

Korakianiti, A, Hillier, S and Clegg, M

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

Korakianiti, A, Hillier, S and Clegg, M (2014) The impact of the cephalic phase on postprandial blood glucose and satiety. e-*SPEN Journal*, 9 (6). pp. e220-e222.

doi: 10.1016/j.clnme.2014.09.002

This version is available: <https://radar.brookes.ac.uk/radar/items/04629882-2161-4272-bf81-4e8880849a96/1/>

Available on RADAR: March 2016

Copyright © and Moral Rights are retained by the author(s) and/ or other copyright owners. A copy can be downloaded for personal non-commercial research or study, without prior permission or charge. This item cannot be reproduced or quoted extensively from without first obtaining permission in writing from the copyright holder(s). The content must not be changed in any way or sold commercially in any format or medium without the formal permission of the copyright holders.

This document is the postprint version of the journal article. Some differences between the published version and this version may remain and you are advised to consult the published version if you wish to cite from it.

15 *Abstract*

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

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

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

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

30 *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 lipolysis¹⁻³.

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 chewing¹ 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 *et al.*¹⁽¹⁾⁽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 *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.* ⁶ and the FAO/WHO ⁷, 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 \pm 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

1. Smeets PA, Erkner A, de Graaf C. Cephalic phase responses and appetite. *Nutr Rev* 2010; **68**(11): 643-55.
2. Bellisle F, Louis-Sylvestre J, Demozay F, Blazy D, Le Magnen J. Cephalic phase of insulin secretion and food stimulation in humans: a new perspective. *Am J Physiol* 1985; **249**(6 Pt 1): E639-45.
3. Teff KL, Engelman K. Palatability and dietary restraint: effect on cephalic phase insulin release in women. *Physiol Behav* 1996; **60**(2): 567-73.
4. Malik VS, Popkin BM, Bray GA, Despres JP, Willett WC, Hu FB. Sugar-sweetened beverages and risk of metabolic syndrome and type 2 diabetes: a meta-analysis. *Diabetes Care* **33**(11): 2477-83.
5. de Graaf C. Texture and satiation: the role of oro-sensory exposure time. *Physiol Behav* **107**(4): 496-501.
6. Brouns F, Bjorck I, Frayn KN, Gibbs AL, Lang V, Slama G, et al. Glycaemic index methodology. *Nutr Res Rev* 2005; **18**(1): 145-71.
7. FAO/WHO. Carbohydrates in human nutrition. Report of a Joint FAO/WHO Expert Consultation. *FAO Food Nutr Pap* 1998; **66**: 1-140.
8. Abdallah L, Chabert M, Louis-Sylvestre J. Cephalic phase responses to sweet taste. *The American journal of clinical nutrition* 1997; **65**(3): 737-43.

9. Teff KL, Devine J, Engelman K. Sweet taste: effect on cephalic phase insulin release in men. *Physiol Behav* 1995; **57**(6): 1089-95.
10. Cecil JE, Francis J, Read NW. Comparison of the effects of a high-fat and high-carbohydrate soup delivered orally and intragastrically on gastric emptying, appetite, and eating behaviour. *Physiol Behav* 1999; **67**(2): 299-306.

178 *List of Table and Figure*

179

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

183

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