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Research report

Prolonged chewing at lunch decreases later snack intake

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ABSTRACT

Prolonged chewing of food can reduce meal intake. However, whether prolonged chewing influences intake at a subsequent eating occasion is unknown. We hypothesised that chewing each mouthful for 30 s would reduce afternoon snack intake more than (a) an habitual chewing control condition, and (b) an habitual chewing condition with a pauses in between each mouthful to equate the meal durations. We further hypothesised that this effect may be related to effects of prolonged chewing on lunch memory. Forty three participants ate a fixed lunch of sandwiches in the laboratory. They were randomly allocated to one of the three experimental groups according to a between-subjects design. Appetite, mood and lunch enjoyment ratings were taken before and after lunch and before snacking. Snack intake of candies at a taste test 2 h after lunch was measured as well as rated vividness of lunch memory. Participants in the prolonged chewing group ate significantly fewer candies than participants in the habitual chewing group. Snack intake by the pauses group did not differ from either the prolonged or habitual chewing groups. Participants in the prolonged chewing group were less happy and enjoyed their lunch significantly less than participants in other conditions. Appetite ratings were not different across groups. Rated vividness of lunch memory was negatively correlated with intake but there was no correlation with rated lunch enjoyment. Prolonged chewing of a meal can reduce later snack intake and further investigation of this technique for appetite control is warranted.

Introduction

Given the continuing rise in levels of obesity in many countries there is an imperative to understand more about the factors that promote excess energy intake (Swinburn et al., 2011). One factor that has received some attention is the relationship between eating style, satiety and energy intake. It has been proposed that decreasing eating rate by eating more slowly or increasing chews per mouthful results in decreased food intake (Martin et al., 2007; Otsuka et al., 2006; Spiegel, Wadden, & Foster, 1991). Andrade and colleagues found that taking small bites, pausing between bites, and chewing food thoroughly decreased food intake and increased satiety compared with a condition in which the meal was eaten as fast as possible with no pauses between bites (Andrade, Greene, & Melanson, 2008). Similarly, Smit and colleagues investigated the effects of prolonged chewing for each mouthful of food on intake (Smit, Kemsley, Tapp, & Henry, 2011). They reported that chewing thirty-five times before swallowing resulted in slower eating, longer meal duration and less food intake than chewing for ten times before swallowing.

Few studies have attempted to isolate the specific components of eating style that might contribute to reduced energy intake. There is some evidence that slowing down eating rate by providing obese children with feedback on their eating rate reduces food intake (Ford et al., 2010), although in another study, slowed eating rate of a fixed portion size was reported to have no effect on postprandial appetite and intake of a subsequent meal (Karl, Young, & Montain, 2011). Other studies have focused on mastication and it has been reported that increased chewing of almonds is associated with a sustained reduction in rated appetite 2 h after consumption (Cassady, Hollis, Fulford, Considine, & Mattes, 2009). In addition, there is evidence that chewing per se without swallowing food suppresses appetite (Hetherington & Boyland, 2007; Nolan & Hetherington, 2009). To our knowledge no study to date has examined the effect of prolonged chewing during consumption of a fixed meal on food intake at the next eating opportunity.

The mechanism underlying the effect of increased mastication on appetite and energy intake is unclear but there are several possibilities. First, increased mastication might enhance cephalic phase responses and release of nutrients from food affecting release of gut hormones (Li et al., 2011). Second, a longer time of oral processing of food due to prolonged chewing might decrease intake due to increased sensory satiety (Zijlstra, de Wijk, Mars, Stafleu, & de Graaf, 2009). Third, food palatability might be reduced by prolonged chewing or the experience might be so novel as to reduce enjoyment of eating and intake (Hill, Magson, & Blundell, 1984). Finally, cognitive factors might have a role to play, especially in influencing

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appetite in the inter-meal interval. Prolonged chewing might enhance attention to and sensory processing of food, leading to enhanced food memory. There is some evidence that satiety is influenced by memories of recently eaten foods leading to the hypothesis that chewing enhances food memory, which enhances satiety (Higgs, 2002; Higgs, Robinson, & Lee, 2012).

In the present study we manipulated the amount of time spent chewing per mouthful of a fixed lunch meal and examined the effect of this manipulation on later appetite and snack consumption. We hypothesised that prolonged chewing would decrease later snack intake. We were also interested in examining the potential mechanisms underlying any effects of prolonged chewing on later lunch intake. We hypothesised that prolonged chewing might have an effect on post-lunch snacking either via reduced mood due to low lunch palatability and/or an effect of prolonged chewing to enhance lunch memory and inhibit later appetite.

Methods

Participants

Forty-three student volunteers (36 female, 7 males, mean age = 20.35, ±2.82, mean BMI = 20.84, ±2.10) were recruited through an online study registration website. Participation was in exchange for course credit. Participants met the recruitment criteria of: non-smoking, not actively dieting, healthy BMI, no food allergies or intolerances, not vegetarian or vegan, not diabetic and no current or ongoing dental problems. Scores for restrained eating (mean = 2.25, ±0.89) and disinhibition (mean = 5.58, ±3.03) were assessed using the restraint scale of the Dutch Eating Behaviour Questionnaire (Van Strien, Frijters, Bergers, & Defares, 1986) and the disinhibition scale of the Three-Factor Eating Questionnaire (Stunkard & Messick, 1985). Participants were asked to refrain from eating for 2 h prior to arriving for the study. So that participants were not alerted to the purpose of the experiment, recruitment to the study was via an advertisement describing the experiment as a study on eating behaviour and mood. Ethical approval was obtained from the University of Birmingham Ethical Review Committee and participants gave their written informed consent prior to taking part.

Design

A between-subjects experimental design was used, in which each participant was randomly assigned to one of three experimental conditions: Condition 1 (“habitual chewing condition”) was a control condition where participants were asked to eat as they usually would; Condition 2 (“pauses condition”), was another control condition in which participants chewed normally but with 10 s pauses between each mouthful; Condition 3 (“prolonged chewing condition”) was the experimental condition in which participants were asked to chew continuously for 30 s before swallowing. We chose to manipulate chewing time rather than number of chews as this allowed for easier control by the experimenter of the conditions and equating of meal duration. The timing of the prolonged chewing condition was based on a pilot study showing that 30 s was longer than usual chewing time but achievable without much discomfort. The timing of the pauses condition was similarly based on a pilot study and was chosen to try to ensure similar meal duration as the prolonged chewing condition but with usual chewing time. Previous studies have found that inserting pauses in between chewing increases concurrent intake, perhaps due to frustration at disruption of habitual chewing (Yeomans, Gray, Mitchell, & True, 1997). However, in the present study participants ate a fixed lunch meal and so concurrent intake could not be altered by pausing. The between-subjects design was used to minimise the possibility that participants guessed the aims of the study.

Test foods

The lunch consisted of one and a half smoked ham and cheddar sandwich (Tesco, UK) with the crusts removed and cut equally into 24 triangular bite sized pieces. The lunch contained approximately 600 calories. The lunch was the same in all three conditions and participants were asked to consume all the meal. The afternoon snack consisted of one bowl containing 100 g of Skittles (The Wrigley Company Limited) and one bowl containing 100 g of Minstrels (Galaxy, Mars Incorporated). Skittles are chewy fruit candies and Minstrels are chocolate candies with a sugar shell. We provided two snacks in case the participants disliked one of them.

Procedure

Each participant completed a pre-study questionnaire prior to taking part to ensure that they met the study requirements. If suitable for the study, they were randomly assigned to one of the three conditions and informed that they were required to attend two sessions on the same day. The first session (lunch) took place at 12:00, 12:30 or 13:00 and lasted approximately 30 min. On arrival, participants were individually taken into a quiet test room and asked to complete a demographics questionnaire and a series of line rating scales assessing mood and appetite. The following items were rated using a 100 mm unmarked line rating scale: hungry, full, desire to eat, happy, sad, stressed, relaxed, irritable, nervous, excited. The anchors at the end of the line were “Not at all” and “Extremely”. The question was in the format “How XXX do you feel right now?” and the text was centred above the line. Ratings were obtained by measuring the distance in mm from the left extremity of the lines. After completing the ratings, participants were given written instructions informing them of how they should eat their lunch, that they should finish all of the lunch and that the researcher would remain in the room. The researcher was seated to the side of the participant and not in the direct line of sight of the participant. In the pauses condition and the prolonged chewing condition, the researcher instructed the participants when to chew and when to pause using a stopwatch. In the habitual chewing condition, the researcher remained in the room but gave no instructions. On completion of the lunch, participants were given a second series of 100 mm rating scales assessing post-lunch appetite, mood and enjoyment of their lunch. They were thanked for their time and reminded not to eat before returning for the second session.

The second session (snack) took place 2 h after the lunch (for example if the lunch session was at 12:00 they returned at 14:00) and took place in the same room. On arrival, participants were asked to complete a set of 100 mm rating scales assessing appetite and mood. Once finished, participants were given another set of 100 mm rating scales assessing mood accompanied by the snack. Participants were told that a printing error had occurred and they needed to be left for 10 min whilst it was corrected. Participants were asked to complete the rating scales whilst waiting and were informed that they could eat as much or as little of the snack as they liked. The snack bowls were weighed before and after to measure the amount consumed during the 10 min interval.

When the researcher returned, the snack was removed and a 100 mm rating scale asking “how vivid is your memory of your lunch” was presented. This question was used to assess the memory of the lunch. A final paper-based question asked the participant to guess and briefly describe the purpose of the study, as well as providing the opportunity for any additional comments. Height and weight measurements were taken and participants then completed the restraint scale of the Dutch Eating Behaviour Questionnaire (Van Strien et al., 1986) and the disinhibition scale of the