Title: The impact of the cephalic phase on postprandial blood glucose and satiety

Authors: A. Korakianiti, S. E. Hillier, and M. E. Clegg

Affiliation: Functional Food Centre, Oxford Brookes University, Oxford, UK. OX3 0BP

Direct correspondence and re-prints:

Dr Miriam Clegg
Senior Lecturer
Functional Food Centre
Faculty of Health and Life Sciences
Oxford Brookes University
Oxford
OX3 0BP
Email: mclegg@brookes.ac.uk
Telephone: +44 1865 484365

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Abstract

Background and Aims: The impact of cephalic phase on postprandial insulin response is well documented however its effects on postprandial blood glucose remain inconsistent. The purpose of the current study was to assess the impact of cephalic phase on postprandial blood glucose and satiety.

Methods: Twelve participants were recruited and tested on two different occasions (i) with modified sham feeding (MSF) (ii) without MSF (Control) followed by white bread (50g available carbohydrate) consumption. Finger-prick blood samples were taken at regular interval for 120 minutes to measure blood glucose. Measurements of satiety (hunger, fullness, desire to eat and prospective eating) were taken using 100 mm visual analogue scales (VAS).

Results: Blood glucose changes did not differ between the two occasions after 30, 60 and 120 min. Similarly, there were no differences in satiety between the MSF test compared with the control.

Conclusion: These findings suggest that the cephalic phase do not affect either postprandial blood glucose or satiety.

Keywords: Cephalic phase, blood glucose, satiety, modified sham feeding
Introduction

The cephalic phase is the first phase of digestion that stimulates gastric and pancreatic secretions, prior to the arrival of food in the stomach. Taste, sight, texture, thought, chewing include a cascade of preabsorptive physiological responses which are collectively known as cephalic phase responses (CRP)\(^1\). It has been well reported that insulin secretions become elevated following taste stimulation, peaking at 1-4 min and returning to baseline within ten minutes. As a consequence this avoids both peak levels of glucose release and subsequent gluconeogenesis and lipolysis\(^1-3\).

The implications of these findings is evident within current western diets where bypassing oro-sensory stimulation may occur with the inclusion of higher energy density foods with less fibre. These foods provide faster oral transit time of energy, as they require less chewing\(^1\) increasing an individual’s risk of hyperglycaemia and hyperinsulinaemia. If this becomes a consistent metabolic profile then there is a greater risk of subsequent metabolic and cardiovascular disease\(^4,5\). Smeets \textit{et al.}\(^{1(1)}\) believes that the loss of adequate oral sensory signalling from such dietary choices is responsible for the reduced satiating capacity of foods.

Smeets \textit{et al.}\(^1\) identifies a need for further work to examine the impact of sensory signals on both short term metabolic pathways and satiety. With this in mind, the aim of the current study is to assess the impact of CPR on postprandial blood glucose and satiety

Methods

Twelve participants; 6 men and 6 women were recruited to the study (23.5±3.6 years; 62.6±9.3kg; 1.43±0.67m). Exclusion criteria included a BMI <18.5 or >30kg/m2, or a fasting blood sugar >6.1 mmol/l. Ethical approval was obtained from the Oxford Brookes University
Research Ethics Committee according to the guidelines laid down in the Declaration of Helsinki. Written informed consent was obtained.

Experimental protocol

The study was conducted over two separate testing days (>2 days, <seven days apart) which were performed in a randomised order. Participants were instructed to refrain from consuming alcohol or caffeine and from undertaking any exercise for 24 hours prior to testing. Participants arrived at the laboratory following a 12 hour overnight fast.

Capillary blood samples were taken by finger-prick using single-use lancing system (Unistik 3, Owen Munford, Woodstock, UK) at -5 and 0 min. Blood glucose was immediately measured using an automatic blood glucose analyser (Glucose 201+, HemoCue AB, Sweden). Further finger-prick blood samples were collected at 3, 6, 9, 12, 15, 30, 45, 60, 90 and 120 minutes post MSF or control feeding.

Ratings of satiety were taken at 0, 5, 15, 30, 45, 60, 90, 120 minutes at both testing days. Participants were asked four questions: How hungry do you feel? How full do you feel? How strong is your desire to eat? How much food do you think you can eat?, each was rated using a 100 mm visual analogue scale anchored from the left 0-100mm.

Modified Sham Feeding (MSF) test

The test food consisted of 11.5 g of chocolates buttons (Cadbury, Birmingham UK). Starting at 0 minutes the buttons were given at regular intervals and participants were instructed to chew the chocolate until the point at which they would usually swallow. Once this was reached they were instructed to spit out the contents. The participants were instructed that they should not swallow any of the chocolate. The procedure was repeated for 5 minutes.
Participants then consumed 117g of white bread (Warburton’s, Bolton UK; reference food) equal to 50g available carbohydrate between minute 6 and minute 15.

Control Test
During the control test, no MSF procedure was conducted. Participants rested during the first 5 minutes and then consumed the reference food between minute 6 and 15 as per the MSF test.

Statistical Analysis
Studies on in vivo assessment of GR and glycemic index have been based on 10 subjects, as reviewed by Brouns et al., and the FAO/WHO, to take account of inter-individual variations. A sample size of 12 was therefore considered adequate for the current study.

Data analysis was performed using SPSS (version 19.0; SPSS Inc., Chicago, IL). Data are expressed as means ± SD. Blood glucose area under the curve (AUC) at 30 min, 60 min and 120 min were calculated using the trapezoidal rule as was satiety at 120 minutes. MSF and control were compared using paired sample t-tests. Significance was set at P<0.05.

Results
Glycaemic response
Although the blood glucose remained lower following MSF than the control throughout the test period (Figure 1), there was no significant difference in GR AUC after 30 min, 60 min, 90 min or 120 min (Table 1).

Satiety
There was no significant difference in satiety parameters – hunger, fullness, desire to eat or prospective consumption AUC after 30 min, 60 min, 90 min or 120 min.

**Discussion**

In the current study, data did not show any significant difference on the early and postprandial blood glucose or satiety when a stimuli was tasted and chewed. The results showed that blood glucose concentration oscillated within narrow limits with and without the stimuli for the first 15 min (Figure 1). Although the blood glucose on the MSF test was lower throughout compared to the control feeding no significant difference was reported. The same results have been presented by previous studies where no significant changes on plasma insulin and glucose were reported after taste stimuli 8, 9. However, a remarkable body of human studies has indicated an insulin release before food ingestion between 2-10 min with a peak at 4 min, which can influence glucose homeostasis 1-3. Difficulty in measuring such small variations in blood samples is acknowledged, as is a large variability of CPR between individuals with some thought to be non-responders; where they do not exhibit CPR 1. It is also acknowledged that in this preliminary study insulin was not measured so CPR could not be guaranteed.

It is suggested that oro-sensory stimulation increases secretions of gastro-intestinal peptides, slowing gastric emptying and therefore increasing satiety 1, 10. The present study therefore hypothesised that bypassing oro-pharyngeal and oesophageal exposure would reduce levels of satiety, however this was not evidenced in the current study through measurements using visual analogues scales.
In conclusion this preliminary study was unable to detect difference in GR and satiety following orosensory stimulation. Future work should include the measurement of insulin and the inclusion of an ad libitum test meal.

References


List of Table and Figure

Table 1: Blood glucose area under the curve and satiety from visual analogue scales following the consumption of either modified sham feeding (MSF) or normal feeding (control). Data are given as mean ± SD (n=12).

Figure 1: Blood glucose response following the consumption of either modified sham feeding (MSF) or normal feeding (control). Data are given as mean ± SD (n=12).