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Short communication

Short-term effects of chewing gum on snack intake and appetite

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Abstract

Consumers report that chewing gum can reduce cravings and the likelihood of snacking. The present study set out to examine the effects of chewing gum on subjective appetite and snack energy intake (EI) in 60 participants (40 females, 20 males, 21.7±4 years; BMI = 22.7±3.4) who came to the laboratory four times for lunch and then returned 3 h later for a snack. Participants consumed salty or sweet snacks after chewing gum (sugar-free or regular) for 15 min hourly after lunch or had no-gum. Hunger, desire to eat and fullness were rated immediately after lunch (T0) and hourly post-lunch (T1 and T2) until just before snack (T3). Chewing gum reduced EI by 36 cal (401.8±22 kcal) compared to no-gum (437.7±23 kcal; $p = 0.04$). Rated hunger increased from T0 to T3 ($p < 0.001$); however, this was less after gum compared to no-gum ($p < 0.01$). Desire to consume salty and sweet snacks also increased. However, desire to eat sweet snacks (but not salty) increased less after gum compared to no-gum ($p = 0.004$). Therefore, chewing gum suppressed appetite, specifically desire for sweets and reduced snack intake. This supports anecdotal reports by consumers and could inform weight control strategies.

Keywords: Chewing gum; Appetite; Cravings; Energy intake

Introduction

The orosensory stimulation associated with eating is key to the development of satiation. Thus, when consumers chew but do not swallow food (sham feed) there is a decline in the pleasantness of the taste of that food relative to foods that have not been sham fed (Rolls & Rolls, 1997). Similarly, if consumers smell a food for the same duration as eating that food to satiety, then there is a significant decrease in pleasantness and desire to eat that food compared to other foods (Rolls & Rolls, 1997). When normal eating is compared to infusion of nutrients which bypass orosensory stimulation, it is apparent that the orosensory component facilitates the development of satiety (Cecil, Francis, & Read, 1998). It is not clear, however, whether chewing without swallowing then acts to reduce subsequent energy intake (EI).

In an experiment comparing the effects of ingesting equicaloric sweetened preloads given as a liquid, semi-solid (jelly) or solid (pastilles), Lavin, French, Ruxton, and Read (2002) found that only chewing the pastilles reduced subsequent intake compared to water and the sweet drink (by 10% and 13%, respectively). Thus, it seems that the additional sensory experience of chewing was sufficient to promote satiation and reduce overall EI.

In contrast, it has been shown that chewing gum sweetened with aspartame may increase hunger (Tordoff & Alleva, 1990) compared to chewing an unsweetened gum or nothing. It is not clear from the latter study whether the effects on hunger would be replicated using commercially available and familiar gums. In any case, Hall, Millward, Rogers, and Morgan (2003) reported decreased hunger and desire to eat with encapsulated aspartame or constituent amino acids of aspartame. It has been reported that individuals with eating disorders are heavy users of sugar-free foods, including chewing gum, in an attempt to avoid consuming foods with energy and to satisfy the need for orosensory stimulation (Klein, Boudreau, Devlin, & Walsh, 2006).

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The route of administration of aspartame (capsules, chewing) may produce conflicting results on hunger. Therefore, the present experiment examined the effect of chewing familiar, commercially available aspartame or sugar-sweetened gum on subsequent snack food intake, coupled with its effects on subjective ratings of appetite (hunger, fullness, desire to eat). It was hypothesized that chewing gum would reduce intake in addition to reducing cravings for snacks.

Methods

Using a within-subjects, repeated measures design, 60 healthy participants (40 females, 20 males) drawn from the staff and students of the University of Liverpool were invited to attend the laboratory on four separate occasions to consume a snack twice a week for 2 weeks (with at least 2 days between each session). Volunteers were relatively young and in good health (21.7±4 years; BMI = 22.7±3.4; 46 were normal weight, 9 were overweight or obese and 4 were underweight). Screening prior to the study was conducted to ensure that they met study criteria, i.e. were in good health (not taking medications, no chronic diseases, diabetes or allergies, especially those in relation to gum ingredients, e.g. mint flavours, high-intensity sweeteners, bulk sugar-free sweeteners, teeth in a good state of repair) and were regular consumers of gum and snacks. They also rated their favourite gum from a list of 10 best-selling regular and sugar-free gums in the UK and rated the pleasantness of the foods used in the study (lunch items and snacks). The gum used in the study was the highest ranked, most preferred gum from the ratings and the snacks were similarly the most preferred of the three salty and three sweet snacks offered. This ensured that both gum and snack were highly acceptable by the participants.

The study was approved by the School of Psychology Ethics Committee and participants gave written, informed consent with the knowledge that they could withdraw at any time without prejudice.

Measures

All subjective ratings were made on 100 mm visual analogue scales from "not at all" on the left to "extremely" on the right. Ratings were made of hunger, desire to eat and fullness before and after lunch, and then at hourly intervals these were repeated alongside ratings of desire to eat a salted snack, desire to eat a sweet snack and mood (relaxed/anxious). Before and after a snack, participants were asked to taste and rate the pleasantness of their chosen snack. Intake was calculated by weighing any left-over snack from amount given. Energy intake (EI) was determined from manufacturers' information.

Foods

The chewing gums offered to participants included regular gum or sugar-free according to preference. On average, sugar-free gums provided 5 kcal per portion (two pellets) and regular gum provided 10 kcal per portion (one stick). Salty and sweet snacks were selected following a pilot study of 100 undergraduates. The students were asked to name their three favourite sweet snacks and three favourite salty snacks. Six snacks were then selected on the basis of being highly liked and similar in macronutrient composition and energy density (see Table 1).

Procedure

On each experimental day participants consumed their normal breakfast at home and were instructed not to eat or drink (except water) until they attended the laboratory between 12 noon and 1 p.m. for a fixed lunch. Lunch consisted of cheese sandwiches, green salad and fruit salad (women: 485 kcal; men: 698 kcal), and represented ~25% of total EI. Ratings of hunger, desire to eat, fullness and desire to eat salty/sweet snacks were completed before and after lunch (T0) and then hourly (T1 and T2) until they returned to the laboratory for a snack 3 h after lunch (T3). During this interval participants were asked not to eat or drink (except water) and to abstain from strenuous physical activity. Condition order (A: sweet snack,

Table 1
Energy and macronutrient information on snack foods used in the study, provided by manufacturers

Product name: Manufacturer	Values per 100 g of product				
	Energy (kJ)	Energy (kcal)	Protein (g)	Carbohydrate (g)	Fat (g)
Salty snack					
Cheese and onion Pringles: Procter & Gamble	2254	541	4.7	50.0	36.0
Cheesy wotsits: Walkers	2220	530	6.0	55.0	32.0
Ready salted potato crisps: Walkers	2200	530	6.5	49.0	34.0
Sweet snack					
Milk chocolate fingers: Cadbury	2185	520	6.8	62.9	26.7
Chocolate digestive biscuits: McVities'	2040	487	6.7	62.6	23.3
Maltesers: Masterfoods	2031	485	7.9	61.7	22.7

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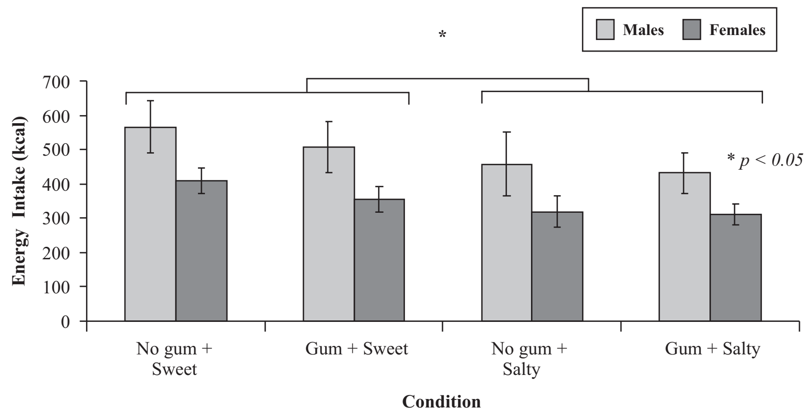

Fig. 1. Mean (SEM) energy intake (kcal) at snack following each of the four experimental conditions.

no-gum; B: salty snack, no-gum; C: sweet snack, gum; D: salty snack, gum) was determined using a Latin-square so that order was counterbalanced across participants. For the gum conditions participants chewed their favoured gum (two pellets or one stick) for at least 15 min 1 h hour after lunch (T1) and 2 h after lunch (T2), and then at these time points they rated appetite again. The ratings were conducted after leaving the laboratory. Participants placed the spent gum into a sealed plastic bag and returned this bag to the investigator. Participants were told to chew for at least 15 min more if they wished, and asked to note the times they started and finished chewing gum so that total chewing time could be calculated. After 3 h, participants returned to the laboratory and re-rated appetite (T3). Compliance with the gum chewing instruction was recorded by return of the bags and spent gum. In the no-gum conditions (A: sweet; B: salty) participants rested for 15 min and in the gum conditions (C: sweet; D: salty) they chewed gum for 15 min before completing the ratings. Participants re-rated appetite and desire to eat/pleasantness of the taste of a small sample of the chosen sweet or salty snack, and then were given 750 kcal[1] of snack (pre-weighed bowl) with ad libitum access to water, and were instructed to eat and drink as much or as little as they wished. Immediately after the snack, participants re-rated all parameters (T4) including the pleasantness of the taste of the snacks, and then they left the laboratory with the instruction to rate appetite 1 and 2 h after the snack (T5 and T6) and to record all food and drink consumption in a diet record for the remainder of the day.

After the final session, each participant returned to the laboratory to submit diet records, complete the Dutch Eating Behaviour Questionnaire (DEBQ, Van Strien, Frijters, Bergers, & Defares, 1986), complete a de-brief questionnaire and have height and weight recorded. Participants were then thanked and paid (£10) for their participation.

[1]The first 15 Ss were given 500 kcal of snack since this was expected to exceed normal portion size; however, this was increased to 750 kcal when the entire portion was consumed by several participants.

Data analysis

Food weight and EIs were subjected to a repeated measures analysis of variance (ANOVA) with two within (gum/no-gum; salty/sweet) and one between groups factor (gender). Ratings of appetite were similarly analysed using ANOVA with three levels (gum/no-gum; salty/sweet; time: T0–T4). Analyses of ratings were conducted only on post-lunch ratings. Post-hoc comparisons were corrected with Bonferroni adjustment for multiple comparisons. The majority (78%) of participants selected sugar-free gum (33 women and 14 men) rather than gum containing sucrose (7 women and 6 men). Effects of gum type on amount of snack eaten were assessed.

Results

Data are presented as mean ± SEM, unless otherwise stated.

A significant main effect of condition revealed that a smaller weight of snack was consumed in both gum conditions (73.2 ± 4.2 g) compared to no-gum [80 ± 4.4 g; $F(1,58) = 4.576$, $p = 0.05$]. Similarly, EI was significantly less following gum compared to no-gum [$F(1,58) = 4.344$, $p = 0.04$; see Fig. 1]. There were no detectable differences in EI by gum type (regular group—no-gum: 454 ± 49 kcal; regular gum: 395 ± 48 kcal; sugar-free group—no-gum: 401.7 ± 26 kcal; sugar-free gum: 374 ± 25 kcal). Interestingly the size of the condition effect was similar for regular and sugar-free gums, despite regular gum containing twice as many calories as sugar-free. Since the main effect of condition on intake was significant, for all subsequent analyses responses to the two types of gum are pooled.

The difference in EI following gum (401.8 ± 22 kcal) was slightly but significantly lower than that in the no-gum conditions (437.7 ± 22.6 kcal), a reduction of 36 cal or 8.2%. As expected, men (490.7 ± 33.5 kcal) consumed more energy than women (348.7 ± 23.7 kcal) [$F(1,58) = 11.930$, $p = 0.001$]. However, there was no significant interaction between gender and condition (gum/no-gum), suggesting that both males and females responded similarly to the experimental manipulation. To test for "cleaning the plate" effects, data from individuals who consumed all snacks provided in any one condition ($n = 12$) were removed from the analyses. Intake remained significantly different by condition [$F(1,47) = 3.928$, $p<0.05$] with a difference of 30 kcal between gum and no-gum conditions.

Around half of the participants reduced intake in response to chewing gum by at least 36 kcal for either salty or sweet snacks (27/60 for salty and 28/60 for sweet). Only 13 (21.7%) reduced intake of both salty and sweet snacks in response to chewing gum by at least 36 kcal.

Restrained eaters ($n = 30$) were more responsive to chewing gum [$F(1,29) = 4.877$, $p = 0.035$] eating significantly less after gum (381.9 ± 32 kcal), compared to no-gum (435.7 ± 35 kcal). However, in unrestrained eaters the effect of condition was only marginally significant [$F(1,29) = 3.833$, $p = 0.060$].

A main effect of snack type (sweet/salty) emerged as significant with greater intake of sweet snack (460 ± 24 kcal), compared to salty snack [379.5 ± 22.2 kcal; $F(1,58) = 14.423$, $p<0.001$]; thus, participants tended to eat more sweet than salty snacks. No significant interaction between condition and snack type was found.

Pleasantness ratings of sweet and salty snacks were similar across conditions, although as predicted, rated pleasantness declined as a function of time [$F(1,59) = 72.2$, $p<0.0001$] for all conditions and equally for salty and sweet snacks. Correlations between rated desire to eat and EI were statistically significant for all but condition D ($r = 0.28, 0.39, 0.48$; $p<0.05$ for A, B, C, respectively).

Self-reported hunger ratings increased significantly between the immediate post-lunch rating (T0) and the pre-snack rating (T3) across all four conditions [$F(3,177) = 111.687$, $p<0.001$]. Overall, mean hunger ratings were marginally but significantly lower in the gum conditions (34.8 ± 1.9 mm) compared to the no-gum conditions (38.8 ± 1.7 mm) [$F(1,59) = 5.313$, $p = 0.025$]. A significant interaction between condition and time indicated that hunger ratings increased to a lesser extent over time (T0–T3) after chewing gum (17.6–49.0 mm) compared to no-gum (18.3–55.6 mm) [$F(3,177) = 2.872$, $p<0.05$]. A similar pattern emerged for fullness with this variable rated marginally but significantly higher in the gum conditions compared to no-gum [$F(1,59) = 4.545$, $p = 0.04$]. Ratings of desire to consume a sweet snack increased over time [$F(3,177) = 39.214$, $p<0.001$] and a significant interaction between condition and time [$F(3,177) = 4.530$, $p = 0.004$] indicated that chewing gum reduced the desire to eat sweet snacks compared to no-gum (see Fig. 2). No such effect was found for desire to eat a salty snack.

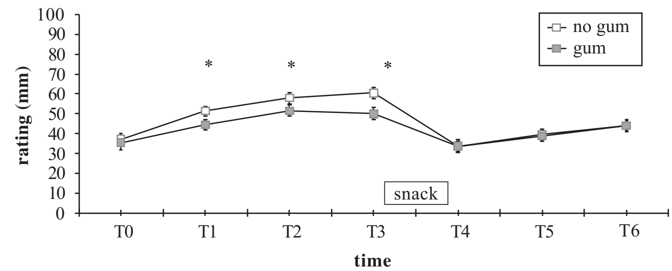

Fig. 2. Mean (SEM) ratings (mm) of desire to eat sweet snack immediately after lunch (T0), hourly post-lunch for 3 h (T1–T3), immediately (T4) after snack, and then hourly post-snack for 2 h.

Discussion

Chewing gum reduced EI by 36 cal or 8.2% for sweet and salty snacks. Hunger ratings were significantly lower and mean fullness ratings significantly higher in the gum conditions compared to no-gum. Hunger ratings also increased less over time when gum had been chewed. Rated desire to consume a sweet snack decreased significantly more over time after chewing gum compared to no-gum, but this effect was not found for the salty snack. Thus, chewing gum had a dual effect on appetite, reducing both the subjective sensations associated with eating and the amount of food eaten during a snack.

There was a specific effect of chewing gum on desire to eat a sweet snack, which might relate to sensory specific satiety. Sensory specific satiety has been observed following sham feeding and after smelling a food (Rolls & Rolls, 1997). Therefore, pleasantness of a food can be reduced by mere exposure to the orosensory features through chewing or smelling a food without the normal post-ingestive consequences associated with eating. However, it was not clear from either sham feeding or smelling food whether intake would also be decreased. In the present study chewing gum reduced rated desire for a sweet snack and amount consumed during the snack.

Limitations of the present study include the relatively small effect size on intake. Overall, 13 individuals (21.7%) reduced their intake by a minimum of 30 kcal in *both* the sweet and the salty snack conditions. Thus, some individuals were more responsive to the experimental manipulation than others. In the present context participants with high restraint scores ate significantly less after gum than no-gum, suggesting that in those who are motivated to lose or maintain weight gum could be a useful strategy to suppress intake.

These results contrast with those of Tordoff and Alleva (1990), who found that chewing gum bases sweetened with aspartame increased rated hunger. In the present study participants chose either aspartame or sucrose-sweetened gums, but there were no differences in EI or appetite as a function of which sweetening agent was used. However, the present results confirm and extend findings by Lavin et al. (2002), in which chewing sucrose-containing pastilles for a 10-min period reduced intake by 10% compared to water and by 13% compared to sucrose in solution. In that study, suppression of appetite was ascribed to enhanced

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orosensory stimulation provided by the pastilles compared to the other pre-loads.

In comparison to sweet pastilles, chewing gum contributes significantly less to total EI. Any reduction in snack consumption associated with chewing gum if repeated over time could contribute to negative energy balance. Therefore, chewing gum may have positive health benefits for weight control. It is not yet clear whether the effect of chewing gum on intake will be observed over time. Given the individual differences in response to chewing gum, it is suggested that involving motivated consumers, i.e. those who wish to lose or maintain body weight, would be the optimal group on which to test the efficacy of gum for weight management.

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