iJRASET
International Journal For Research in
Applied Science and Engineering Technology

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 11 **Issue:** IV **Month of publication:** April 2023

**DOI:** https://doi.org/10.22214/ijraset.2023.50013

# Evaluating the Effects of Artificial Sweeteners on the Role of Food Priming in Food Consumption

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***Abstract: As a result of globalization and economic advancements, dietary habits have shifted towards increased energy intake and heightened consumption of energy-dense foods, which have contributed to the obesity epidemic and cardiovascular disease. [1] This increase in food intake has been furthered by numerous external stimuli in the form of advertising, which is focused on immediate pleasure and can be difficult to resist. [2] Such advertising plays the role of a food prime, or a cue that serves to induce food intake under tempting circumstances. [3] The effect of artificial sweeteners on the role of food priming in food consumption was evaluated by comparing Coca-Cola with Diet Coca-Cola consumption on M&M consumption in differently primed settings, as well as to observe the independent effects of these factors on food intake. Fifty-eight college students were recruited to participate in a two-week study in which they were assigned different combinations of beverages and commercials to analyze both the independent and dependent effects of both factors on food consumption. A significant positive association was observed between commercial type and food intake (p=0.03), while no significant association was recorded between the beverage type and food intake. Further research is needed to examine the relationship between the two factors on a significant level and determine the mechanism behind these findings.***

## I. INTRODUCTION

Since 1970, globalization and economic advancements have shifted dietary habits toward increased energy intake and heightened consumption of animal fat and energy-dense foods, contributing to obesity, diabetes, cardiovascular disease, and cancer. [1] According to the World Health Organization, more than 41.9% of US adults were overweight or obese in 2022, [4] classifying the issue as a major public health concern. [5] The obesity epidemic traces back to reduced physical activity and overconsumption of high-fat, high-sugar foods, [3] with packaged food and beverages comprising 75% of daily caloric intake in the United States. [6] An analysis of 80,000 items sold in grocery stores across the United States shows that 60% of the products evaluated contained added sugar. [7] The largest source of sugar for US adults is sugary drinks, which supply 35.7% of sugar intake. [8] Based on dietary guidelines from the American Heart Association, the average US woman should not exceed 6 teaspoons (100 kcal, 24g) of added sugar per day, while the threshold is 9 teaspoons (150 kcal, 35g) for men. [9] However, a 12oz can of Coca-Cola contains 10 teaspoons of added sugar, exceeding both recommended intakes. Since dietary habits influence health outcomes, the blame is often placed on the food industry for promoting poor food labeling, large portion sizes, and cheap, convenient processed foods. [10]

Food intake is influenced by numerous external stimuli, including advertising, which acts as a food prime, or a cue that induces food intake under tempting circumstances. [3] Indeed, health officials believe that food advertising is a leading cause of poor diet. [10] A 1989 study found that exposure to sensory aspects of palatable food boosts craving and intake, even if participants are not hungry prior to stimulus exposure, [11] which was later confirmed by further studies. [10] A 2007 report by the Federal Trade Commission found that US children view 15 television food advertisements each day that promote unhealthy food choices. [12] Although these practices have likely improved in the last decade, the rise of technology has exposed children to similar advertisements on other accessible technological platforms, posing a similar risk. Food advertising focuses on immediate pleasure and makes resistance to caloric consumption more difficult - a 2005 study found that food advertising increased food intake in children and adults, with the former consuming 45% more due to advertising, unrelated to any conscious influences. [13] Ninety-eight percent of these advertisements promote products that are high in fat, sugar, or sodium. [14] Studies show a link between advertising and consumption, but there is a lack of direct causation between food advertising and unhealthy food choices. [10]

In efforts to curb weight gain and the incidence of weight-related diseases, energy density of foods has been found to take precedence over macronutrient content in terms of influencing energy intake, transitioning the focus toward consuming less energy dense foods. [15] Although sugar and carbohydrates are a major energy source in the human body, carbohydrates have been found to increase insulin levels, causing more fat retention, and preventing caloric burn. [16] Insulin also activates limbic-striatal brain regions, increasing an individual’s desire to high-calorie or high-carbohydrate foods, often causing individuals to turn to fast-food restaurants to relieve hunger. [17]

Reducing energy density only yields tangible weight loss if consumption is regulated, making it a difficult long-term approach due to individual desires to eat palatable food and the need to replace carbohydrates with other energy-dense foods, which typically contain more calories. [14] As a result, there has been a steady shift toward the consumption of artificial sweeteners, which are often sweeter and provide little to zero calories per gram, [18] often being promoted as the “diet-friendly” or “light” option. [19] The Calorie Control Council found that in 2007, 86% of Americans previously used low-calorie, reduced-sugar, or sugar-free foods and beverages. [13] More recent NHANES data from 2007-2012 shows that nearly 50% of Americans report regular consumption of artificially sweetened foods and beverages. [20] However, research analyzing the effectiveness and safety of artificial sweeteners is controversial.

Although the preliminary consensus was that artificial sweetener consumption does not contribute to weight gain in humans, [21] recent studies have shown conflicting results on the effectiveness of artificial sweeteners on weight loss has been inconclusive. Several reports have found that consuming artificial sweeteners substitutes leads to heightened fat consumption, [14] while other research denies a link between non-caloric sweeteners and increased food intake. [22] One of the most used artificial sweeteners is aspartame, which gained popularity in recent decades among diabetics, as well as diet-focused adolescents and adults looking to control their weight. [23]

Aspartame is metabolized by digestive esterases and peptidases to amino acids, aspartic acid, phenylalanine, and a minimal amount of methanol. These compounds are utilized by the body in similar ways as if they had been derived from natural foods, in which they are typically found in larger amounts. [24] This sweetener is notably found in diet sodas, such as Diet Coca Cola and Diet Pepsi Cola.

The research surrounding the effects of artificial sweeteners on health and weight control is largely inconclusive. Both short-term and long-term studies have found that food and beverages sweetened with aspartame do not affect or decrease food intake, [25] while other research suggests that aspartame has a postingestive inhibitory role on appetite and reduces subsequent hunger and food intake. [26]

To our knowledge, there is no current literature investigating the role of artificial sweeteners on food priming. The purpose of this investigation was to evaluate the effects of artificial sweeteners on the role of food priming in food consumption by comparing Coca-Cola with Diet Coca-Cola consumption on M&M consumption in differently primed settings, as well as to observe the independent effects of these factors on food intake.

## II. MATERIALS AND METHODS

### *A. Participants*

Fifty-eight student volunteers were recruited from Cornell University in Spring 2022. Forty-six participants were enrolled in NS 3150, “Obesity and the Regulation of Body Weight,” and were offered extra credit for participation. The remaining 12 participants were recruited from other departments at Cornell University. Inclusion criteria included students from Cornell University. Exclusion criteria included those with a food allergy to Coca-Cola, Diet Coca-Cola, M&Ms, and students with an eating disorder. One participant enrolled in NS 3150 was excluded for completing only one week of the study. Informed consent was obtained with an electronic survey from all participants. IRB authorization for human subjects’ research was received.

### *B. Materials*

Each volunteer was instructed to pick up 2 sets of the following materials from Savage Hall at Cornell University: 12 oz of Coca-Cola, Diet Coca-Cola, or Poland Spring water, 1.69 oz of M&Ms, and a TriScale™ Digital Kitchen food scale. [27]

### *C. Survey*

A web-based survey was developed using Google Forms and emailed to each participant. The survey was open for 1.5 months during the duration of the experimental period and the questions were available in English. The questions included the providing one’s unique Cornell NetID, confirmation of consent, week number, commercial type, beverage consumed, confirmation of beverage consumption, snack weight pre- and post-consumption, rates of activity and pre- and post-hunger levels on a scale of 1-5, whether participants enjoyed the snack, beverage, or commercial in the form of yes/no, why they may not have eaten the snack, and a comments section. Participants were instructed to use the provided scale for objectively quantifiable results and their best judgment to determine their activity and hunger level on a scale of 1-5, with 5 being “most active” or “most hungry.” All survey data was self-reported.

### *D. Commercials*

Volunteers were assigned two commercials obtained from YouTube: one for Pizza Hut [28] and the other for the Toyota Highlander vehicle, [29] both of which were produced in 2021. Each commercial was around 1 minute long. The materials provided for consumption in the experiment (i.e., water, Coca Cola, Diet Coca Cola, and m&m candy) were not present in either commercial.

## III. PROCEDURE

Participants were randomly assigned to one of three groups based on beverage consumption: 18 in the Coca Cola group, 16 in the Diet Coca Cola Group, and 23 in the water group. Each participant was assigned either the food prime commercial or non-food prime commercial for Week 1 and instructed to watch the other commercial for Week 2. Participants received an initial email with the experimental structures and follow-up emails throughout the course of the study. The experiment was conducted over the span of two days, exactly one week apart. Participants were instructed to consume the entirety of the provided beverage within 30 minutes and confirm completion of this task in a provided google form. After a 30-minute waiting period during which they were instructed not to consume any other food or beverage, participants were told to fill a bowl with the M&Ms provided with more than they could eat and record the combined weight of the bowl and snack. They were instructed to watch their assigned commercial, during which they could consume the provided snack. After watching the commercial, participants were to use the provided scale to determine the combined weight of the bowl and snack and record the value in the google form and complete the remaining questions. Participants received the same instructions for week 2 with the commercial they were not previously assigned.

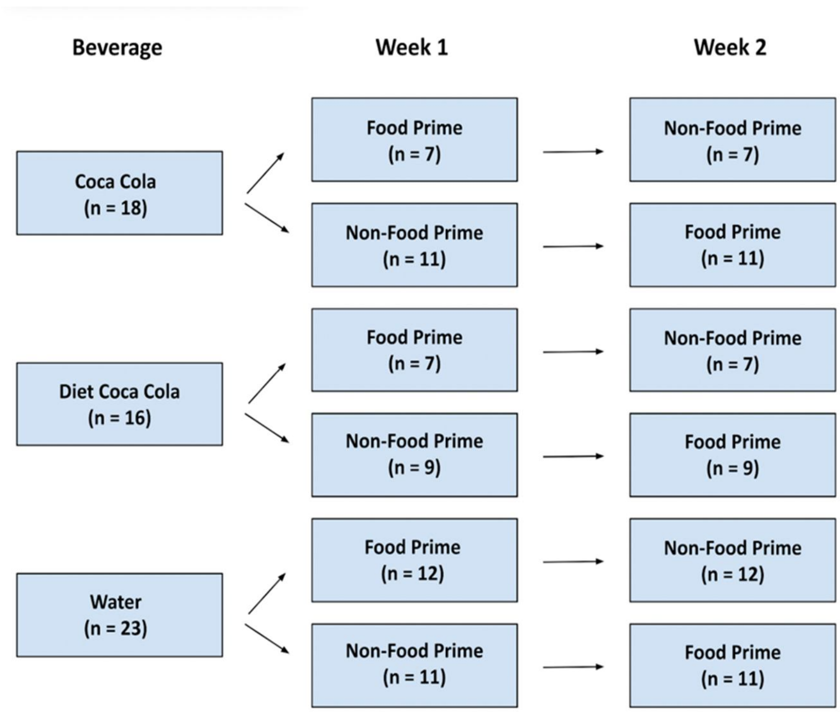


Figure 1. Participant Assignments and Procedure. Participants were randomly assigned to three different groups based on beverage type and assigned a food or non-food prime commercial for Week 1, with the commercial not previously watched assigned for Week 2.

## IV. STATISTICAL ANALYSIS

Data was analyzed using Python 3.10.7 software. For a preliminary assessment of the significance of the results, an ANOVA test was conducted using the statsmodels Python package. Since this test assumes independence, the change in food consumption for each participant across the two weeks was studied and a paired t-test was performed using the SciPy Python package. Statistical significance was set at $p<0.05$. Box plots were generated using Python to demonstrate the effects of activity level, hunger level pre- and post-experimentation, and the enjoyment levels of the snack, beverages, and commercials on food intake.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue IV Apr 2023- Available at www.ijraset.com

## V. RESULTS

Of the 58 participants, 1 participant did not complete both weeks of the study, for which they were excluded. Data from the remaining 57 participants is presented in Table I.

Table I. Participant Statistics. Participants were recruited from different groups at Cornell University and assigned to one of three beverage groups.

| Category | | Number of Participants |
|---|---|---|
| Beverage | Coca Cola | 18 |
| | Diet Coca Cola | 16 |
| | Water | 23 |
| Recruitment Method | NS 3150 | 45 |
| | Other | 12 |
| Total | | 57 |

After administering a two-way ANOVA test, the two variables were tested independently and in combination. The effect of the commercial on food intake was found to be significant (P<0.05), while the effect of the beverage on food intake was insignificant (P>0.05). (Table II)

Table II. Two-Way ANOVA Test Comparing the Effects of Beverage and Commercial on Food Intake. This test was performed using Python.

| | Sum of Squares (sum_sq) | Degrees of Freedom (df) | Analysis of Variance (F) | PR(>F) |
|---|---|---|---|---|
| Beverage | 425.26 | 2.0 | 0.56 | P > 0.05 |
| Commercial | 1589.42 | 1.0 | 4.21 | P < 0.05 |
| Beverage : Commercial | 38.36 | 2.0 | 0.051 | P > 0.05 |
| Residual | 40818.59 | 108.0 | N/A | N/A |

*KEY*: sum_sq = Sum of Squares. df = Degrees of Freedom. F = Analysis of Variance. PR(>F) = probability of observing a difference equal to or larger than that observed, assuming null hypothesis were true.

Food intake was higher with a food prime commercial versus a non-food prime, supporting the results from the two-way ANOVA test in Table I. Using data in Figure 2, a paired t-test was administered with a p-value of 0.03, rejecting the null hypothesis of p<0.05. The rejection of the null hypothesis indicates that commercial type influenced food intake.

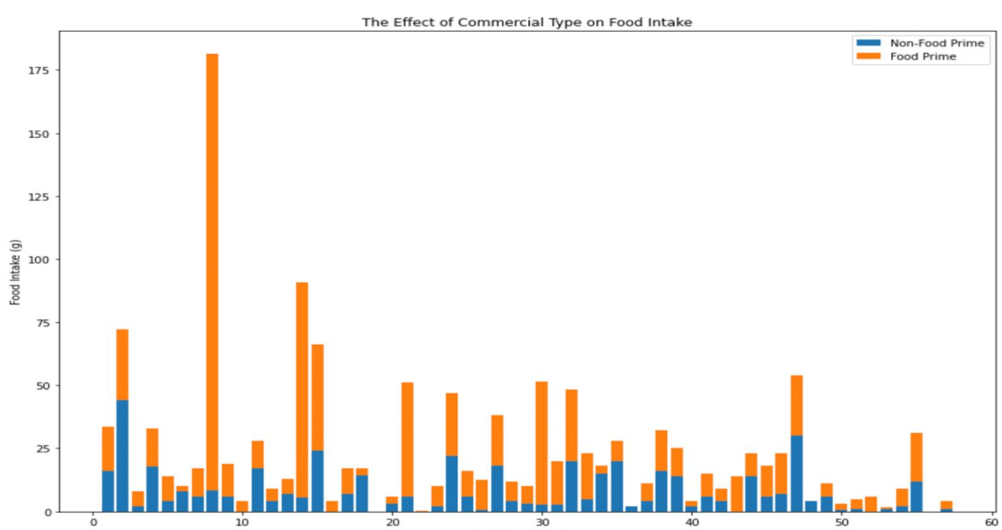


Figure 2. Amount of Food Consumed While Varying Commercial Type. The food intake of the provided snack independent of commercial type is shown for each participant with a bar plot created using Python.

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The mean food intake increased with each hunger level pre-experimentation, excluding the transition from hunger level 3 to 4. (Figure 3) Given the overall trend, there was a positive relationship between hunger level and food intake.

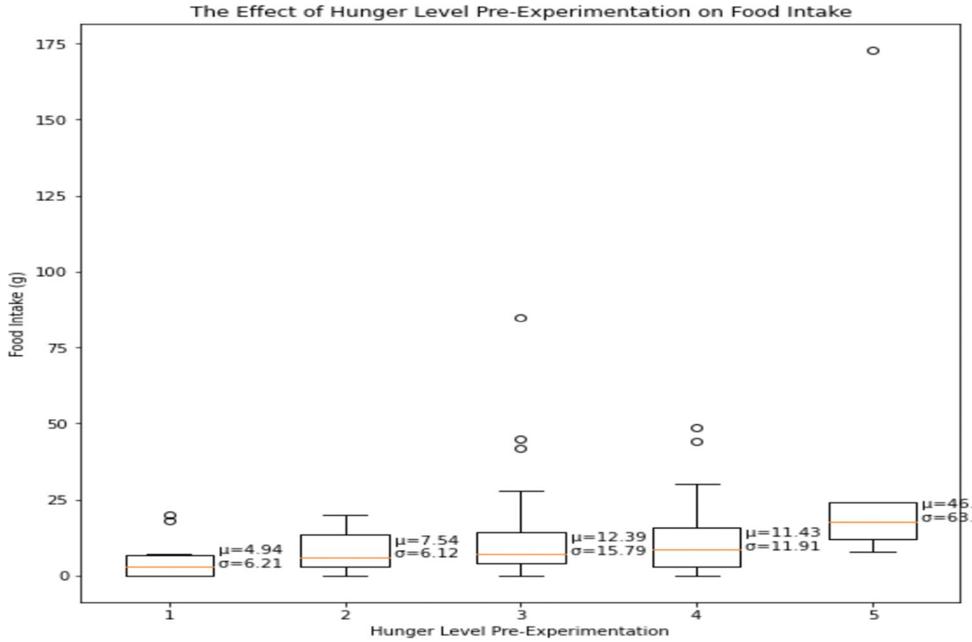


Figure 3. The Effect of Hunger Level Pre-Experimentation on Food Intake. A box-and-whisker plot was created using Python to demonstrate the relationship between the hunger level of each participant prior to food and beverage consumption and total food intake (g), independent of the type of beverage, snack, and commercial. Data was obtained from the survey results, in which hunger level was rated on a scale of 1-5, with 5 being the hungriest.

No clear trend was observed between hunger level post-experimentation and food intake, (Figure 4) indicating that the relationship between snack and/or beverage consumption was inconclusive.


Figure 4. The Effect of Hunger Level Post-Experimentation on Food Intake. A box-and-whisker plot was created using Python to demonstrate the relationship between the hunger level of each participant after food and beverage consumption and total food intake (g), independent of the type of beverage, snack, and commercial. Data was obtained from the survey results, in which hunger level was rated on a scale of 1-5 from least to most hungry.

Participants who rated their activity level at a 5 had a mean food intake of 14.58g with a standard deviation of 13.30g, while those who rated themselves as inactive at level 1 had a mean food intake of 6.65g with a standard deviation of 5.14g. (Figure 5) Although these results indicate a positive relationship between activity level and food intake, the high standard deviation of both groups may have skewed the results in favor of this conclusion.

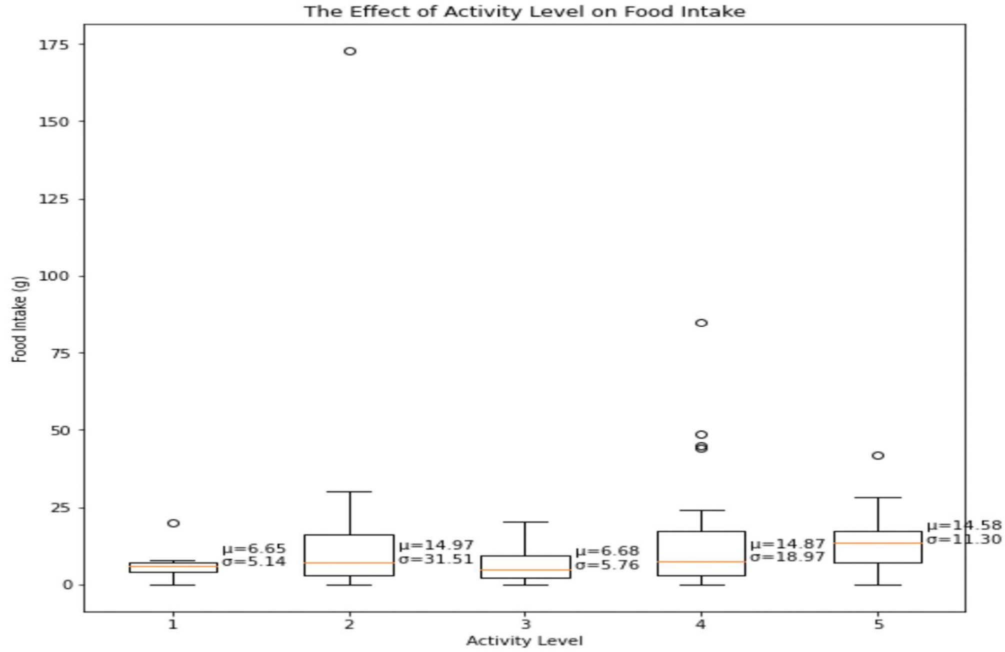


Figure 5. The Effect of Activity Level on Food Intake. A box-and-whisker plot was created using Python to demonstrate the relationship between the activity level of each participant and total food intake (g), independent of the type of beverage, snack, and commercial. Data was obtained from the survey results, in which activity level was rated on a scale of 1-5 from least to most active.

The mean food intake of the participants who indicated enjoyment of the commercial was 12.98g with a standard deviation of 21.44g. The mean intake of those who did not enjoy the commercial was 7.10g with a standard deviation of 7.21g. (Figure 6) This data suggests a positive relationship between advertisement enjoyment and food consumption.

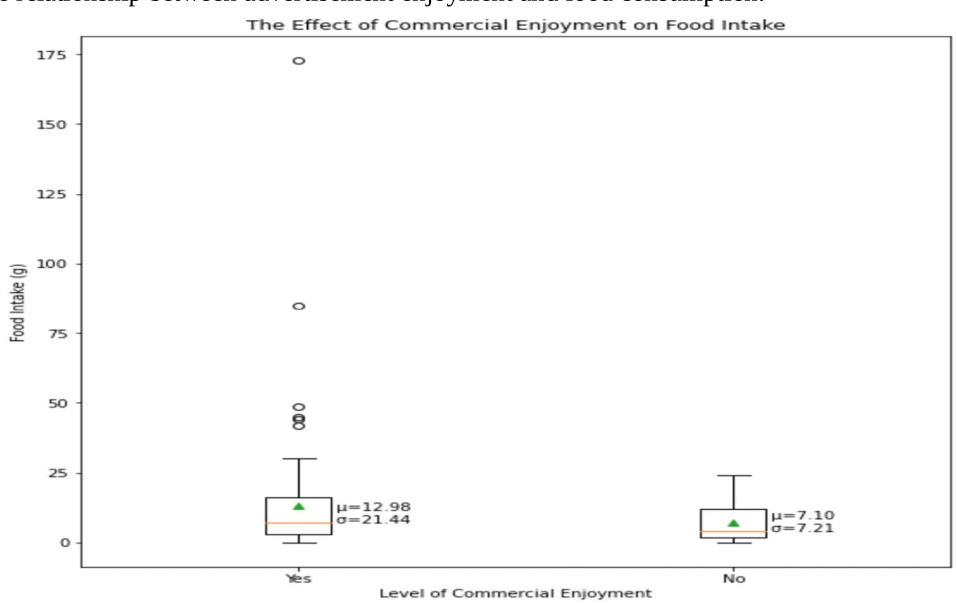


Figure 6. The Effect of Commercial Enjoyment on Food Intake. A box-and-whisker plot was created using Python to demonstrate the relationship between the level of commercial enjoyment and total food intake (g), independent of the type of beverage, snack, and commercial. Data was obtained from the survey results, in which participants indicated enjoyment by selecting "yes" or "no."

The mean food intake of participants who enjoyed the provided snack was 12.91g with a standard deviation of 20.45g, while those who denied snack enjoyment had a mean food intake of 3.66g with a standard deviation of 4.96g. (Figure 7) Although these results indicate a positive association between the level of snack enjoyment and food intake, the high standard deviation of those who selected "yes" may have skewed these results in favor of this conclusion.

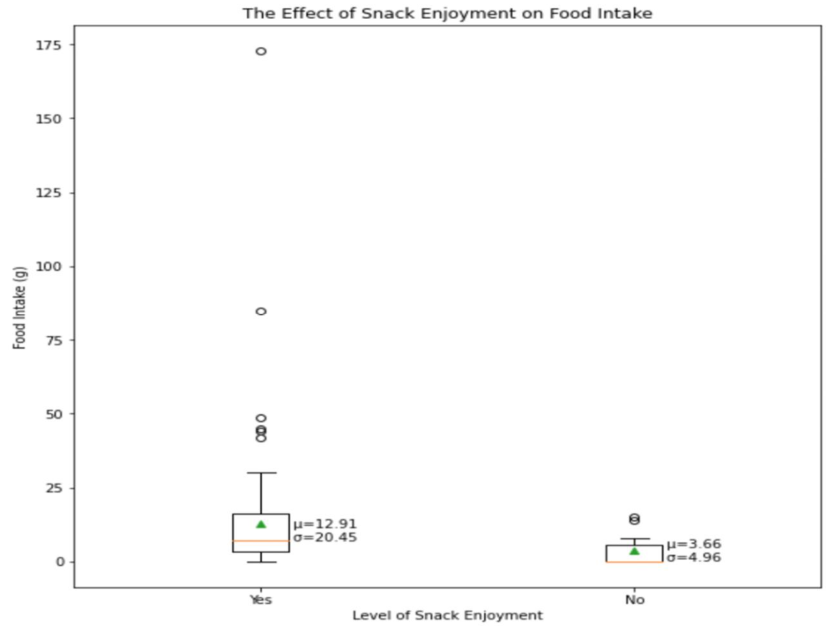


Figure 7. The Effect of Snack Enjoyment on Food Intake. A box-and-whisker plot was created using Python to demonstrate the relationship between the level of snack enjoyment and total food intake (g), independent of the type of beverage, snack, and commercial. Data was obtained from the survey results.

The mean food intake of those who indicated that they enjoyed the provided beverage was 12.03g with a standard deviation of 21.24g, while the mean food intake of those who did not enjoy the provided beverage was 10.60g with a standard deviation of 11.52g. (Figure 8) Given the high standard deviation of both groups, there is no clear relationship between beverage enjoyment and food intake.

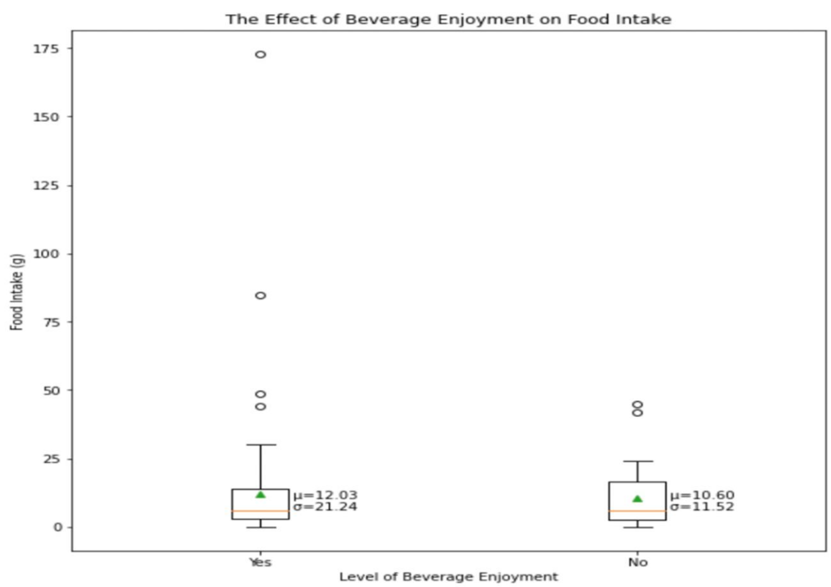


Figure 8. The Effect of Beverage Enjoyment on Food Intake. A box-and-whisker plot was created using Python to demonstrate the relationship between the level of beverage enjoyment and total food intake (g), independent of the type of beverage, snack, and commercial. Data was obtained from the survey results.

## VI. DISCUSSION

Food priming and artificial sweeteners consumption have individually been shown to affect food intake and weight gain. Based on the results, food intake was found to be positively associated with food priming, whereas no significant effect due to artificial sweetener consumption alone, or in combination with food priming, was observed.

Our study found a significant positive association between commercial type and food intake (Table II, Figure 1), which is consistent with current literature. A meta-analysis of 39 studies shows that exposure to unhealthy food advertisements contributes to significant increases in food consumption, specifically of energy-dense, low-nutrient foods. [30] Overweight and obese children consuming an average 45.6 kcal more following exposure to food adverts, but children made healthier choices if popular figures were associated with healthier products, [30] showing that advertisements effectively prime individuals with recognizable characteristics and brand names. Comparably, an analysis of feeding behavior in 5–7-year-old children shows that food advertising led to a 14-17% increase in food intake, with the largest increase in caloric intake stemming from the intake of sweet foods. [31] A similar relationship was observed in children based on a meta-analysis of 22 studies evaluating advertisement exposure and food intake, but not adults. This discrepancy is likely due to children's developing brains and inability to understand the persuasive intent of advertising, [32] though more research is needed to evaluate the mechanism behind these results. Although our study corroborates current literature that indicates a positive relationship between food advertising and food consumption, there remains a lack of direct causation between food advertising and unhealthy food choices, emphasizing the need for a mechanistic approach.

Our findings indicate that the type of beverage did not have a significant effect on food consumption (Table II, Figure 1), consistent with current literature that suggests no difference in food intake due to artificial sweetener consumption. A study conducted in 42 nondieting adult males shows that consumption of 8 oz or 16 oz of aspartame-sweetened lemonade did not increase hunger ratings or food intake. [25] These results are corroborated by data collected from 20 normal weight young adult males, which shows that ingestion of aspartame-sweetened soft drinks did not increase short-term subjective hunger or food intake. [33] Furthermore, 5 randomized controlled trials showed no significant differences in the change in body weight in adults receiving artificial sweeteners versus sugar or a placebo. [34] On the contrary, several reports have found that consuming artificial sweeteners contribute to weight gain. [22] A study conducted in 1454 male and female adult participants showed that low-calorie sweetener users were found to have a 0.80 $kg/m^2$ higher body mass index, 2.6 cm larger waist circumference, 36.7% prevalence and 53% higher incidence of abdominal obesity than those who did not consume low-calorie sweeteners. [35] Furthermore, data collected in 1.2 million men and women shows that the rate of weight gain in those who used artificial sweeteners was significantly greater than in those who did not, and the proportion of artificial sweetener users who gained 10 pounds was significantly greater than the proportion of those who gained 10 pounds without using artificial sweeteners. [36] Importantly, individuals with larger BMIs may look for ways to reduce weight and select artificial sweeteners, signifying the necessity to observe the cause-and-effect relationship of food intake and artificial sweeteners. More mechanistic research is required to better understand the role of aspartame in the regulation of hunger levels and digestion. Our results are inconsistent with other research that has found an inverse relationship between artificial sweetener consumption and obesity indicators, which represent the effects of food consumption on weight changes. Participants who drank large amounts of aspartame-sweetened sodas were found to have reduced sugar intakes in comparison to those consuming drinks containing high fructose corn syrup. Furthermore, a study conducted in a group of 163 obese women found that consuming aspartame lost significantly more weight and regained less weight during maintenance. [37] These findings were confirmed by a meta-analysis conducted in 15 studies, which showed that aspartame consumption leads to a significant reduction in energy intake compared to non-sucrose controls, excluding water. [38] When comparing artificial sweeteners to sucrose, a 10-week study of 41 overweight men and women found that subjects consuming sucrose saw increases in total energy intake, while the artificial sweetener group had decreases in sucrose intake and energy density; body weight and fat mass increased in the former but decreased in the latter. [39] Another study found that drinking large amounts of aspartame-sweetened soda, compared to that sweetened with high fructose corn syrup, reduced sugar intake. [40] However, the same study found that although drinking soda sweetened with aspartame for 3 weeks significantly reduced the caloric intake of females and males, body weight only decreased in the latter. [40] It is important to investigate the relationship between caloric intake and body weight changes, as well as consider the demographics of the population in question. However, any positive effects are not indicative of long-term benefits and further epidemiologic data is needed to validate the results.

The survey results were used to develop possible explanations and evaluate confounding variables for associations between food intake and commercial, beverage, and snack type. Participants with a higher level of hunger pre-experimentation had a greater food intake than those with a lower hunger level, but there may be a confounding variable given the standard deviation of 63.22, (Figure 3) which indicates that the presence of an outlier may have skewed the data.

The mean values for hunger level post-experimentation do not show a clear trend of food intake, (Figure 4) and it is unknown whether participants ate until satiety or overate. Participants with a higher activity level had a greater food consumption than those who reported being less active, which may be a confounding variable given that there is no outlier skewing the results. (Figure 5) The trends in enjoyment levels of the commercials and snack show a positive association between commercial enjoyment and food intake, (Figures 6 and 7) indicating that participants who enjoyed the advertisement were more likely to consume food. The same trend exists for beverage enjoyment, but the difference between the means of those who selected "yes" and "no" is smaller than that for the other variables, (Figures 5, 6, and 7) corroborating that beverage type had less of an effect on food intake. These survey results can be used in future experimentation by providing insight into which snacks, beverages, and commercials should be included in the experiment and which variables to consider when analyzing factors that may influence food consumption.

There are several strengths associated with this study. Firstly, the partial within-subject design allowed for each subject to be tested for each commercial, contributing to the consistency of the results. The results were generalizable to artificial sweetener research, given that aspartame is one of the most used artificial sweeteners. Additionally, the food and beverage items provided are typically found on college campuses, so unwillingness to try new food or beverages is an unlikely confounding variable. A study that examined how and why college students choose beverages, namely investigating their high consumption of sugar-sweetened beverages, nearly all (93%) of participants reported taste as an important factor, followed by price and caloric content. [41] The foods and beverages provided in this study were popular drinks with relatively well-liked tastes, low in price, and some low in caloric content, meaning that they would likely have been chosen for consumption by college students. Another strength is the study's relatively simple, reproducible study design with low-cost materials and an easily accessible online format. The chosen snack of M&Ms was easy to consume and required no preparation, increasing the likelihood of those who lack time to dedicate to a prospective long-term study.

The study also has several limitations. Firstly, BMI, sex, and demographic information of the participants was not collected or accounted for. Although the partial within-subject design allowed for a focus on individual changes regardless of demographics, this data could be used in future studies that hope to evaluate the influence of demographics on food priming and food consumption. Indeed, research shows that obesity prevalence is higher in Hispanic and non-Hispanic black adults, indicating a possible relationship between demographics and food intake. [42] Another important factor to account for is stress level, which has been shown to increase food intake, [43] particularly of calorie-dense foods, such as the M&M's snack provided in the study. Since all participants were college students from Cornell University, a high-stress environment for many, accounting for stress levels may lead to more accurate conclusions. Furthermore, the sample size was small (n=57), and the majority of participants were recruited from a nutrition course, due to which they may have prior knowledge of the health effects of aspartame and artificial sweeteners, which are found to increase the risk of cancer, hepatotoxicity, headaches, allergies, seizures, and other adverse health outcomes. [35] The FDA has yet to conclude that aspartame is unsafe for consumption, but the methanol in aspartame has been found to break down into cytotoxic formate and phenylalanine may affect neurotransmission after crossing the blood-brain barrier. [44] Additionally, the study did not investigate the mechanism behind aspartame decreasing hunger level of participants on a biochemical level, which would provide a better explanation for the role of aspartame on regulating hunger levels and whether it controls digestive processes and associated hormones.

There is conflicting research surrounding online studies, which is both a strength and limitation of this study. A study analyzing portion size in adult participants indicated higher levels of self-awareness in the standard laboratory, which may lead to an underestimation of food intake when studied under laboratory conditions. [45] Since participants in the current experiment completed the study on their own, they chose their own portion sizes and were not limited by laboratory conditions. However, participants in studies that lack monitoring are subject to decreased accountability, decreasing the validity of the results. Given COVID-19 restrictions that were in place at the time of the study, this was the most efficient method of recruiting the largest possible number of participants.

Further research is needed to investigate whether artificial sweeteners decrease food intake, as well as their role in food priming. To our knowledge, this may be the only study in current literature investigating the role of artificial sweeteners on food priming. Although the results concerning the effect of the type of beverage on food consumption were not found to be significant, a notable modification to the current study that may address this finding is assigning the same commercial for each participant and increasing the variety of the beverages consumed. If this study were reproduced, a larger and more diverse sample size, increased accountability for participants, and an investigation of the mechanism behind aspartame and hunger level may increase the validity and reliability of the results. Furthermore, including more artificial sweeteners and foods within different categories would widen the scope of the research to reflect the general diet.

The end-of-survey questions concerning enjoyment of the snack, beverages, and commercials in the current study were initially included for a background of whether participants are eager to consume the provided snack and beverage and can serve as a basis for choosing future items for consumption. Additionally, activity level can be further accounted for based on responses to the survey question concerning activity level around the time of consumption. Overall, the study was able to produce both significant and insignificant results and modification of the study design would increase reliability and validity.

Additional research is needed to examine the underlying mechanism behind the effects of artificial sweeteners on the role of food priming in food consumption. Current research in mouse and rat models is limited and contradictory, but recent evidence shows changes in glucose absorption and insulin secretion in humans and animals. [46] A study evaluating the anti–obesity effects of aspartame versus a natural sweetener on mice fed with a high fat diet found fat inflammation and dysregulation of gut microbiota in the aspartame group. [47] Similarly, rats who consumed aspartame for 7 weeks exhibited an increase in body weight gain due to fat accumulation after 3 weeks, as well as reduced insulin sensitivity and higher levels of liver and epididymal fat. [48] Randomized controlled trials in humans show lower levels of fasting blood glucose in those receiving aspartame, while others observed no significant differences in body weight or food intake between those consuming artificial sweeteners versus sugar or a placebo. [49] It is important to investigate the link between biomarker levels and weight gain, which may be affected by the demographics and disease status of the subject population.

Future clinical trials can use this data as a basis for testing the role of artificial sweeteners and food priming in regulating hunger levels and weight gain, which can assist in decreasing the possibility of developing adverse health outcomes such as obesity and cardiovascular disease. Furthermore, clinical trials are needed to investigate the safety of these compounds to avoid adverse health risks associated with their consumption and ensure that future human research involving artificial sweetener consumption does not pose any health risks. Aspartame was initially improved after extensive toxicologic and pharmacologic experimentation on animals that consumed larger-than-human doses of aspartame, and later tested in health infants, children, adolescents, adults, obese individuals, diabetics, lactating women, and individuals heterozygous for phenylketonuria, who have an impaired ability to metabolize phenylalanine. [13] Evidence was later discovered in the post-marketing period suggesting that aspartame is carcinogenic, with another study showing a positive dose-response relationships in which aspartame increased incidence of malignant tumors in multiple organs in rodents. [50] Research published in 2021 shows that aspartame acts as a chemical carcinogen in rodents, increasing cancer risk in offspring. [51] These findings are corroborated by a French population-based cohort study evaluating the dietary intakes and consumption of artificial sweeteners of 102,865 adults with a 7-year follow-up period, which observed an association with increased cancer risk. [52] However, organizations like the FDA have determined that aspartame is not carcinogenic, and there is no study with aspartame that shows a dose-response relationship between the sweetener and brain tumors. [24] Each study yields different results based on the idea that if no adverse effects manifest after a single large dose of aspartame, it has no effect, and no further analysis is conducted. Research may be limited due to the profitability of artificial sweeteners for food manufacturers, but it is important to conduct more human and animal trials to determine the carcinogenic risk of these compounds to avoid any severe adverse complications.

Ultimately, although society is aware of the obesity epidemic and the importance of healthy eating, there is a lack of consensus on what qualifies as “healthy” or “effective.” The research surrounding potential benefits and adverse effects of artificial sweeteners on health and weight control is inconclusive, with studies finding significant increases or decreases in weight gain and BMI or no effect at all. Long-term experimentation that establishes direct causality between artificial sweeteners and weight control is needed to establish a clear consensus.

## VI. CONCLUSION

Food intake was found to be positively associated with food priming, whereas artificial sweetener consumption did not have a significant effect on its own or in combination with the former variable. These results are largely consistent with current literature. Further research is needed to determine the role of artificial sweeteners on the role of food priming in food consumption, given the lack of significance of the results pertaining to artificial sweeteners. This study lays the groundwork for future studies analyzing the role of artificial sweeteners and different types of food primes in hunger levels and food consumption, as well as clinical trials investigating hunger regulation and weight control.

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