates as a snack, how much ice cream could you have?
3. Your doctor advises you to reduce the amount of saturated fat in your diet. You usually have 42g of saturated fat each day, which includes one servicing of ice cream. If you stop eating ice cream, how many grams of saturated fat would you be consuming each day?
4. If you usually eat 2500 calories a day, what percentage of your daily value of calories will you be eating if you eat one serving?

Pretend that you are allergic to the following substances: Penicillin, peanuts, latex gloves and bee stings.

5. Is it safe for you to eat this ice cream
6. Why not?

Appendix F Power of Food Scale

Please indicate the extent to which you agree that the following items describe you. Use the following 1-5 scale for your responses.

1 don't agree at all
2 agree a little
3 agree somewhat
4 agree
5 strongly agree

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1. I find myself thinking about food even when I'm not physically hungry. ___

2. I get more pleasure from eating than I do from almost anything else. ___

3. If I see or smell a food I like, I get a powerful urge to have some. ___

4. When I'm around a fattening food I love, it's hard to stop myself from at least tasting it. ___

5. It's scary to think of the power that food has over me. ___

6. When I know a delicious food is available, I can't help myself from thinking about having some. ___

7. I love the taste of certain foods so much that I can't avoid eating them even if they're bad for me. ___

8. Just before I taste a favorite food, I feel intense anticipation. ___

9. When I eat delicious food I focus a lot on how good it tastes. ___

10. Sometimes, when I'm doing everyday activities, I get an urge to eat "out of the blue" (for no apparent reason). ___

11. I think I enjoy eating a lot more than most other people. ___

12. Hearing someone describe a great meal makes me really want to have something to eat. ___

13. It seems like I have food on my mind a lot. ___

14. It’s very important to me that the foods I eat are as delicious as possible. ___

15. Before I eat a favorite food my mouth tends to flood with saliva. ___