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Test-meal palatability alters the effects of intragastric fat but not carbohydrate preloads on intake and rated appetite in healthy volunteers

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Abstract

Manipulations of test meal palatability and nutritional need-state to examine feeding behaviour have, to date, been studied in isolation. Recent investigations have attempted to examine these influences in combination. In the present study, healthy young males received intragastric infusions of soup (265 or 1514 kJ) on four different occasions. The infusion was shortly followed by a meal varying in its palatability (PALATABLE or BLAND). The effect of macronutrient type (CHO or Fat) in the high-energy preloads was also examined in a between-subject manner. High CHO preloads significantly decreased test meal intake and this decrease was unaffected by meal palatability. High fat preloads did not significantly reduce test meal intake. Additionally, more food was consumed following high fat preloads when the test meal was PALATABLE. Within-meal ratings of appetite revealed that hunger was diminished to a greater extent by CHO than by Fat preloads. Appetite was stimulated by the PALATABLE meal to a greater extent in the group receiving Fat than in those receiving the CHO preload. Comparison with a similar oral preloading study revealed differences that suggest possible interactions between cognitive, oro-sensory and gastric controls of feeding when palatable foods are consumed.

Keywords: Appetite; Food intake; Gastric preloading; Universal Eating Monitor

1. Introduction

The incidence of overweight and obesity is continuing to grow in Western society and it is accepted that obesity occurs as a net result of a positive energy balance [1,2]. This usually arises due to excessive energy intake relative to daily energy expenditure. In order to develop treatments for and prevention of obesity we must gain insight into what motivates people to overeat. The regulation of food intake occurs at a number of levels, from oro-sensory cues through gastro-intestinal feedback to metabolic signals from the ingested food, with all of these levels integrating to produce a net intake of food (see Ref. [3] for review).

The increasing availability of highly palatable foods has been suggested to be a contributory factor in the growing incidence of obesity in recent years [1]. This suggestion has arisen from the proposal that palatability of food may interact with or even override satiety responses to food consumption [4]. The effects of manipulated palatability on eating behaviour and of gastro-intestinal responses to food ingestion have both been extensively examined. These investigations have, however, been limited to either one in isolation. The present investigation is part of our attempt to study how both of these influences interact in relation to compensatory eating and rated appetite.

The potential mechanisms through which palatability and satiety may interact have been previously discussed [5]. Briefly, increases and decreases in need-state may enhance and reduce subjective palatability, respectively. The former idea has been given support by the finding that

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exercise conducted prior to a meal increased its rated palatability [6]. Animal investigations have revealed, however, that the influence of palatability becomes diminished as rats become hungrier [7]. Reducing the motivation to eat by preloading prior to a palatable meal has yielded ambiguous results, with some studies finding a reduction in food intake (e.g. Refs. [8–11]) and others finding no effect (e.g. Ref. [12]).

In a previous investigation we demonstrated that palatability influenced short-term food intake and rated appetite following a high-energy soup preload [5]. Normal weight individuals given a pasta meal 30 min following a high-energy soup (1500 kJ) ate less than after a low-energy soup (265 kJ), however the reduction in food intake was less when the pasta meal was in a more palatable form. Changes in rated hunger and fullness were then plotted across the meal to enable microstructural analysis of these changes in subjective appetite (see Ref. [13]). High-energy preloading resulted in significant decreases and increases in hunger and fullness prior to the test meal, respectively. Intake of the palatable food was associated with a general enhancement of rated hunger (the appetiser effect [14]) regardless of the preload condition. The influence of palatability on short-term food intake regulation may be significant, therefore, given the abundance and variety of palatable foods available in the Western society.

The soup preloads in our previous study [5] had their energy content manipulated by addition of fat (olive oil) or carbohydrate (maltodextrin). No difference in food intake was observed when preload macronutrient content was contrasted, however, carbohydrate (CHO) preloads tended to decrease hunger prior to the test meal to a greater extent than fat preloads. Subjective evaluations indicated no discernible differences between the sensory characteristics of the different soup preloads. Previously it has been suggested that orosensory factors of a preload have an important influence on subsequent eating and appetite [15]. Although we are confident that subjects did not use sensory cues to discriminate the preloads used in our previous study [5], here we remove all possibility of any such sensory feedback by repeating our previous study using intragastric infusion of the same preloads.

The aims of the present investigation, therefore, were to examine the satiating effects of intragastric infusions of high- and low-energy fat and carbohydrate soup preloads on rated appetite and food intake during meals of different palatabilities. As in our earlier study [5], we included a microstructural analysis of changes in rated appetite within the test meal partly in order to assess fully the impact of the flavour manipulation, but also to allow evaluation of potential undesirable side-effects of the intra-gastric preload infusions which could potentially have resulted in non-specific effects on eating and appetite.

2. Methods

2.1. Design

The study used a within-subjects design to contrast intake of a seasoned (PALATABLE) or unseasoned (BLAND) lunch eaten 30 min after intragastric infusion of a low- or high-energy soup preload, giving four test sessions per subject. The additional energy in the soup was principally in the form of fat (olive oil) for half the subjects, and principally carbohydrate (maltodextrin) for the remainder, giving a between-subjects contrast of the effects of these two macronutrients. Test conditions were counterbalanced across subjects in both macronutrient groups.

2.2. Subjects

Twenty-one young men (aged 23.8±1.0 years, Body mass index 22.9±1.9 kg m^{-2}) were recruited from students and staff at the University of Sheffield. Standard exclusion criteria included: diabetes; food allergies; regular smoking; weight-loss dieting; prescription medication; eating disorders; drug abuse problems. Subjects were also required to score seven points or less for dietary restraint on the Three Factor Eating Questionnaire (TFEQ [16]). Their mean restraint score was 3.1±1.8.

The study was presented as an investigation of the "effects of food on mood". Subjects were each tested on four non-consecutive days, and debriefed following completion of the study. Foods and procedures were described in advance in order that subjects could give their written, informed consent, except in that the preloading design and the function of the Universal Eating Monitor (UEM) were concealed until debriefing took place. The protocol was approved by the North Sheffield Research Ethics Committee.

Subjects were assigned at random to the fat or carbohydrate groups, and these groups did not differ significantly in age (carbohydrate, 23.6±1.2 years: fat, 24.0±1.6 years), BMI (carbohydrate, 21.7±1.9: fat, 23.8±1.2) or dietary restraint (TFEQ score: carbohydrate 3.0±2.1, fat 3.3±1.4). Participants were given no indication that the preloads differed in any way.

2.3. Apparatus

Subjects were tested in individual laboratory-based eating cubicles using custom-made UEM equipment (see Refs. [5,13]). Briefly, the cubicle consisted of a bench holding a placemat below which was hidden an electronic balance (Sartorius BP 4100-S, Sartorius, Goettingen, Germany) connected via a serial line to an Apple G4 computer (Apple, USA), which was custom-programmed using Future Basic II (Staz Software, USA) to read the balance weight to 0.1 g accuracy every 2 s during feeding bouts.