
The Influence of an Environmental Cue and Exercise on Food Consumption in College Students

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ABSTRACT

Int J Exerc Sci 2(2): 94-105, 2009. The purpose of this study was to determine the effect of an environmental cue (bowl size) on food consumption and to examine the influence of exercise on that relationship. This cross-sectional study included 286 college students attending a large Midwestern University. Upon arrival at an ice cream social for university students, participants were randomly given a small (8 oz) or large (12 oz) bowl and a 4-page survey addressing exercise and eating habits. At the social, participants were invited to dish themselves as much ice cream as they wanted and the amount consumed was determined by weighing the bowl with ice cream before and after consumption using a scale that measured to the nearest tenth of a gram. Participants who were provided the 12 oz bowl scooped and consumed significantly more ice cream than the participants provided the 8 oz bowl. Regular exercisers consumed more ice cream than non-regular exercisers regardless of statistical control for bowl size and body weight. Those participants who reported exercising previously that day also consumed significantly more ice cream than those not previously exercising; however, the difference was no longer significant after controlling for bowl size and body weight. Environment cues significantly influence food consumption and exercise may also influence subsequent food consumption but further research is needed.

KEY WORDS: Eating Behaviors, Physical Activity, Food Consumption, Bowl

INTRODUCTION

There are an alarming number of overweight or obese individuals among all ages and ethnic groups in the United States (2). According to the National Health and Nutrition Examination Survey approximately 17% of children and adolescents are overweight and 32% of adults are obese (14). Further, approximately 5% of adults are extremely

obese (2). Weight gain results when energy intake consistently exceeds energy expenditure. It has been suggested that a positive energy imbalance, as little as 100 kcal per day, may explain the current trends in weight gain observed in the United States (10, 15).

Powerful environmental cues to overeat may contribute to recent trends in weight gain (16, 17, 21). For example, the

“supersizing” phenomenon has put an emphasis on getting more food for your money. Americans are surrounded by large portion sizes at relatively low prices, appealing to economic sensibilities (3,9). Unfortunately, large portion sizes may also lead to a short-term increase in food consumption and energy intake (16). Other environmental cues such as the size of a cup, plate, or food package have been shown to influence food consumption (21, 18, 19). For example, Wansink et al. demonstrated an 18% to 25% increase in food intake when the size of the food package was doubled (21). Subtle influences such as these may not be recognizable to many individuals but may contribute to creeping weight gain and the obesity epidemic.

Physical activity (exercise) is known to be an effective contributor to long-term weight maintenance and an important strategy for preventing obesity (1, 5). Exercise increases energy expenditure and may cancel out the effect of small increases in energy intake. However, there may be characteristics of exercisers and/or responses to an exercise bout, not often considered, that may also influence food consumption and the effect of exercise for body weight management. For example, investigations of acute exercise suggest that exercise may decrease subsequent energy intake (perhaps by decreasing appetite) (11), while other research shows no effect (20) or even an increase in food consumption following an exercise bout (13). In the present study we sought to investigate the role of an environmental cue and the effect of exercise on food consumption.

Therefore, the primary purpose of this study was to determine the effect of an environmental cue (bowl size) on food consumption at a university social event. As previous research indicates that environmental cues may induce increased food consumption, it was hypothesized that participants who received larger bowls would consume more food than those participants with smaller bowls. The secondary purpose of this study was to examine the influence of exercise on food consumption by addressing the following questions. First, was there any difference in food consumption or eating behaviors between regular exercisers and non-regular exercisers with and without the influence of bowl size and body weight? Second, did exercising previously that day influence food consumption and eating behaviors with and without the influence of bowl size and body weight? Taking the approach that individuals may compensate for increased energy expenditure by increasing energy intake, it was hypothesized that those participants who exercised regularly and who exercised previously that day would consume more food, regardless of bowl size or body weight.

METHODS

Participants, Design, and Setting

The study received University Institutional Review Board approval prior to initiation. A cross-sectional study design was employed for this study and participants were from a convenience sample of male and female college students attending a large Midwestern university. Participants were recruited during a fall, 2007 “welcome-back-to-school ice cream social” held at each of the four on-campus resident

halls during the fifth week of school. Participants attending this event were invited to serve themselves ice cream and complete a questionnaire regarding their exercise and dietary habits. Each participant provided informed consent prior to initiation; however, the informed consent document did not reveal the main purposes of the study. This was done to prevent potential bias in the amount of ice cream they served themselves or consumed as well as bias their responses on the questionnaire. In addition, to maintain the "single blind" nature of the experiment, participants were informed that the event was taking place to obtain opinions and suggestions regarding the existing Wellness Center services offered on campus.

Procedures

Flyers, posters, and e-mails advertised the "welcome-back-to-school ice cream social" event with the purpose of increasing social interaction among new freshman and also to provide new transfer students with information about the Wellness Center programs provided on campus. The flyers included information regarding date, time, location of event, and that free ice cream would be provided if a survey was completed.

Ice cream and materials were taken to the resident halls one hour prior to the event. Materials included a physician weigh scale (Detecto, Webb City, MO), ice cream bowls (8 oz and 12 oz), ice cream scoopers (3 oz), hand sanitizer, clipboards, surveys, pens, prizes, and wellness packets regarding the Wellness Center services offered on campus. Randomization of bowl size was achieved by including equal numbers of 8 oz and 12 oz bowls and mixing them up

prior to handing them out to participants. Also, each bowl was labeled on the bottom with a reference number for data management purposes. Three flavors of ice cream were available (Schnucks brand: vanilla, chocolate, and strawberry) and the ice cream was removed from the freezer within fifteen minutes prior to each event in order to minimize melting.

As participants arrived at the social event they were offered free ice cream with the condition that they completed a survey. They were then instructed to complete the top portion of the survey, which included the informed consent, and were randomly given an 8 oz or 12 oz ice cream bowl. Participants were asked to clean their hands using the provided hand sanitizer and were then instructed to dish themselves to as much ice cream as they liked. When participants finished dishing themselves ice cream, they were allowed to pick one item from a plastic bag full of prizes (key chain, pen, sticky notes) while their bowl of ice cream was weighed. The amount dished was measured to the nearest tenth of a gram by weighing the bowl with ice cream using a food scale (Detecto, Webb City, MO). The weight of the bowls was light enough to not register on the food scale; thus, zeroing out (tare) the scale was not necessary. If participants asked why their bowl was weighed, they were told that the purpose was to estimate the amount of ice cream consumed in order to ensure that enough ice cream was purchased for subsequent events. Participants were informed that if they returned their bowl and survey they would have a chance to place their name into a drawing for a gift certificate.

Participants were required to stay in the common area within visible distance while eating and completing their questionnaires, and were instructed to return their ice cream bowls (regardless of the amount of ice cream that remained) and questionnaires when finished. Upon return of the ice cream bowl and questionnaire, the weight of the remaining ice cream was weighed and immediately recorded on a data sheet separate from their questionnaire. At that time, each participant received a slip of paper to be filled out with contact information for a drawing and a packet of information containing flyers of wellness services offered on campus. Lastly, participants were thanked for their time and dismissed.

Questionnaire

Along with the ice cream each participant received a questionnaire containing selected questions from the survey reported by Wansink, Painter, and North which was modified to fit the purposes of this study (22). The questionnaire assessed gender, age, height, weight, BMI (kg/m²), university status, and ethnicity. The questionnaire also assessed the average number of days per week participants usually exercise, the average duration of exercise, and whether or not participants

exercised that day.

The questionnaire further asked if participants felt that they ate more because they exercised earlier, whether they tend to eat more on days when they exercise, whether the bowl influenced how much they dished themselves at the social, how carefully they paid attention to the amount of ice cream they ate at the social, how carefully they typically monitor how much they eat, and whether they usually eat until reaching the bottom of the bowl. These statements were rated on a 9-point Likert scale (1 = strongly disagree, 9 = strongly agree).

Data Management

To ensure confidentiality, each bowl was numbered, and when each questionnaire was given to the participants, the number on the bowl was recorded on the accompanying survey. This linked the bowl of ice cream to the survey and ensured that participant information was kept anonymous and confidential. Data was entered into an Excel database (Microsoft, 2003) for statistical analysis.

Statistical Analysis

All data analyses were performed using PC-SAS (version 8.2). Significance was set

Table 1. Participants Characteristics

Variable	Total (n = 286)	8 oz (n = 146)	12 oz (n = 140)
Height (inches)	67.6 ± 3.9	67.3 ± 3.8	67.9 ± 3.9
Weight (lbs)	153.8 ± 35.9	152.7 ± 33.5	154.70 ± 38.3
BMI (kg/m ²)	23.5 ± 4.3	23.5 ± 3.9	23.5 ± 4.7
Age (yrs)	18.7 ± 1.1	18.7 ± 1.1	18.7 ± 1.1
Gender (M/F)	124/162	56/90	68/72

Data are mean ± standard deviation.

No significant differences between 8 oz bowl and 12 oz bowl participants for any variable (*p*>0 .05).

Table 2. University Status and Ethnicity of Participants

	Total	8 oz	12 oz
University Status			
<i>Freshman</i>	195	99	96
<i>Sophomore</i>	45	22	23
<i>Junior</i>	29	18	11
<i>Senior</i>	17	7	10
Ethnicity			
<i>White</i>	233	116	117
<i>African American</i>	37	21	16
<i>Asian</i>	5	4	1
<i>Other</i>	11	5	6

at $p < 0.05$ for all tests. Means and standard deviations were calculated for demographic variables and all main outcome variables in the study. To determine the amount of ice cream consumed, the end bowl weight was subtracted from the beginning bowl weight. Energy consumption (kcal) was calculated by averaging the number of kcal per gram of ice cream using the information contained on the nutrition labels and then multiplying that number by the total grams consumed for each participant. To analyze the effect of bowl size on food consumption, participants were grouped according to bowl size (8 oz or 12 oz) and t-tests were performed to assess differences in ice cream consumption. Thereafter, sub-analyses using the general linear model (GLM) compared those who were regular exercisers (≥ 4 times per week) vs. non-regular exercisers (< 4 times per week) and those who exercised that day vs. those who did not exercise that day on the dependent variables of exercise amount, ice cream consumed, and other eating characteristics. In addition, bowl size and body weight were used as covariates in the GLM to control for their potential influence in the exercise analyses.

RESULTS

Participants

Three-hundred and twelve university students participated in this study. For unknown reasons, 15 participants did not return their bowls to be weighed after consumption and 11 subjects filled out a survey but did not consume any ice cream. Therefore, 26 participants were excluded from our data analysis leaving a final sample size of 286 participants. Participants were approximately 57% female and 43% male, normal weight, and young with 146 participants receiving an 8 oz bowl and 140 participants receiving a 12 oz bowl. Analyses by bowl size showed no significant differences for height, weight, BMI, age, or gender (Table 1). Most participants were freshman students (68%) and Caucasian (81%), (Table 2).

The Effect of Bowl Size on Food Consumption

Participants who were provided the 12 oz bowl scooped significantly more ice cream (13%) than the participants provided the 8 oz bowl ($p < 0.00$). Those with the 12 oz bowls also ate approximately 14% more ice cream than those with the 8 oz bowl ($p = 0.01$) (Table 3). Both groups consumed

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Table 3. Food Consumption by Bowl Size

Variable	8 oz (n=146)	12 oz (n=140)	<i>p</i>
Amount Scooped (g)	102.9 ± 41.0	117.38 ± 43.3	<0.01
Amount Remaining (g)	8.4 ± 20.9	7.1 ± 20.1	0.61
Amount Consumed (g)	94.5 ± 43.6	110.2 ± 43.4	<0.01
Energy Consumed (kcal)	200.4 ± 92.5	233.8 ± 92.1	<0.01

Data are mean ± standard deviation

most of the ice cream they scooped (92% vs. 94% for the 8 oz and 12 oz bowl groups, respectively). Further, the participants who received the 12 oz bowl consumed 33 more kcal (14%) than those who received the 8 oz bowl (Table 3).

Exercise, Food Consumption, and Eating Behaviors of Regular Exercisers

Of the 286 participants, 237 reported both their exercise behavior and completed the questions for each item discussed in Table 4. There were 91 regular exercisers and 146 non-regular exercisers. Regular exercisers reported exercising over twice as often (days/week) as non-regular exercisers, approximately 15 minutes longer per exercise session, and consumed approximately 20% more ice cream than non-regular exercisers (Table 4) with each difference demonstrating statistical significance ($p < 0.05$). After controlling for both bowl size and body weight, length of time of usual exercise was no longer statistically significant ($p > 0.05$). When participants responded to the questionnaire items reported in Table 4, regular exercisers reported that they ate more on days when they exercised, that the bowl influenced to a greater extent how much they dished, that they paid more attention to how much they ate, and more carefully monitored how much they eat compared to the non-regular exercisers; however, none of these were

statistically significant ($p > 0.05$). Statistically controlling for the influence of bowl size and body weight did not change the differences between exercise groups for any of the above items (Table 4). Non-regular exercisers tended to report a greater likelihood of eating until reaching the bottom of the bowl. This difference became statistically significant only when controlling for both bowl size and body weight ($p < 0.05$).

The Influence of Previous Exercise that Day on Food Consumption

Of the 286 participants, 237 reported whether or not they exercised that day and completed the questions for each item reported in Table 5. There were 84 participants who exercised previously that day and 153 who did not exercise that day. Participants that exercised previously that day reported consuming 13.4% more ice cream than those who did not exercise previously that day. However, when statistically controlling for the influence of bowl size and body weight, the difference in ice cream consumption was no longer statistically significant (Table 5). Participants that exercised previously that day exercised significantly longer than those who did not previously exercise that day; however there was no statistically significant difference by exercise status in how often (days/week) each group

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Table 4. Exercise, Food Consumption, and Eating Behaviors of Regular Exercisers

Variable	Regular Exercisers (n=91)	Non-Regular Exercisers (n=146)	<i>p</i>	<i>p</i> *	<i>p</i> **
Body Weight	161.7 ± 38.6	147.0 ± 31.0	<0.00	<0.00	NA
How many days per week do you usually exercise?	5.9 ± 6.4	2.5 ± 0.7	0.03	0.03	<0.00
How long do you usually exercise? (min)	79.6 ± 51.5	65.0 ± 49.3	<0.00	<0.00	0.27
Ice Cream Consumption (g)	114.1 ± 44.7	95.1 ± 44.2	<0.00	<0.00	0.03
I eat more on days when I exercise†	3.3 ± 2.3	3.0 ± 2.1	0.23	0.23	0.16
The bowl influenced how much I dished myself†	4.8 ± 2.8	4.5 ± 3.0	0.53	0.53	0.38
I carefully paid attention to how much I ate†	4.2 ± 2.2	3.9 ± 2.2	0.43	0.41	0.20
I carefully monitored how much ice cream I ate†	3.2 ± 2.1	2.9 ± 2.2	0.42	0.42	0.12
I usually eat until I reach the bottom of the bowl†	6.2 ± 2.6	6.7 ± 2.6	0.11	0.11	0.04

Data are mean ± standard deviation

*Statistical Control of Bowl Size; **Statistical Control for bowl size and body weight

†(1 = strongly disagree, 9 = strongly agree)

Note: 90 and 141 Regular Exercisers and Non-regular Exercisers, respectively, reported their body weight

Table 5. Exercise, Food Consumption, and Eating Behaviors of those who Exercised that Day

Variable	Exercised that Day (n=84)	No Exercise that Day (n=153)	<i>p</i>	<i>p</i> *	<i>p</i> **
Body Weight (lbs)	154.3 ± 28.5	151.8 ± 38.0	0.60	0.36	NA
How many days per week do you usually exercise	4.2 ± 1.6	3.6 ± 5.2	0.31	0.28	0.29
How long do you usually exercise (min)	81.5 ± 48.5	64.6 ± 50.8	0.01	0.02	0.02
Ice Cream Consumption (g)	110.8 ± 49.3	97.7 ± 42.4	0.03	0.06	0.11
I ate more because I exercised earlier†	3.2 ± 2.3	2.1 ± 1.6	<0.00	<0.00	0.02
I eat more on days when I exercise†	3.5 ± 2.4	2.9 ± 2.0	0.04	0.04	<0.00
The bowl influenced how much I dished myself†	4.4 ± 2.9	4.7 ± 2.9	0.48	0.47	0.38
I carefully paid attention to how much I ate†	4.5 ± 2.3	3.8 ± 2.1	0.03	0.02	0.02
I carefully monitored how much ice cream I ate†	3.6 ± 2.5	2.7 ± 1.9	<0.00	<0.00	<0.00
I usually eat until I reach the bottom of the bowl†	6.4 ± 2.6	6.5 ± 2.6	0.73	0.68	0.52

Data are mean ± standard deviation

*Statistical Control of Bowl Size; **Statistical Control for bowl size and body weight

†(1 = strongly disagree, 9 = strongly agree)

routinely exercised ($p > 0.05$) and this relationship persisted after controlling for bowl size and body weight (Table 5).

When participants responded to the questionnaire items reported in Table 5, those who exercised previously that day reported that they ate more because they

exercised previously, that they eat more on days when they exercise, paid more attention to how much they ate, and more carefully monitored how much ice cream they ate compared to those who did not exercise that day ($p < 0.05$). These differences persisted when controlling for bowl size and body weight (Table 5).

DISCUSSION

This study was in agreement with previous studies demonstrating the profound effect of a subtle environmental cue on food consumption in adults (17, 21). In the present study, participants given a larger bowl both served and consumed more ice cream than those who received the smaller bowl. Interestingly, results showed that both bowl size groups consumed virtually all of their ice cream. These data imply that bowl size influences how much is initially scooped and that there is a tendency to eat all that is served.

The relationship between bowl size and food consumption has interesting implications for weight management. Obviously, increased food consumption can lead to increased energy consumption and, ultimately, unwanted body weight gain. Because monitoring food or drink consumption takes continuous effort and can be burdensome, factors such as package size, plate size, or the presence of other environmental cues are unwittingly used by individuals to gauge consumption (21). Individuals may clean their plate/bowl without realizing the weight management implications because it is a custom that has continuously been reinforced in our society. Indeed, research has shown that, although individuals acknowledge that

environmental cues may influence their eating, they feel that they themselves are not personally influenced (21). Understanding that environmental cues exert subtle influences on eating, we can better manipulate these cues to promote better portion control and reduce over-eating.

In the present study, regular exercisers were defined as those who reported any exercise 4 or more times per week and non-regular exercisers were defined as those who reported exercise less than 4 times per week. The American College of Sports Medicine recommends an exercise regimen of 30 minutes or more of moderate-intensity physical activity for 5 days per week and/or vigorous physical activity for 20 minutes on 3 days per week (6, 8). We chose a cutpoint of 4 days per week as it was directly in the middle of 3 and 5 days per week. In addition, we also analyzed using a cutpoint of 3 days per week and found that the results were not statistically different compared to analyzing using 4 days per week. Therefore, using a cutpoint of 4 days per week the regular exercisers averaged 5.9 ± 6.4 exercise sessions per week and the non-regular exercisers averaged 2.5 ± 0.7 exercise sessions per week. Our original hypothesis was proven to be correct that regular exercisers would consume more ice cream than non-regular exercisers regardless of the influence of bowl size. The rationale for this hypothesis was based on previous studies showing that regular exercisers may exhibit some compensation in food consumption (behavioral or physiological) in response to exercise (4, 12). While it was beyond the scope of this study to measure behavioral or physiological mechanisms for

compensation, some exercise and eating behaviors were assessed and are noteworthy.

As expected, regular exercisers engaged in exercise significantly more often and longer per session than non-regular exercisers, though statistical difference in the length of time in regular exercise was weakened after adjustment for body weight. In addition, regular exercisers consumed 20% more ice cream than non-regular exercisers. However, in response to survey questions regarding perceived exercise and eating behaviors there was no statistical difference between regular and non-regular exercisers (Table 4). For example, exercisers did not self-report that they ate any more food on days in which they exercise compared to non-regular exercisers in spite of the measured ice cream consumption being higher in regular exercisers. It is possible that the influence of regular exercise exerts a subtle influence on subsequent eating that is not easily recognizable by individuals or perhaps that because of regular exercise, individuals feel more freedom to eat subsequent to exercise. Future research in this area is welcome.

This study also assessed whether exercising previous to the ice cream social influenced the relationship between bowl size and ice cream consumption. Similar to above, we hypothesized that exercising previously would impact ice cream consumption regardless of the influence of bowl size or body weight. This rationale was also based on previous studies indicating that there may be compensation in food consumption resulting from previous exercise (4, 12).

The data in the present study showed that participants who exercised previously that day ate more ice cream than those who did not exercise previously; however, this was no longer statistically significant after controlling for bowl size ($p=0.06$) and body weight ($p=0.11$). This likely means that bowl size may have been a stronger determinant of ice cream consumption than previous exercise that day and body weight exerts additional influence on the relationship. However, with and without statistically controlling for bowl size and body weight, previous exercisers self-reported, via questionnaire, that they ate more that day because they exercised earlier, that they typically eat more on days when they exercise, that they paid more careful attention to how much they ate, and that they more carefully monitored how much they ate compared to those who did not exercise previously that day (Table 5). Though these were statistically different, both exercise groupings tended to have only low to moderate responses (2.9-6.5 out of 9) on the questions. These data seem to indicate a possible food compensation effect in response to previous exercise, as seen in other studies. However, because total daily dietary intake or pre and post measurements were not assessed, we cannot conclude this with certainty (11). Regardless, it is apparent the exercising on a given day may exert a reasonable influence on subsequent food intake that day regardless of the influence of bowl size and body weight.

This study may be limited by the following factors. First, all questionnaire information was self-reported (e.g., height, weight, exercise, etc.). Second, this study was cross-sectional and therefore, we do not know

how environmental cues or exercise influenced food consumption or normal eating patterns over time. Third, this study only assessed ice cream consumption at the university social event and did not assess full course meals, total daily food consumption, or food consumption and exercise following the ice cream social. Therefore, we are limited in our ability to elaborate on the influence of exercise on bowl size and food consumption. Further, students were not allowed to take a second helping of ice cream. It is possible that unlimited access to ice cream might have increased consumption for some participants regardless of bowl size. Lastly, we asked each participant to fill out the questionnaire subsequent to eating the ice cream; however, we did not verify this order. Whether or not participants consumed the ice cream prior to filling out the questionnaire may have influenced the way participants answered questions such as, "I usually eat until I reach the bottom of the bowl" or "I usually eat until I reach the bottom of the bowl".

In summary, three main findings emerged from this study. First, this study confirmed previous studies that environmental cues exert a powerful influence on the amount of food consumed. In the present study, there was only a 4 oz difference in the bowl sizes, yet those randomly given the 12 oz bowl size voluntarily dished and consumed significantly more ice cream than those given the 8 oz bowl. Second, regular exercisers consumed more ice cream than non-regular exercisers with and without controlling for bowl size and body weight; however, self-reported data tended to show little difference between exercise groups in the perceived effect of exercise on eating

behaviors. Third, exercising previously that day (compared to not exercising previously that day) appears to be associated with some eating behaviors that may lead to extra consumption.

This study has interesting implications for weight management. Alterations in bowl, plate, or cup sizes may help influence passive over-consumption of food and may be an appropriate strategy to modestly reduce energy intake. Further, regular exercisers should be aware that there may be influences that lead to over-consumption resulting from exercise. To best manage weight, conscious attempts should be made to minimize over-consumption of food that offsets the energy expended during exercise. Future research should focus on the long-term effects of environmental cues (e.g., increased portion sizes) and how these cues affect regular exercisers. Further investigations into such a study could be very beneficial for health professionals and fitness professionals, as well as college educators. Given the continuing obesity epidemic, it is more important than ever to focus on education and strategies that attenuate weight gain. The college population is a perfect place to start since these individuals are a known risk group for weight gain and develop habits that may persist into older adulthood (1, 2, 7). Educational topics such as portion control, adhering to a regular exercise program, and energy balance are all topics that should begin with young adults and be emphasized among all-age groups.

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