Eating with a smaller spoon decreases bite size, eating rate and *ad-libitum* food intake in healthy young males

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Running Head: Spoon size and eating behaviour

Abstract

There is a paucity of data examining the effect of cutlery size on the microstructure of within-meal eating behaviour or food intake. Therefore, the present studies examined how manipulation of spoon size influenced these eating behaviour measures in lean young men. In study one, subjects ate a semi-solid porridge breakfast *ad-libitum*, until satiation. In study two, subjects ate a standardised amount of porridge, with mean bite size and mean eating rate covertly measured by observation through a one-way mirror. Both studies involved subjects completing a familiarisation visit and two experimental visits, where they ate with a tea spoon (SMALL) or dessert spoon (LARGE), in randomised order. Subjective appetite measures (hunger, fullness, desire to eat, and satisfaction) were made before and after meals. In study one, subjects ate 8% less food when they ate with the SMALL spoon (SMALL 532 (SD 189) g; LARGE 575 (SD 227) g; P=0.006). In study two, mean bite size (SMALL 10.5 (SD 1.3) g; LARGE 13.7 (SD 2.6) g; P<0.001) and eating rate (SMALL 92 (SD 25) g/min; LARGE 108 (SD 29) g/min; P<0.001) were reduced in the SMALL condition. There were no condition or interaction effects for subjective appetite measures. These results suggest that eating with a small spoon decreaseses *ad-libitum* food intake, possibly via a cascade of effects on within-meal eating microstructure. A small spoon might be a practical strategy for decreasing bite size, and eating rate, likely increasing oral processing, and subsequently decreasing food intake, at least in lean young men.

Key words: appetite; energy balance; weight gain; obesity; portion size

Introduction

Obesity, the result of chronic positive energy balance, continues to rise[1,2], representing a major health and economic burden on society. Increases in portion size are believed to contribute to excess energy intake (i.e. energy intake greater than energy expenditure), and recent evidence suggests that reducing portion size can decrease food intake[3]. Manipulation of the eating environment, and specifically tableware, is one strategy that has been used to reduce portion size[3,4]. Whilst the impact of dishware size (i.e. plate or bowl size) on food intake has been well studied, albeit with varied findings[4], the role of cutlery size has received little attention.

Manipulating the microstructure of within-meal eating behaviour (e.g. bite size, eating rate etc.) might independently or interactively influence food intake. A recent meta-analysis of intervention studies reported that a faster eating rate was associated with increased *ad-libitum* food intake compared eating more slowly[5]. Similarly, bite or sip size has been shown to influence food intake, with smaller bites or sips decreasing *ad-libitum* intake[6-8], possibly via an interaction with eating rate[9,10]. Intuitively, manipulation of cutlery size might influence bite size by altering the amount of food presented to the mouth, potentially influencing eating rate and food intake. Indeed, Geier *et al.*[11] reported that increasing the size of a spoon used to serve chocolate confectionary increased the amount of food served, but little is known about how cutlery used to eat meals influences food intake.

Previous studies have used smaller cutlery (namely spoons) as part of a combined strategy (including instructions to eat slowly, chew the food more, put the spoon down between bites etc.) to reduce eating rate[12,13]. However, the combination of strategies used makes it difficult to discern the specific effects of cutlery size on eating behaviour. Mishra *et al.*[14] is, to our knowledge, the only study to directly examine the effect of cutlery size on *ad-libitum* food intake. Mishra *et al.*[14] reported that in a controlled laboratory environment, eating with a small fork decreased *ad-libitum* food intake, but the reverse was reported (i.e. a smaller fork increased food intake) when meals were consumed in a habitual restaurant setting. The authors attribute this disparity between settings to goal-effort links pertaining to the eating environment, although interpretation of the results from the restaurant are complicated by the uncontrolled conditions present (i.e. the different meals selected, starters eaten, variety of drinks available/ consumed, dessert planned, social interactions etc.), making firm conclusions difficult to make. How manipulation of cutlery size influences the micro-structure of within-meal eating behaviour is currently unknown.

Due to the paucity and inconsistency of data examining the influence of cutlery size on within-meal eating behaviour, the present studies aimed to compare the effects of eating a semi-solid breakfast with a tea spoon (small spoon) or dessert spoon (large spoon) on 1) *ad-libitum* food intake (study one) and 2) the microstructure of within-meal eating behaviour including bite size, eating rate and meal duration (study two). It was hypothesised that eating with a small spoon would reduce *ad-libitum* food intake in study one, and that eating with a small spoon would reduce bite size and eating rate, as well as increasing meal duration in study two.

Methods

Overview of experimental protocol

This investigation comprised two separate studies, which were conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures were approved by the Loughborough University Ethics Approvals (Human Participants) Sub-Committee and Sheffield Hallam University Faculty of Health and Wellbeing Ethics Committee (R13-P7; C15-34). Data for study one were collected at both institutions, whilst data for study two were only collected at Loughborough University. Written informed consent was obtained from all subjects before participation. During both studies, subjects completed a familiarisation trial, followed by two experimental trials completed in a randomised order and separated by ≥7 days. Randomisation was undertaken before the start of data collection. During experimental trials, subjects consumed an *ad-libitum* (study one) or a standardised (study two) breakfast meal with a tea spoon (SMALL) or dessert spoon (LARGE). Spoons were from the same cutlery set (Tesco Value, Tesco, Cheshunt, UK) and thus, except for size, were identical in appearance. The SMALL and LARGE spoons were 146 mm and 194 mm in length, respectively and had heads that were roughly oval in shape. The length and width of the SMALL spoon's head were 46 mm and 31 mm, respectively, whilst the length and.width of the LARGE spoon's head were 61 mm and 42 mm, respectively. The estimated surface area of the SMALL spoon's head was ~39% less than the LARGE spoon's head (i.e. ~1230 mm^2 vs ~2030 mm^2).

Subjects

Twenty-nine men (age 24 (SD 4) y, height 1.77 (SD 0.06) m, body mass 73.7 (SD 8.8) kg, BMI 23.5 (SD 2.4 kg/m^2), body fat 17 (SD 4) %) completed study one, whilst sixteen men (age 27 (SD 3) y, height 1.82 (SD 0.06) m, body mass 79.9 (SD 9.9) kg, BMI 24.0 (SD 1.9 kg/m^2), body fat 15 (SD 3) %) completed study two. For inclusion subjects were required to be male, with a

BMI <30kg/m^2 and body fat <25%, be generally fit and healthy with no acute or chronic morbidity known to influence appetite/ food intake and had to not score in the clinical range for dietary restraint, disinhibition or hunger, as measured by the Three Factor Eating Questionnaire[15]. Eight subjects had a BMI >25 kg/m^2 (range 25.2-27.9 kg/m^2).

Pre-trial standardisation

In both studies subjects recorded all food and drink consumed, as well as any low intensity habitual physical activity undertaken in the 24 h before the first experimental trial. They were then asked to replicated these diet and activity patterns in the 24 h before the second experimental trial. Subjects were asked to refrain from moderate or strenuous physical activity and alcohol intake during this 24 h period. All trials commenced in the morning after an overnight fast (07:00-10:00), with the time standardised for each subject.

Familiarisation trials

During both studies, subjects initially completed a familiarisation trial prior to experimental trials. At this visit, subjects' height and body mass were determined, before subcutaneous skinfold measurements were obtained from the triceps, biceps, subscapular and suprailiac for estimation of body fat percentage[16]. Subjects were then familiarised with the methods used in experimental trials, by undertaking a practice trial identical in procedure to the experimental trials, during which the LARGE spoon was used to eat.

The breakfast meal

Porridge was used as a breakfast meal in both studies. In study one, three flavours of porridge were available (plain, chocolate and golden syrup), with subjects choosing their preferred flavour before the familiarisation trial and eating this flavour during all subsequent trials. The meal was made by mixing a commercially available porridge oat mix (Ready Brek, Weetabix, Kettering, UK) with semi-skimmed milk (Tesco, Cheshunt, UK) in a ratio of 90 g oats: 420 mL milk. In study two, all subjects were provided with the plain porridge, sweetened with sugar, with a ratio of 72 g oats: 18 g sugar: 420 mL milk. In each study, all meals were prepared using standardised operating procedures to ensure identical temperature, texture and flavour for each participant for each trial, with bowls and spoons weighed before preparation, as well as before and after eating to determine food consumption.

Study one experimental protocol

Subjects consumed an *ad-libitum* porridge breakfast in each trial, and were given standardised instructions to 'eat until you are comfortably full and satisfied'. The meal was served in a custom-made eating booth to minimise external distractions and to allow experimenters to supply food to subjects with minimal interaction. Subjects were provided with a bowl of porridge and a spoon to eat with. They ate until they had consumed approximately ½ to ¾ of the bowl (time taken to do this was determined during the familiarisation trial), when another bowl was supplied. This pattern continued until subjects were satiated. The eating booth was situated inside a larger eating laboratory (still devoid of food cues) and subjects left the booth, but remained inside the laboratory once satiated. They remained inside the laboratory for the duration of the 30-min eating period, and could return to the eating booth and continue eating if they desired. Each subject was in isolation in the eating laboratory during each 30 min eating period, with only essential interaction between experimenter and subject for the delivery of food and water at pre-determined time points. Water was available *ad-libitum* throughout the meal, with glasses weighed before and after the meal to determine the amount consumed. Before and after the 30-min eating period, subjects provided ratings of hunger, fullness, desire to eat (DTE) and satisfaction.

To blind subjects to the true aim of the study they were told the purpose of the study was to assess the reproducibility of the *ad-libitum* breakfast meal. This information was disseminated to subjects through a written information sheet that they read prior to consenting to take part in the study. This was reaffirmed by an experimenter verbally explaining the study design and the purpose (i.e. to examine reproducibility of the meal). At the end of the study, subjects were asked three exit questions: 'Did you think the meals were similar in texture/ taste', 'Do you think the eating environment was similar between trials?', 'Do you have any other comments?'. These questions gave subjects the opportunity to indicate if they had noticed the difference in spoon size between trials.

Study two experimental protocol

Subjects were provided with a standardised porridge meal providing 15% of estimated daily energy requirements, which were determined using their predicted resting metabolic rate[17] multiplied by a physical activity level of 1.5. The meal was consumed in an observation laboratory, which included a section of one-way mirror, so an experimenter could observe the subject whilst they ate. The meal was served in a single bowl and subjects were instructed to 'eat until you have finished the bowl'. During eating, the same experimenter recorded each

time the subject took a spoonful of porridge from the bowl and each time they took a mouthful (bite) of porridge from the spoon. The total time taken to eat the meal was also recorded. Before and immediately after finishing the meal, subjects provided ratings of hunger, fullness, DTE and satisfaction, with a final rating taken 15 min after starting the meal. No water was consumed during the meal. Again, each subject was in isolation in the eating laboratory during each 15 min eating period, with only essential interaction between experimenter and subject for the delivery of food and appetite questionnaires.

Mean eating rate (g/min) was determined by dividing the total weight of porridge consumed by the time taken to eat the meal. Mean bite size (g) was determined by dividing the total weight of porridge consumed by the number of bites taken to eat the porridge.

To blind subjects to the true aim of the study they were told the purpose of the study was to assess the subjective appetite response to eating with different size spoons. Subjects were not aware they were being observed.

Subjective appetite sensations

Subjects completed visual analogue scale questionnaires[18] to assess their hunger 'How hungry do you feel now?', fullness 'How full do you feel now?', desire to eat 'how much would you like to eat a meal now?', and satisfaction 'How satisfied do you feel now?'. Questions were administered on a 100 mm lines, with the verbal anchors 'not at all' and 'very' at 0 mm and 100 mm, respectively.

Sample size

An α of 0.05 and a β of 0.2 were used to estimate the required sample size for each study. For study 1, previous data from our laboratory[19] was used to estimate food intake and a between group correlation of 0.9 estimated 25 subjects would be required to detect an 8% difference in food intake, providing an estimated effect size (dz) of 0.59. For study 2, approximate eating rates and the between group correlation of 0.94 observed in study 1 were used to estimate 16 subjects would be required to detect an 8% difference in mean eating rate, providing an estimated effect size (dz) of 0.77.

Statistical analysis

All data were analysed using IBM SPSS Statistics 23. All data was initially checked for normality of distribution using a Shapiro-Wilk test. Subjective appetite data were analysed

using two-way repeated measures ANOVA. Where the assumption of sphericity was violated the degrees of freedom were corrected using the Greenhouse-Geisser estimate. Data containing one factor were analysed using paired t-tests (normally distributed data) or Wilcoxon signed-rank tests (non-normally distributed data). Effect sizes (Cohen's dz) were calculated for paired comparisons. Relationships between variables were explored using Pearson's product-moment correlation coefficient or Spearman's rank correlation coefficient, as appropriate. Differences were accepted as being significant when $P \leq 0.05$ and all data are presented as mean (SD) unless otherwise stated.

Results

Study one

Ad-libitum food intake

The amount of food consumed during the *ad libitum* meal was 8% less when subjects ate with the small spoon compared to the large spoon (SMALL 532 (SD 189) g, LARGE 575 (SD 227) g; Z=-2.692; dz=0.55; P=0.006; Figure 1a), whilst water drunk with the meal was similar between trials (SMALL (362 (SD 130) g; LARGE 325 (SD 129) g; t=1.454; ; dz=-0.27; P=0.157).

Subjective appetite

Due to an issue with one appetite questionnaire on one trial for one subject, the results for 28 subjects are presented. There were main effects of time for hunger ($F_{(1,27)}$=574.336; P<0.001; Table 1), fullness ($F_{(1,27)}$=640.587; P<0.001; Table 1), DTE ($F_{(1,27)}$=688.796; P<0.001; Table 1) and satisfaction ($F_{(1,27)}$=312.917; P<0.001; Table 1), with hunger and DTE decreasing and fullness and satisfaction increasing over the meal. However, there were no main effects of trial (hunger $F_{(1,27)}$=0.547; P=0.466; fullness $F_{(1,27)}$=0.159; P=0.693; DTE $F_{(1,27)}$=0.939; P=0.341; satisfaction $F_{(1,15)}$=1.191; P=0.285), or interaction effects (hunger $F_{(1,27)}$=0.005; P=0.945; fullness $F_{(1,27)}$=0.473; P=0.497: DTE $F_{(1,27)}$=0.149; P=0.703; satisfaction $F_{(1,27)}$=0.989; P=0.329).

Study blinding

Seven subjects (24%) identified that the spoons used in the two experimental trials were different sizes during the exit questions. When the 7 subjects who reported an awareness of the difference in spoon size between conditions were removed, *ad libitum* food consumption

was still ~8% less in the small spoon condition (SMALL 554 (SD 198) g, LARGE 599 (SD 238) g; t=-2.364; dz=0.54; *P*=0.028; Figure 1b)

Study two

Eating behaviour

The amount of residual porridge remaining on the bowl and spoon at the end of the meal was similar between trials (Z=-0.085; dz=0.14; *P*=0.932; Table 2), and consequently the amount of porridge consumed was also similar between trials (t=0.122; dz=0.03; *P*=0.904; Table 2).

The number of spoonfuls (Z=-3.520; dz=2.03; *P*<0.001; Table 2) and bites (Z=-3.519; dz=2.00; *P*<0.001; Table 2), as well as the total time (t=4.078; dz=-1.05; *P*<0.001; Table 2) taken to eat the meal were all greater during the SMALL trial. In both trials there was a strong correlation between the number of spoonfuls and bites used to eat the meal (SMALL *r*=0.991; *P*<0.001; LARGE *r*=0.968; *P*<0.001), with 11 out of 16 subjects using an identical number of spoonfuls and bites in both trials. Consequently, mean bite size (t=-6.155; dz=1.59; *P*<0.001; Figure 2a) and eating rate (Z=-3.258; dz=1.04; *P*=0.001; Figure 2b) were lower during the SMALL trial. There were positive correlations between the change in bite size and change in eating rate, when represented as absolute (*r*=0.612; *P*=0.012; Figure 3) or relative (*r*=0.613; *P*=0.012) values.

Subjective appetite

There were main effects of time for hunger ($F_{(1.094,16.403)}$=66.761; *P*<0.001; Table 1), fullness ($F_{(1.193,17.902)}$=116.390; *P*<0.001; Table 1), DTE ($F_{(1.068,16.021)}$=98.587; *P*<0.001; Table 1) and satisfaction ($F_{(1.116,16.737)}$=106.283; *P*<0.001; Table 1), with hunger and DTE decreasing and fullness and satisfaction increasing over the meal. However, there were no main effects of trial (hunger $F_{(1,15)}$=0.010; *P*=0.923; fullness $F_{(1,15)}$=3.587; *P*=0.078; DTE $F_{(1,15)}$=0.037; *P*=0.851; satisfaction $F_{(1,15)}$=2.402; *P*=0.142), or interaction effects (hunger $F_{(2,30)}$=0.911; *P*=0.413; fullness $F_{(2,30)}$=0.661; *P*=0.524; DTE $F_{(2,30)}$=0.461; *P*=0.635; satisfaction $F_{(2,30)}$=1.437; *P*=0.253).

Discussion

These studies aimed to examine the effect of manipulating cutlery size (i.e. spoon size) on *ad-libitum* food intake (study one) and the microstructure of within-meal eating behaviour (specifically bite size, eating rate and meal duration; study two) using a semi-solid breakfast

food (porridge) in lean young men. The main finding from study one was that eating with the small spoon resulted in a small, but statistically significant (~8%) decrease in *ad-libitum* food intake. The main findings from study two were that subjects used more spoonfuls, used more bites, and took more time to finish the standardised meal when they ate with the small spoon. These findings meant that both mean bite size and mean eating rate were less when subjects ate with the small spoon.

Prolonged positive energy balance (i.e. energy intake greater than energy expenditure) results in accumulation of energy within the body, principally in adipose tissue, and ultimately leads to obesity. As the prevalence of obesity continues to rise both in the UK[(1)] and around the globe[(2)], strategies that reduce energy balance become increasingly important. Clearly, reducing energy intake by moderating portion size is one such strategy that might assist with energy balance control. The results for *ad-libitum* food intake (i.e. study one) are consistent with those of a similar controlled laboratory experiment, reporting that eating with a smaller fork reduce

d food intake from an *ad-libitum* pasta meal[(14)]. Interestingly, Mishra *et al.*[(14)] also reported the reverse response in an uncontrolled restaurant setting (i.e. those who ate with the larger fork ate less). The authors suggest the disparity in findings between laboratory and restaurant settings relate to the presence of a well-defined goal-effort link in the restaurant setting. However, the lack of control between groups (i.e. small/large fork) in the restaurant study for the meal selected, starters eaten, variety of drinks available/consumed, dessert planned, social interactions etc. make the findings difficult to interpret. It seems, when tested in a controlled laboratory environment, that reducing cutlery size decreases food intake, but further work is needed to explore other eating occasions and environments to better understand the effects. None-the-less, the finding that *ad-libitum* food intake is reduced when the food is eaten with a smaller spoon is intriguing as it suggests using smaller cutlery might offer a simple practical strategy to help moderate daily energy intake.

In study two we investigated some of the potential mechanisms by which manipulating cutlery size might influence *ad-libitum* food intake. Accumulating evidence suggests that oral processing might represent an important factor governing food intake, with increased oral processing (i.e. increased orosensory exposure) increasing satiation[(9)]. Two inter-related elements of within-meal eating microstructure that might influence oral processing are bite size and eating rate.

The results of study two demonstrate that eating with a small spoon increases the number of spoonfuls used to eat the meal, consequently reducing bite size by ~24%. Although not a universal finding[20], reducing bite/sip size of a food/liquid has been shown to decrease *ad-libitum* intake[6-8]. For example, Zijlstra *et al.*[7] reported an ~18% decrease in *ad-libitum* intake of a chocolate custard when bite size was reduced from 15 g to 5 g (i.e. ~67% reduction). Similarly, reducing sip size of soup by ~67% (i.e. 15 g vs. 5 g) decreased intake by ~30%[8], whilst reducing sip size of regular-energy and no-energy orangeade by 75% (i.e. 20 g vs 5 g) decreased intake by ~29% and ~17%, respectively[6]. The result for *ad-libitum* food intake in study one was more modest than these previous studies that have manipulated bite size (i.e. a reduction of ~8% vs ~17-30%), but this is unsurprising given the reduction in bite size observed in study two was also more modest (i.e. a reduction of ~24% vs 67-75%). These previous studies used a peristaltic pump to deliver the food to the mouth, but study two demonstrates that using a small spoon is a practical method of achieving a meaningful reduction in bite size, and apparently food intake, without the requirement for the individual to consciously reduce their bite size.

Previous studies have reported bite size is associated with eating rate[9,10,20]. In study two, subjects took longer to eat the standardised meal when eating with the small spoon, facilitating a reduction of ~14% in mean eating rate. A recent systematic review/meta-analysis reported that eating more slowly was associated with a lower energy intake compared to faster eating[5], and that this was consistent across the various interventions used to alter eating rate. Whilst not all studies that have experimentally manipulated eating rate report reduced energy intake with slower eating[13,21], the majority do[12,21-25]. The change in eating rate between trials was positively associated with the change in bite size, suggesting that the decreased bite size produced by eating with a small spoon may, at least partially, be responsible for the reduced eating rate. Although oral processing time was not measured in the present study, previous work has demonstrated that taking smaller bites leads to a larger number of chews per unit of food[19,26,27]. Therefore, the increased number of bites, likely lead to more chewing/oral processing of the food per unit weight, consequently reducing eating rate. Although these elements of eating microstructure were not measured in study one, we propose the cascade of effects observed in study two likely explain the reduction in *ad-libitum* food intake observed in study one.

Interestingly, the manipulation of spoon size appeared to produce diminishing effects as this cascade of eating behaviour responses progressed. The surface area of the small spoon was

~39% less than the large spoon, which caused a decrease in mean bite size of ~24%, leading to a reduction in mean eating rate of ~14%, and finally a decrease in *ad-libitum* food intake of ~8%. As this intervention represented a relatively large reduction in the size of spoon used, the utility of manipulating cutlery size might be limited to relatively small reductions in food intake (i.e. <10%). It has been suggested that the discrepancy between energy intake and expenditure causing weight gain is slight[28], and thus even a small difference induced by using smaller cutlery might have a meaningful effect on weight maintenance/loss goals in the long-term. The studies reported here only tested a relatively small homogenous sample of lean young males. Hopefully these preliminary results will stimulate future research in a much larger and more heterogenous sample including females, children, older adults and those with greater levels of adiposity. Future studies should seek to explore these different groups as well as document responses to repeated exposure to smaller cutlery to explore whether eating behaviour responses are altered by increased exposure, as well as examining the effects of different cutlery types (i.e. fork, knife etc.).

Manipulation of spoon size did not alter the subjective appetite response to either an *ad-libitum* or a standardised meal. This is consistent with previous studies that have manipulated eating rate, with Robinson *et al.*[5] reporting that eating more slowly did not affect subjective appetite for *ad-libitum* or standardised meals. The fact that hunger, fullness and desire to eat were similar at the end of the meal in study one suggests that subjects terminated eating due to satiation, as opposed to boredom or frustration from using the small spoon. Whilst subjects were not specifically asked about their perceptions of using the different size spoons, ratings of satisfaction were similar between trials in both study one and study two, possibly suggesting subjects did not find the experience of eating with a small spoon a negative one. However, these satisfaction ratings more likely represent subjects feeling of satisfaction related to their appetite than how satisfied they were with the spoon they ate with. Future work should focus more specifically on how subjects eating experience/ enjoyment is affected by manipulation of cutlery size. None-the-less, given the similarity in sensations of hunger and fullness between trials, it does not appear that subjects in this study terminated eating due to frustration with eating with a small spoon. We attempted to control for demand characteristics in both studies using cover stories and in study 1 tried to covertly understand who had noticed the difference between conditions through the post-trial interview. Whilst removal of those subjects who reported an awareness of the different spoon sizes did not influence the results for energy intake (Figure 1b), more direct questions about the conditions would have given us a better picture of

the success of our cover story and the experience of eating with a small spoon. Interestingly, perhaps future studies should look to blind investigators that interact with subjects too[29], although this might be difficult in the context of the present studies.

The present study used methods that are consistent with literature exploring eating behaviour responses in a controlled laboratory environment. Whilst this allows relatively small differences between treatments to be detected, it must be acknowledged that the eating situation is not representative of many naturalistic meal environments. Much food intake is planned in advance of eating[30] or is served onto a plate in what the server (whoever that may be) deems to be an appropriate portion. At least for self-served portions, food served is generally eaten in its entirety[31], meaning that in a naturalistic eating setting there may be no opportunity for cutlery size to interact with *ad libitum* food intake. However, given study 2 presented here suggests that reducing spoon size reduces bite size and eating rate, the manipulation of cutlery might offer a simple method of manipulating these components of eating behaviour microstructure. It is also worth noting that in some situations where increased energy intake or increased intake of specific foods might be a goal, it may be advantageous to eat with a larger spoon.

In conclusion, the results of these studies demonstrate that eating with a small spoon reduces *ad-libitum* food intake, an effect that is likely caused by alterations in the microstructure of within-meal eating behaviour in lean young men. Specifically, it appears that eating with a small spoon decreases bite size, likely increasing oral processing time, and consequently reducing eating rate. The data reported here suggests using a small spoon might represent a simple practical strategy to reduce bite size, eating rate and *ad-libitum* food intake at a single meal and might be a useful tool that could be used, possibly along with other interventions, to aid in the prevention of weight gain and obesity. Given this study only examined the effect of spoon size on eating behaviour at a single laboratory-based breakfast meal, future studies should examine how different types of cutlery, or different eating occasions/environments influence eating behaviour, as well as how chronic manipulation of cutlery size effects energy intake and energy balance.

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Conflict of interest

None.

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Wansink B, Cheney MM (2005) "Superbowls: serving bowl and food consumption" *JAMA* **293**, 1727-1728.

505 Table 1. Hunger (mm), fullness (mm) and satisfaction (mm) before and after the fixed meal
506 periods for both study one (30 min) and study two (15 min), as well as immediately after
507 finishing eating the standardised meal in study two. Data are presented as mean (SD).

	Before meal period		Immediately after eating		After meal period	
	Mean	SD	Mean	SD	Mean	SD
Study one: hunger (mm)						
SMALL	76	15	-	-	5	5
LARGE	75	15	-	-	4	5
Study one: fullness (mm)						
SMALL	17	13	-	-	89	8
LARGE	16	11	-	-	89	8
Study one: desire to eat (mm)						
SMALL	82	11	-	-	7	11
LARGE	81	13	-	-	5	6
Study one: satisfaction (mm)						
SMALL	22	13	-	-	86	16
LARGE	22	17	-	-	90	8
Study two: hunger (mm)						
SMALL	74	19	20	15	16	15
LARGE	75	21	18	14	17	15
Study two: fullness (mm)						
SMALL	19	15	78	9	78	14
LARGE	15	14	74	14	77	15
Study two: desire to eat (mm)						
SMALL	82	18	19	17	17	16
LARGE	78	17	20	13	19	15
Study two: satisfaction (mm)						
SMALL	25	17	81	16	82	14
LARGE	19	17	80	16	80	16

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Table 2. Food consumption and within-meal eating behaviour variables for study two. Data are presented as mean (SD). † indicates significantly different between trials.

	SMALL		LARGE	
	Mean	SD	Mean	SD
Food eaten (g)	375.5	27.4	375.6	29.1
Food left (g)	2.6	1.9	2.5	1.2
Spoons used	36	5	28 †	6
Bites used	36	5	28 †	6
Meal duration (min)	4.3	0.8	3.7 †	0.8

525 **Figure legends**

526 Figure 1. A) *Ad-libitum* food consumed during study one for all subjects and B) for subjects
527 who did not report an awareness of the difference in spoon size between conditions. Bars are
528 mean values, with error bars representing SD. Lines are individual subject data. † indicates
529 significantly different between trials.

530 Figure 2. A) mean bite size and B) mean eating rate during study two. Bars are mean values,
531 with error bars representing SD. Lines are individual subject data. † indicates significantly
532 different between trials.

533 Figure 3. Change in mean bite size (g) vs change in mean eating rate (g/min) on the SMALL
534 trial relative to the LARGE trial during study two. Data points are individual subject values.
535 Dashed line represents linear line of best fit.

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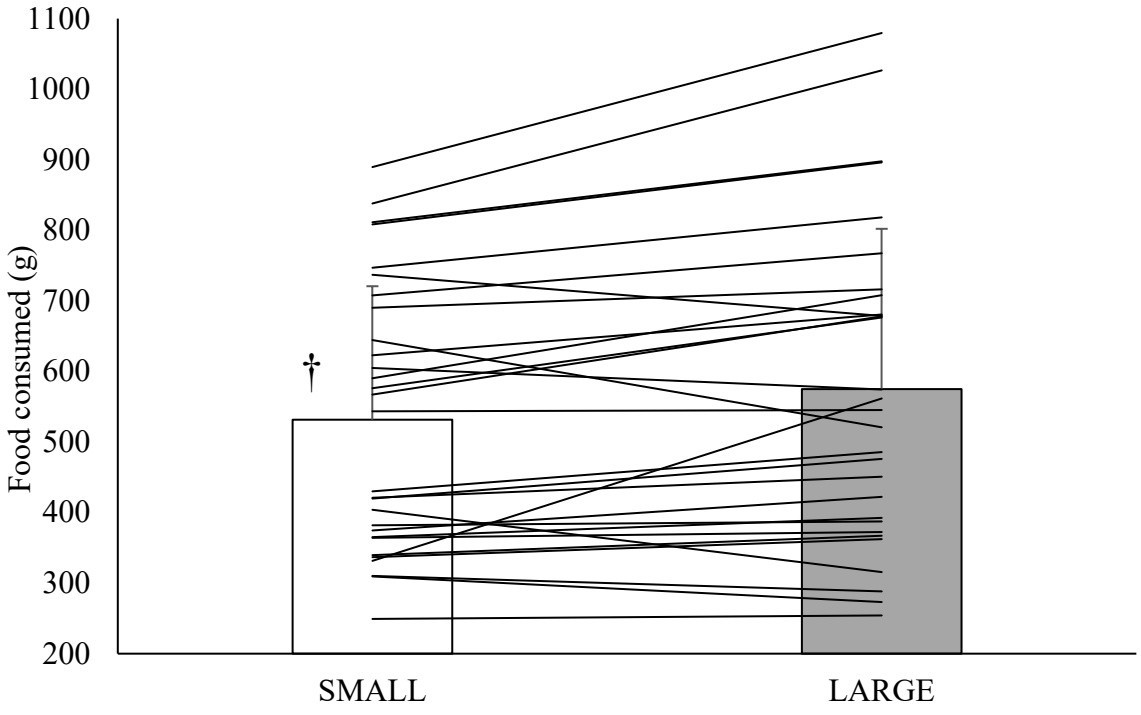
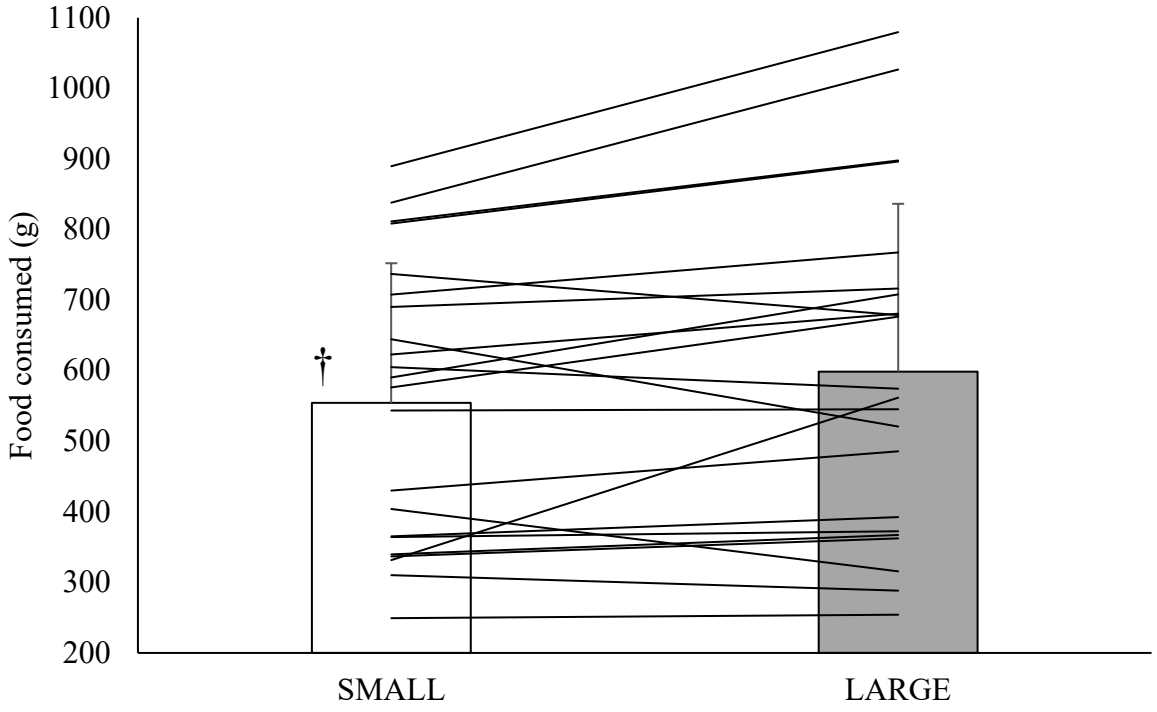
Figure 1

A)


1100
1000
900
800
700
600
500
400
300
200
Food consumed (g)
†
SMALL
LARGE

B)


1100
1000
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800
700
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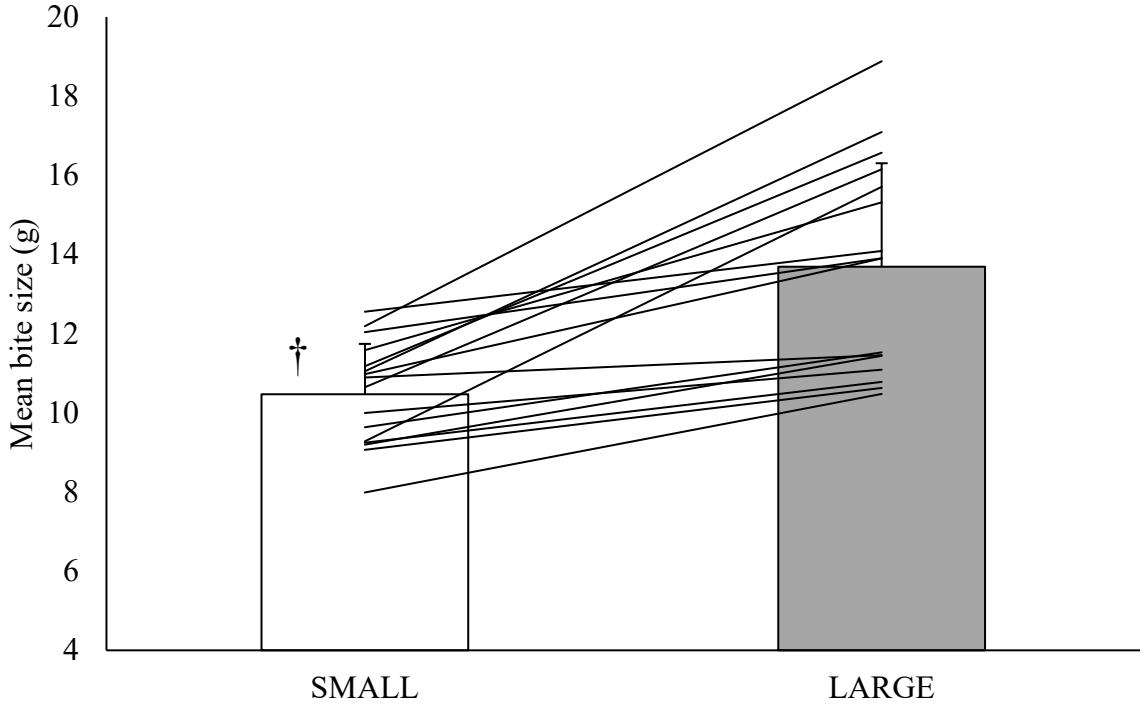
500
400
300
200
Food consumed (g)
†
SMALL
LARGE

Figure 2

A)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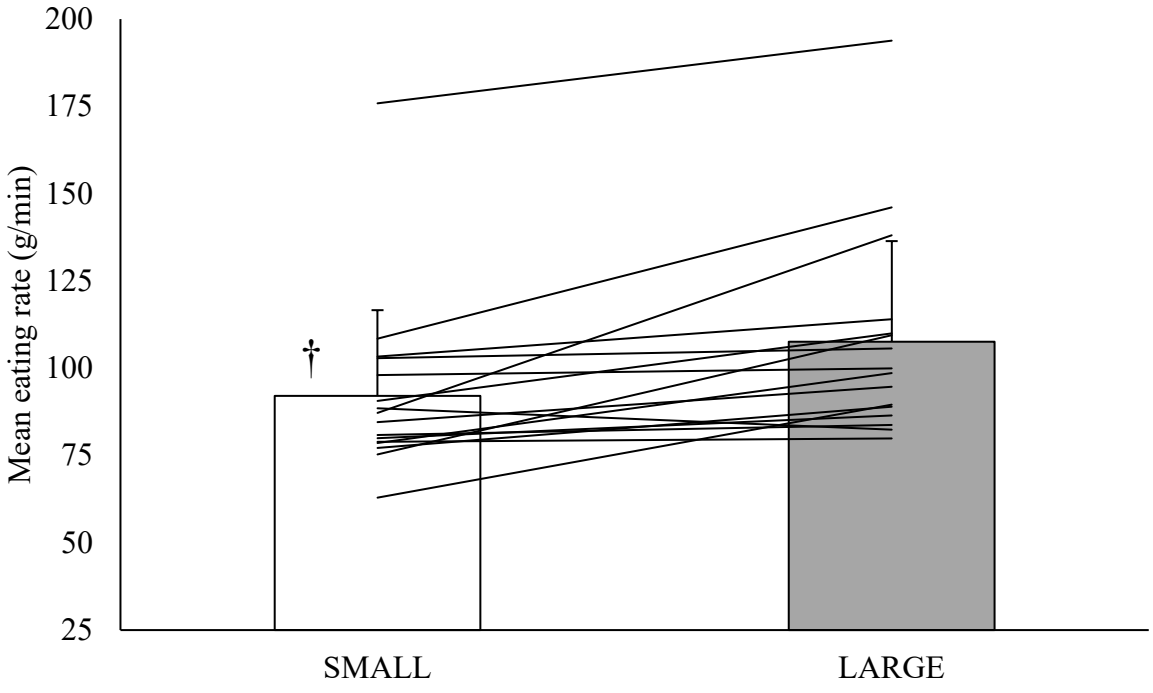
18
16
14
12
10
8
6
4
Mean bite size (g)
†
SMALL
LARGE

B)


200
175
150
125
100
75
50
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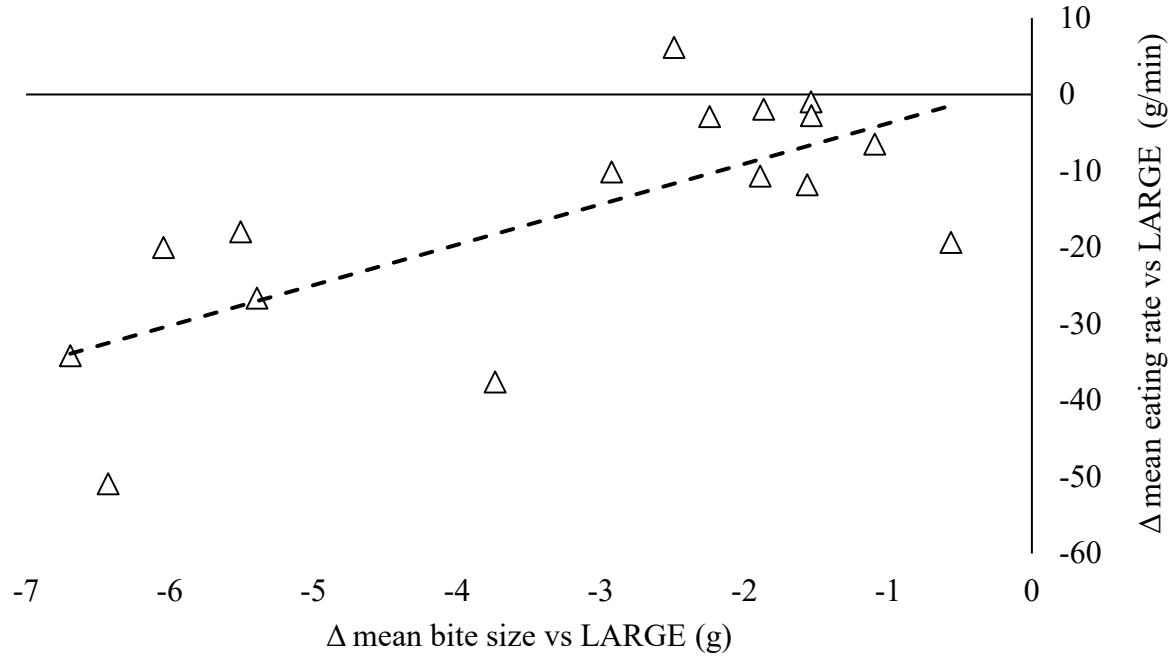
Mean eating rate (g/min)
†
SMALL
LARGE

561 **Figure 3.**



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