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Short Communication

Assessment of eating rate and food intake in spoon versus fork users in a laboratory setting

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Accumulating evidence show positive relationships between eating rate and body weight. Acute food intake is affected by eating rate, bite size, and palatability. The objective was to assess differences between participants who chose to use a spoon vs. fork in eating rate and food intake of four meals that differ in palatability (low vs. high salt) and in energy density (low vs. high fat). Forty-eight healthy adults (16 males, 18–54 y, BMI: 17.8–34.4 kg/m^2) were recruited. Participants attended four lunch time sessions after a standardised breakfast. Meals were either (1) low-fat/low-salt, (2) low-fat/high-salt, (3) high-fat/low-salt, or (4) high-fat/high-salt. Nineteen participants (6 males) consistently used a fork and 21 (8 males) used a spoon, 8 participants were inconsistent in cutlery use and excluded from analyses. Spoon users had on average a higher BMI than fork users ($p = 0.006$). Effects of cutlery use, BMI status (BMI < 25 vs. BMI > 25), salt, and fat, and their interactions were assessed in a General Linear Model. Spoon users consumed faster (fork: 53 ± 2.8 g/min; spoon: 62 ± 2.1 g/min, $p = 0.022$) and tended to consume more ($p = 0.09$), whereas the duration of the meals were similar (fork: 6.9 ± 0.3 min; spoon: 6:7 ± 0.2 min, $p = 0.55$). BMI status affected both eating rate and food intake ($p = 0.005$). There were no significant two-way or three-way interactions between salt, fat, and cutlery use on eating rate or food intake. In conclusion, participants who chose to consume with forks ate slower compared to spoon users.

1. Introduction

There is increasing evidence that faster eating rate promotes energy intake and weight gain (Leong, Madden, Gray, Waters, & Horwath, 2011; Llewellyn, van Jaarsveld, Boniface, Carnell, & Wardle, 2008; Ohkuma et al., 2015; Otsuka et al., 2006). Slower eating rate is associated with lower energy intake, regardless the type of manipulation used to change the eating rate (e.g., textural changes, instructions, and manner of consumption, see for review (Robinson et al., 2014)). Laboratory studies have shown that obese individuals consume with larger bites (or spoonful), consume at a higher eating rate, and this has been associated with greater food intake (Hill & McCutcheon, 1984; Laessle, Lehrke, & Duckers, 2007). Eating rate (Bobroff & Kissileff, 1986; Yeomans, 1996) and bite size (Bolhuis, Lakemond, de Wijk, Luning, & de Graaf, 2011) are positively related to palatability. Both bite size and eating rate are influenced by the individual manner of consumption (Hiiemae et al., 1996). Meals that mainly consists of rice, (small) pasta, lentils, or beans can be consumed with either forks or spoons. Some people prefer to eat this with spoons whereas others use forks.

In general, more food fits on a spoon than on a fork, it is therefore expected that a spoon increase the bite sizes and therefore the eating rate. The objective was to assess differences between fork vs. spoon users in eating rate and food intake in four meals that differ in palatability (by varying salt content) and in energy density (by varying fat content). We used a laboratory setting to measure eating rate and food intake of meals with variations in palatability and energy density in a controlled manner.

2. Methods

Forty-eight healthy participants (16 males, 18–54 y, BMI: 17.8–34.4 kg/m^2)enrolled in the study. Participants were recruited via posters at the Deakin University Campus in Burwood, Vic, Australia. Participants were informed about the procedure of the study and signed an informed consent before participation. This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Deakin University Human Research Ethics Committee. This study was registered (ACTRN12615000048583) at the Australian New Zealand Clinical Trials Registry (ANZCTR).

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Participants consumed ad libitum from a lunch that consisted of 750 cooked g elbow macaroni (Homebrand Coles, Vic, Australia) with 600 g tomato sauce that was either (1) low-salt/low-fat (LSLF), (2) high-salt/low-fat (HSLF), (3) low-salt/high-fat (LSHF), or (4) high-salt/high-fat (HSHF). The order of the four meals at lunch were randomized between subjects. The low-salt meals did not contain any added salt (<0.08% NaCl in sauce) and the salt concentration in the high-salt meals was 0.5% NaCl in sauce and was estimated to have optimal pleasant saltiness, based on earlier studies (Bolhuis, Lakemond, de Wijk, Luning, & de Graaf, 2010, 2012). The sauce of high-fat meals contained 30% canola oil (Home brand Coles, Vic, Australia) and 10% thickened cream (Home brand Coles, Vic, Australia), and was calculated to contain 15.5 g fat and 945 kJ per 100 g. The sauce of the low-fat meals did not have added fat and these contained 0.6 g fat and 412 kJ per 100 g.

In total, participants came on four different days, separated by one week, to the Centre of Advanced Sensory Science at Deakin University. Participants came to consume a standardised breakfast at either 8:30 am or 9:30 am, and an ad libitum lunch at either 12:30 pm or 1:30 pm, respectively. Participants were instructed to refrain from eating and drinking (except water) between breakfast and lunch.

Standardised breakfast consisted of plain mini croissants (Home brand Coles, Vic, Australia) and the amount was calculated to be 18% energy of the daily energy needs, estimated by the Schofield I equation (WHO, 1985), taking into account: gender, age, and weight. At the ad libitum lunch sessions, participants were served with macaroni with sauce and were instructed to eat until comfortably full. Participants were presented with a fork (6.0 × 2.2 cm) and spoon (6.0 × 3.9 cm) and free to choose which utensil to use, without further instructions. The researcher took note of the utensil use after consumption.

The ad libitum intake (g) was calculated as the difference in weight before and after food intake. The eating rate (g/min) was calculated by dividing the ad libitum intake (g) by the total eating duration (min). Participants were instructed to turn on a light as soon as they started eating and as soon as they had finished, the eating duration (s) was assessed by the researcher by using a stopwatch.

Participants rated hunger and fullness on a computer screen before ad libitum intake. After answering these questions, participants were served with the meal. They were instructed to take one bite and rate their perceived pleasantness on a computer screen. After this participants were instructed to eat until they felt comfortably full. After ad libitum intake, subjects rated again hunger and fullness. All questions were answered on a 100 mm visual analogue scale (VAS) labelled "not at all" (0) to "very much" (100) and data was collected using Compusense Five Software Version 5.2 (Compusense Inc., Ontario, Canada).

Statistical analyses were performed using SAS version 9.3 (SAS Institute Inc., Cary, NC, USA). Data are presented as LS means ± SEM, unless indicated otherwise. Differences in characteristics (age, BMI, restraint score) between spoon and fork users were assessed with independent *t*-tests. Because spoon users had on average a higher BMI, BMI status(<25 kg/m^2 vs. >25 kg/m^2), was put into the General Linear Model (GLM) that assessed effects of cutlery use on all outcome measurements. The fixed effects of cutlery use, BMI status, fat, salt, and their interactions on food intake, eating rate, pleasantness, and changes in appetite ratings (decrease hunger, increase fullness) were assessed in a GLM that included participant(nested within both cutlery use and BMI status). Tukey–Kramer adjustments were used for all post hoc comparisons. Pearson correlations coefficients were calculated for correlations between various outcome parameters.

3. Results

3.1. Participants characteristics

Twenty-one participants (8 males) consistently used a spoon and 19 participants (6 males) consistently used a fork (Table 1), 8 participants were inconsistent in use over the sessions (for example, using a fork in one session and using a spoon in the other three sessions) and were excluded from analyses. Spoon users had on average a higher BMI (Table 1). Twenty-four participants had a BMI < 25 kg/m^2; 9 used spoons and 15 used forks. Sixteen participants had a BMI > 25 kg/m^2; 12 used spoons and 4 used forks.

3.2. Ad libitum food intake, eating rate, and meal duration

Spoon users tend to consume more than fork users ($p = 0.09$, see Table 2), and consume significantly more when not adjusted for BMI status (unadjusted means: fork: 319 ± 13 g; spoon: 372 ± 13 g, $p = 0.004$). Spoon users consumed at a higher eating rate, both when adjusted ($p = 0.022$, Table 2) and not adjusted for BMI status ($p < 0.001$). BMI status greatly affected food intake (LS means BMI < 25: 319 ± 12 g vs. BMI > 25: 379 ± 17 g, $p = 0.005$) and eating rate (LS means BMI < 25: 52 ± 2.0 g/min vs. BMI > 25: 63 ± 2.9 g/min, $p = 0.005$). The total duration of the meal was not affected by cutlery use ($p = 0.55$, Table 2) and not by BMI status (0.23).

Food intake and eating rate were not affected by salt (intake: $p = 0.24$; eating rate: $p = 0.73$) or fat (intake: $p = 0.35$; eating rate $p = 0.78$). However fat did not affect food intake in grams, it greatly affect energy intake ($p < 0.001$). There were no interactions between all combinations of salt, fat, cutlery use, and BMI status (salt * fat, salt * cutlery use, fat * cutlery use, BMI status * cutlery use, BMI status * salt, BMI status * fat, and all three-way interactions)on either food intake (all *p*-values > 0.22) or on eating rate (all *p*-values > 0.16).

3.3. Appetite and pleasantness ratings

Pleasantness of the meals tend to be higher rated in the spoon users vs. the fork users (Table 2). There was neither a main effect of BMI status ($p = 0.70$), nor an interaction of BMI status * cutlery use on pleasantness ($p = 0.89$). Salt increased pleasantness ($p < 0.001$), but there was no interaction of cutlery use * salt on pleasantness ($p = 0.36$). There was no main effect of fat on pleasantness ($p = 0.85$), but there was a trend for an interaction of cutlery use * fat on pleasantness ($p = 0.06$, Table 2). There was no interaction of BMI status * fat on pleasantness ($p = 0.42$). In addition, no other significant two-way or three-way interactions between salt, fat, cutlery use, and BMI status on pleasantness were found (all *p*-values > 0.21).

There was no difference between spoon and fork users in hunger ratings ($p = 0.58$) and fullness ratings ($p = 0.45$) before ad libitum intake (data not shown). BMI status showed a main effect

Table 1
Mean ± SEM of BMI, age, and restraint score in fork and spoon users.

	Fork	Spoon	*p*
N (male/female)	19(6/13)	21(8/13)	
BMI (kg/m^2)	22.5 ± 0.4	25.8 ± 0.4	**0.006**
Age (y)	23.0 ± 0.8	26.9 ± 1.6	**0.044**
Dietary restraint[a]	6.7 ± 0.9	8.7 ± 0.8	0.10

Bold indicates significant difference.
[a] Dietary restraint score was measured according to factor 1 of the three factor eating questionnaire (Stunkard & Messick, 1985) (scale: min: 0–max: 20).

Table 2
LS means ± SEM of ad libitum intake, eating rate, pleasantness, and decrease in hunger and increase in fullness (calculated as rating after ad libitum intake – rating before ad libitum intake) of fork and spoon users, where BMI status was included in the GLM.

	Fork	Spoon	*p* (main cutlery)	*p* (cutlery * salt)	*p* (cutlery * fat)
Ad libitum intake (g)	332 ± 16	367 ± 13	0.09		
LSLF	295 ± 33	394 ± 26		0.22	0.33
HSLF	367 ± 33	380 ± 26			
LSHF	317 ± 33	341 ± 26			
HSHF	346 ± 33	353 ± 26			
Eating rate (g/min)	53 ± 2.8	62 ± 2.1	**0.022**		
LSLF	54 ± 5.3	63 ± 4.3		0.17	0.42
HSLF	57 ± 6.2	59 ± 4.4			
LSHF	47 ± 5.4	64 ± 4.2			
HSHF	56 ± 5.3	61 ± 4.2			
Meal duration (min)	6.9 ± 0.3	6.7 ± 0.2	0.55		
LSLF	6.4 ± 0.6	6.2 ± 0.5		0.24	0.87
HSLF	7.9 ± 0.7	6.9 ± 0.5			
LSHF	6.6 ± 0.6	6.4 ± 0.5			
HSHF	6.7 ± 0.6	6.2 ± 0.5			
Pleasantness (units)	44 ± 2.4	50 ± 1.9	0.08		
LSLF	40 ± 4.8	41 ± 3.7		0.29	0.06
HSLF	54 ± 4.8	52 ± 3.7			
LSHF	33 ± 4.8	49 ± 3.7			
HSHF	50 ± 4.8	57 ± 3.7			
Decrease in hunger (units)	−47 ± 3.2	−43 ± 2.5	0.25		
LSLF	−46 ± 6.4	−43 ± 5.0		0.59	0.89
HSLF	−55 ± 6.3	−47 ± 5.0			
LSHF	−42 ± 6.3	−40 ± 5.0			
HSHF	−46 ± 6.3	−40 ± 5.0			
Increase in fullness (units)	55 ± 3.5	45 ± 2.8	**0.025**		
LSLF	52 ± 7.1	47 ± 5.5		0.09	0.19
HSLF	72 ± 7.0	43 ± 5.5			
LSHF	43 ± 7.0	41 ± 5.5			
HSHF	52 ± 7.0	50 ± 5.5			

Bold indicates significant difference.

on ratings before ad libitum intake, as the BMI < 25 group was hungrier and less full than the BMI > 25 group (both *p*-values < 0.001).

The decrease in hunger after the meals was not affected by cutlery use (Table 2), but was larger in the BMI < 25 group compared to the BMI > 25 group ($p = 0.007$). The increase in fullness was larger in the fork users compared to the spoon users ($p = 0.025$, Table 2), and tend to be larger in the BMI < 25 group compared to the BMI > 25 group ($p = 0.054$). There were no two-way or three-way interactions between all combinations of salt, fat, cutlery use, and BMI status on decrease in hunger (all *p*-values > 0.11) or increase in fullness (all *p*-values > 0.10).

3.4. Correlations between food intake, eating rate and BMI

The eating rate was positively correlated with food intake (g) for fork ($r = 0.45$, $p < 0.001$) and spoon users ($r = 0.47$, $p < 0.001$). BMI was positively correlated with eating rate for fork ($r = 0.25$, $p = 0.033$) and spoon users ($r = 0.24$, $p = 0.028$), and tended to be correlated with food intake in spoon users ($r = 0.21$, $p = 0.06$), but not in fork users ($r = -0.02$, $p = 0.84$).

4. Discussion

To the best of our knowledge, differences in food intake between fork users vs. spoon users has not been investigated before. We show that spoon users consume at a higher eating rate, most likely due to larger bite sizes, and tend to consume more than fork users. Both groups spend equal time for consumption (about ~7 min), suggesting that spoon users consumed faster resulting unconsciously in higher intake in response to the utensil that has been used. The state of hunger and fullness before ad libitum intake did not differ between fork and spoon users. Despite this spoon users tended to consume more than fork users, yet fork users had larger increase in fullness after the meal.

Spoon users, who consumed at a faster eating rate, had on average a higher BMI, in line with studies showing positive relationships between eating rate and body weight (Leong et al., 2011; Llewellyn et al., 2008; Ohkuma et al., 2015; Otsuka et al., 2006). Llewellyn et al. have shown that faster eating is a heritable behavioural phenotype related to higher weight and propose it is one of the genetically behavioural risk factors for weight gain. We also show strong effects of BMI status on eating rate and food intake and positive correlations for BMI and eating rate within fork and spoon users separately. This is consistent with the quantitative associations found between eating rate and adiposity (Llewellyn et al., 2008), and not just an abnormal eating rate in overweight/obese individuals. This implies that consuming at a lower eating rate may help to reduce energy intake a large part of the population to prevent weight gain.

This study focusses on differences between fork and spoon users in this particular laboratory setting. The population consisted of mostly students, having free breakfast and lunch may have affected their eating behaviour. Using a spoon instead of fork may be the result of an (unconscious) decision to consume more in a shorter time, or just being the result of habits of cutlery use within a family. Future research is needed to clarify whether spoon users in general are likely to show higher energy intake and have higher BMI.

This study gives insights in differences in acute food intake behaviour between individuals that naturally chose for a fork or a spoon, which would not be possible in a cross-over design in which participants were forced to consume with forks or spoons. Consequently, effects of spoon vs. fork use *per se* on eating rate and food intake are not addressed in this study. However, the results are in line with several cross-over and mostly laboratory studies have consistently shown that reducing bite sizes or eating rate within individuals decrease food intake (Andrade, Greene, & Melanson, 2008; Bolhuis, Forde, et al., 2014; Bolhuis et al., 2011; Bolhuis, Lakemond, de Wijk, Luning, & de Graaf, 2013, 2014; Robinson et al., 2014; Weijzen, Smeets, & de Graaf, 2009). The underlying mechanism is considered to be less oral sensory exposure to taste when eating fast, the latter has been shown to play a major role in regulation of acute food intake (Spetter, Mars, Viergever, de Graaf, & Smeets, 2014).

It needs to be studied further whether spoon users forced to consume with smaller bites would slow down the eating rate and decrease food intake. Mishra, Mishra, and Masters (2012) have found that smaller forks unexpectedly lead to higher food intake compared to larger forks in a restaurant setting, indicating that the translation to real life situations may be more challenging as expected.

In conclusion, participants who chose to consume with forks ate slower compared to spoon users. It needs to be studied further whether using forks instead of spoons or just using smaller spoons are useful tools to decrease energy intake in the long term. These findings are especially relevant in a modern food environment that is characterised by a wide variety of highly palatable, energy dense, softy textured foods can easily be consumed at a higher eating rate.

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