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Acute and chronic effects of gum chewing on food reinforcement and energy intake

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ABSTRACT

Although chewing gum has been considered a potential method for reducing energy intake, little empirical data exist to support this idea. The purpose of this study was to test the hypothesis that chewing gum before eating reduces motivation to eat, hunger, and energy intake. In order to test this hypothesis, we conducted two experiments in which participants chewed gum prior to completing a food reinforcement task or before all eating occasions for two of three weeks. In Experiment 1, we found that chewing gum had no influence on the reinforcing value of food, but chewing mint gum reduced liking of and energy intake from fruit. In addition, chewing gum reduced self-reported hunger immediately after gum chewing and after eating compared with the no gum condition. In Experiment 2, gum chewing had no significant effect on total energy intake, but participants consumed fewer meals, consumed more energy per meal, and had a lower nutrient adequacy ratio during the gum chewing weeks. These studies provide no evidence that acute or chronic gum chewing reduces hunger or energy intake. In fact, chewing mint-flavored gum may deter consumption of fruit and reduce diet quality.

1. Introduction

The increasing obesity rate in the United States has highlighted the importance of studying eating behavior. Any methods to reduce intake of food, especially unhealthy food, could be extremely useful in preventing weight gain and assisting with weight loss. There are many gums on the market that purport to help with weight loss due to ingredients including guarana or other forms of caffeine, chromium compounds, green tea, L-carnitine, artificial sweeteners, and other chemicals. There is some evidence that gum chewing may alter appetite (Hetherington & Boyland, 2007; Julis & Mattes, 2007; Tordoff & Alleva, 1990), energy intake (Hetherington & Boyland, 2007), and food choices (Hetherington & Boyland, 2007), but the data remain equivocal.

There are several potential mechanisms by which gum could influence food intake. For example, gum could influence food intake by reducing hunger. One study showed that chewing gum with increasing concentrations of aspartame produced an increase in hunger ratings compared to unsweetened gum or no gum controls (Tordoff & Alleva, 1990). Another study examined the effect of chewing a sucrose-containing pastille (a solidified liquid which had to be chewed and dissolved in the mouth over a ten-minute period) on appetite and meal intake and showed that energy intake from the meal was reduced after chewing the pastilles compared with water and other sucrose conditions that provided the same amount of energy, but required less chewing (Lavin, French, Ruxton, & Read, 2002). Gum could also affect intermeal interval and appetite. In one study, participants had lunch in a lab setting four times and either chewed gum for the first 15 min of each hour for the 3 h following lunch or did not chew gum. After this time, participants returned for a snack (Hetherington & Boyland, 2007). There was a reduction in appetite and a reduction in desire for sweet snacks. However, in another study, researchers found that when participants chewed gum right before eating, they reported increased hunger, preoccupation with food, and desire to eat compared to the chewing gum 2 h post-meal and no gum chewing conditions (Julis & Mattes, 2007). This study concluded that gum does not influence appetite, meal pattern, or energy intake significantly. Another mechanism by which gum chewing could reduce energy intake is by reducing food reinforcement, or the amount of work people are willing to do to get access to food (Epstein, Leddy, Temple, & Faith, 2007). There is a strong positive relationship between the reinforcing value of food and energy intake (Epstein et al., 2007; Fletcher, Carr, Epstein, & Lin, 2011; Raynor & Epstein, 2003; Temple, Chappel, Shalik, Volcy, & Epstein, 2008; Temple et al., 2009), so we hypothesize that if chewing gum reduces motivation to get food, it would also reduce food intake. To date, no studies have investigated the effect of gum chewing on food reinforcement.

The influence of gum chewing on food could also depend on the flavor of the gum and on the type of food consumed after gum chewing. In a study done on toothpaste, brushing teeth with mint flavored toothpaste altered the perception of orange juice flavor for over an hour, but fatty and savory foods tasted normal soon after toothbrushing (Allison & Chambers, 2005). One possible explanation for this is that the cooling or burning sensation from the mint gum sensitized the nerves that also respond to citric acid (Allison & Chambers, 2005). In another study mentioned above, participants had lunch and either

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chewed sugar free gum or did not chew gum for the first 15 min of each hour for the 3 h following lunch or did not chew gum (Hetherington & Boyland, 2007). After 3 h, there was a reduction in the desire for sweet snacks, but no reduction in the desire for salty snacks. When taken together, these studies suggest that eating following gum chewing can be influenced by multiple factors related to the flavors of the gum and the food.

Another question that remains is whether gum chewing has an acute effect on food selection and energy intake or whether the effects are seen with more chronic intake. The majority of the studies cited above examined food intake within a single eating bout, or in two simultaneous eating bouts. It is possible that after several days of gum chewing, cumulative energy intake may be decreased. To our knowledge, no one has attempted to determine whether the primary effects of gum chewing on energy intake occur acutely or chronically.

The purpose of this study was to test the hypothesis that acute and chronic gum chewing reduces energy intake. We examined two potential mechanisms for this reduction in energy intake: the flavor of the gum and reduction in the reinforcing value of food. We hypothesized that acute chewing of mint gum would reduce energy intake and food reinforcement more than chewing fruit gum or no gum at all. The second study tested the hypothesis that chewing mint gum (either a purported weight loss gum or a regular mint gum) before every eating occasion for one week reduces energy intake. If chewing gum has effects on food reinforcement, snack food intake, or energy intake, it could be a useful tool for those trying to lose weight.

2. Methods

2.1. Experiment 1

2.1.1. Participants

The participants were 18–50 year old men (n = 21) and women (n = 23) living in Buffalo, New York or the surrounding communities. They were recruited through posters on the North and South campuses of the University at Buffalo, word of mouth, and participation in past, unrelated studies. People were excluded from participating in the study if they reported any medical conditions or drugs that affected appetite or diet, they have an aversion to chewing gum or the study foods, they have any medical condition that would not allow them to chew gum, they are current smokers, they have eating disorders, they are currently on special or weight loss diets, or they are unwilling to keep a food journal. The studies described in this manuscript were approved by the Social and Behavioral Sciences Institutional Review Board of The State University of New York at Buffalo.

2.1.2. Screening

Potential participants were e-mailed a link to a SurveyMonkey™ survey to determine eligibility. The surveys had questions about demographic information, medical history, diet history, chewing gum habits, and food preferences. Participants were asked to rate how much they liked the four study foods on a 7-point Likert scale (1 = do not like at all, 7 = like very much) and if they did not like at least one of the healthy options and one of the snack food options (a rating of 5 or above) they would be excluded from the study. If a participant was eligible to participate they would be e-mailed with more information and asked to schedule visits if they were still interested.

2.1.3. General procedures

Participants came in for three one-hour sessions scheduled between 11 AM and 2 PM Monday through Friday, with at least one day in between sessions. Participants were told not to consume any food or drink other than water within 3 h of the lab visits. At the first session, participants read and signed a consent form and filled out the demographic questionnaire. The consent form had information about the visits, the risks of participation, the compensation, and the numbers to call if they have any questions. Participants were told that the purpose of the study was to determine whether chewing gum can alter how much they want to eat snack food. The researcher sat with the participant to answer any questions during this time. Participants were then randomized to one of six possible orders of gum conditions.

For all of the visits, a 24 hour recall was done to assess the participant's intake from the previous day and the morning of the visit. The participants then rated their hunger and perceived liking of the study foods. After this, participants either chewed gum or sat for 10 min. On one visit, they chewed Wrigley's™ Spearmint gum, and on one visit they chewed Juicy Fruit™ gum. They then filled out the hunger and food liking scale for the second time. Next, they completed a food reinforcement task (described below) to earn points to exchange for food. They could play for a low energy density ("healthier") food on one computer (grapes or mandarin oranges), and on the other computer they could play for a high energy density "snack" food (M&M's chocolate candies or potato chips). They could win up to ten, 30 gram portions of each food. Participants were told that they could not eat any of the food until after they were completely done playing the food reinforcement game. Right before eating the food they earned, participants had to fill out a third hunger and food liking scale. Then participants could take as much time as they wanted eating food and were permitted to read magazines or books during this time. Finally, the participants did one last hunger and food liking scale before leaving.

On the third and final visit, after eating and filling out the final food liking scale, participants filled out the three eating habit questionnaires (described below) and had their height and weight measured. Then, participants were given a debriefing form detailing the study purpose. The researcher answered any questions that the participants had about the study and provided payment in the form of a $60 gift card to Wegmans.

2.1.4. Food reinforcement task

The food reinforcement task was designed to assess how hard people will work to win a portion of food (Epstein et al., 2007; Temple et al., 2008). The game shows three boxes with different colored shapes, and the participants click the mouse until the three shapes and colors match, at which time they get one point. After winning five points, the participant was given a 30 gram portion of the food for which they had worked. Every time the participants won a portion of food, the researcher came out and placed a portion of food on a table for the participants to eat later. The participant could not eat until after they were done playing the game. The game was programmed on a progressive ratio schedule of reinforcement, with the first portion of each food taking about 20 clicks, the second, 40, then 80, 160, 320, 640, 1280, 2560, 5120, and 10,240. Each type of food was earned on a separate computer and the participants could switch between the computers whenever they pleased. The participants were instructed to play until they earned all foods of both types that they wish to consume. The game recorded the amount of clicks and the speed it took to earn each portion of food. After they were finished playing the game, they rated their hunger and food liking before consuming as much or as little of the food as they wanted.

2.1.5. Assessment of energy intake

The portions of food were weighed before they were put into containers. The weights of all the portions of each food won by the participants were recorded during the experiment, and after the experiment, all of the remaining food was weighed to determine the amount of food consumed. The calories per gram were calculated for each food previously and multiplied by the weight of the food consumed to find the energy consumed by the participants.

2.1.6. Hunger and food liking scale

Hunger and liking of study foods was assessed using a 100 millimeter visual analog scale anchored by "Not hungry" or "Do not like at all" on one end and "Extremely hungry" and "like a lot" on the other end.