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The effect of a high versus low glycaemic index breakfast cereal and snack on children's cognitive performance

Greta Defeyter



Background

Nutritional Benefits

- ✚ Better nutritional profiles (Williams, 2007)
- ✚ Skipping breakfast associated with higher levels of snack food consumption (Billon et al., 2002).

Cognitive Benefits

- ✚ Consumption of breakfast has positive effects
 - ✚ Short-term improvements to memory (Smith, 1999)
 - ✚ Attention (Ingwersen et al., 2007)
 - ✚ Mood (Smith et al., 1999; though see Benton et al., 2001)
 - ✚ Behaviour (Bro et al., 1994).
-
- ✚ However, no consensus on the specific processes that are affected by breakfast consumption (Dye et al., 2000)

Background

Wesnes et al (2003)

9- to 16-year-olds

Cheerios, Shreddies, glucose drink or no breakfast

Computerised tests of attention and memory

Prior to and at 30, 90, 150 and 210 minutes after breakfast

Glucose Drink & No Breakfast:

Decline in Focused Attention and
Episodic Memory

Cheerios & Shreddies:

Decline seen in Focused Attention and
Episodic Memory was significantly reduced

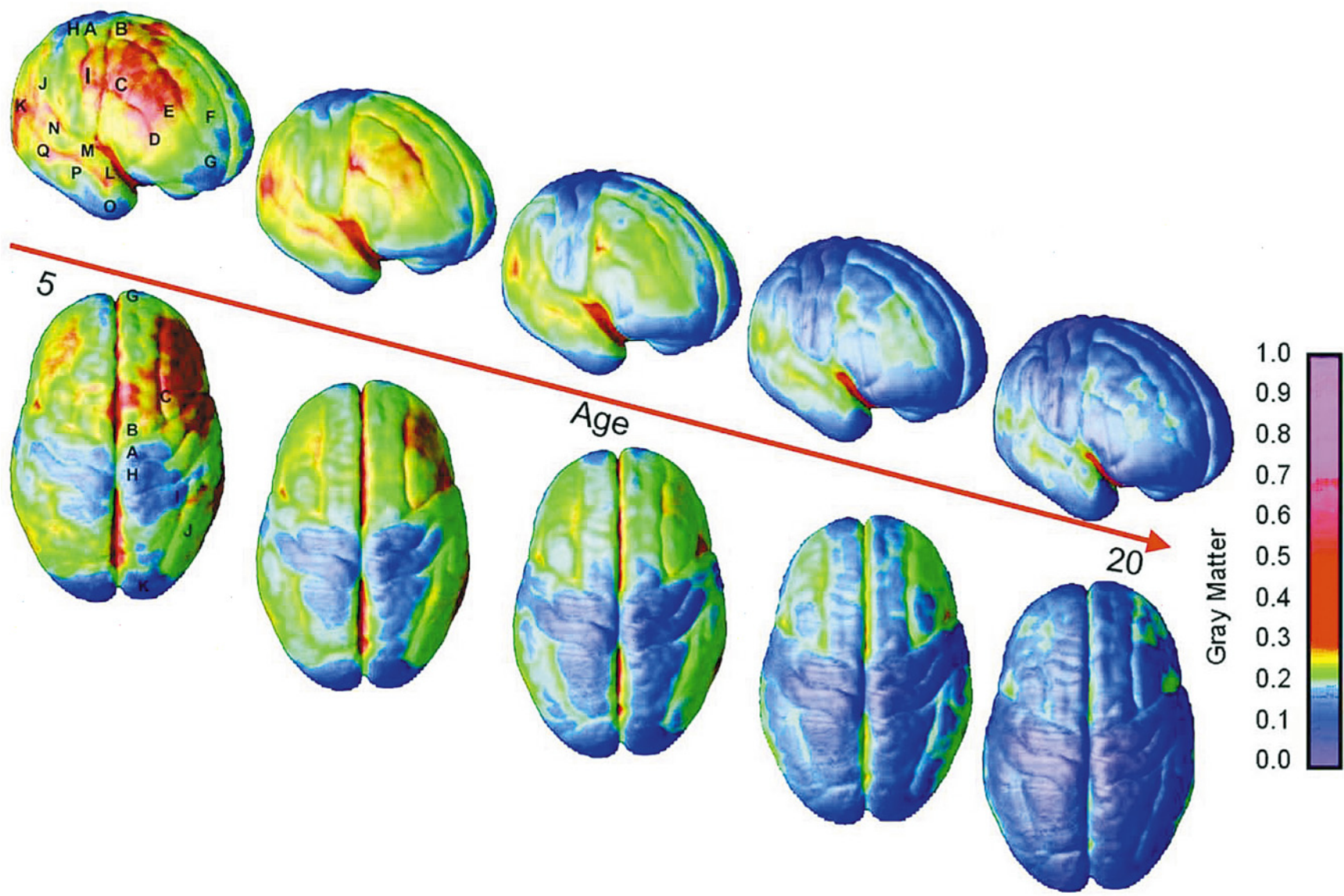
Background

The 'Best' Breakfast..."You are what you eat"

✎ Few studies have investigated the impact of the composition of breakfast on children's cognitive processes.

(Wyon et al., 1997; Wesnes et al., 2003; Mahoney et al., 2005; Benton, 2003; Smith & Foster, 2008).





Background

- ✚ High Glycaemic Index ($GI > 70$)
- ✚ Low Glycaemic Index ($GI < 40$)

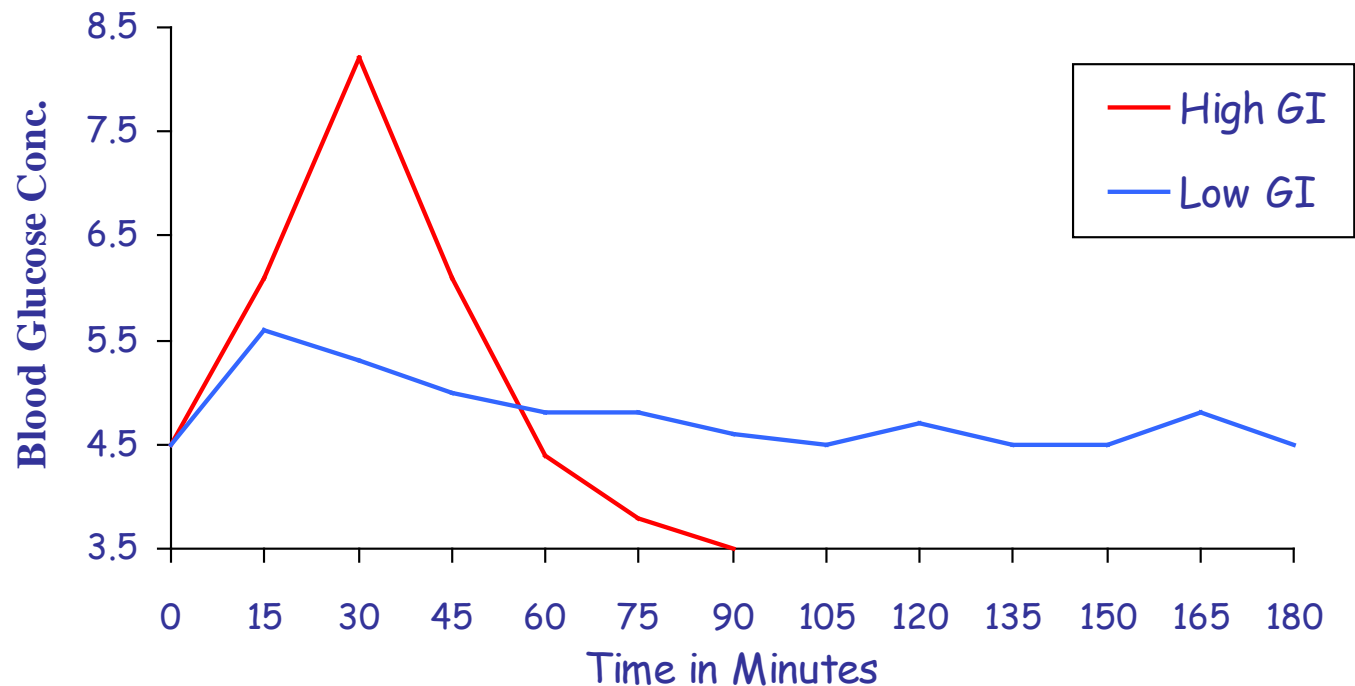


Fig. 1: Blood glucose response after intake of high and low GI carbohydrates (Roberts, 2000)

Present Study

Aims

- a) Does the glycaemic index of breakfast have an effect on cognitive performance?

Prediction: low rather than high GI breakfast more beneficial to performance, particularly in late morning

- b) Are the effects found across all cognitive functions or restricted to particular processes?

Participants

Three age groups:

7-year-olds (N = 18)

Mean age 7:2 (range 6:3-7:11); 10 females, 8 males

9-year-olds (N = 23)

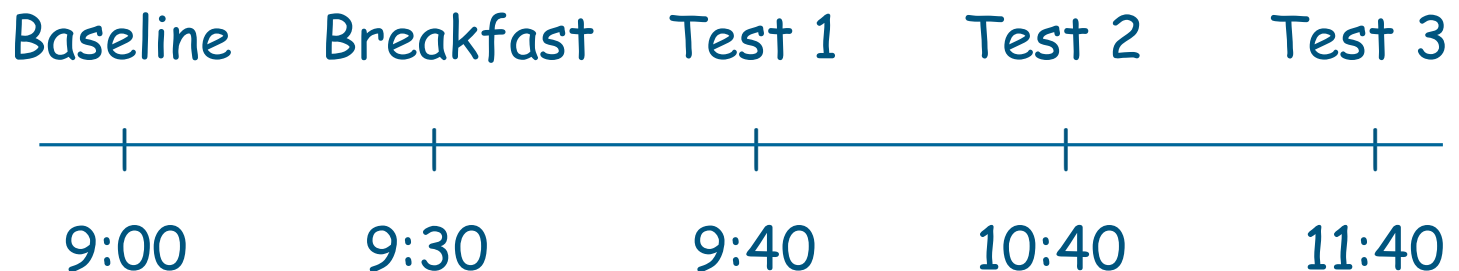
Mean age 9:1 (range 8:2-9:11); 10 females, 13 males

11-year-olds (N = 23)

Mean age 11:0 (range 10:0-11:7); 18 females, 5 males

Procedure

- ✎ Two consecutive days
- ✎ High GI: Coco Pops
(35g with 125ml semi-skimmed milk)
- ✎ Low GI: All Bran
(35g with 125ml semi-skimmed milk)



Procedure

Cognitive Drug Research (CDR) Computerised Assessment Battery (Wesnes et al, 2003)

Word Presentation
Immediate Word Recall
Picture Presentation
Simple Reaction Time
Digit Vigilance
Choice Reaction Time
Spatial Working Memory
Numeric Working Memory
Delayed Word Recall
Delayed Word Recognition
Delayed Picture Recognition



Fig. 2: CDR Test Battery

Cognitive Drug Research computerised assessment battery



Fig 3: Computerised assessment battery

<i>measure</i>	TASK
Number correct (%) Errors (number) Intrusions (number)	Immediate Word Recall
Reaction time (msec)	Simple Reaction Time
Accuracy (%) Reaction time (msec) False alarms (number)	Digit Vigilance Task
Reaction time (msec) Accuracy (%)	Choice Reaction Time
Reaction time (msec) Accuracy original stimuli (%) Accuracy new stimuli (%)	Spatial Memory Task
Reaction time (msec) Accuracy original stimuli (%) Accuracy new stimuli (%)	Numeric Working Memory
Number correct (%) Errors (number) Intrusions (number)	Delayed Word Recall
Reaction time (msec) Accuracy original stimuli (%) Accuracy new stimuli (%)	Delayed Word Recognition
Reaction time (msec) Accuracy original stimuli (%) Accuracy new stimuli (%)	Delayed Picture Recognition

Analysis of Data

- 📌 Focused Attention
- 📌 Sustained Attention
- 📌 Working Memory
- 📌 Episodic Memory
- 📌 Speed of Memory

Analysis of Data

📌 Change from Baseline

Test 1/2/3 - Baseline

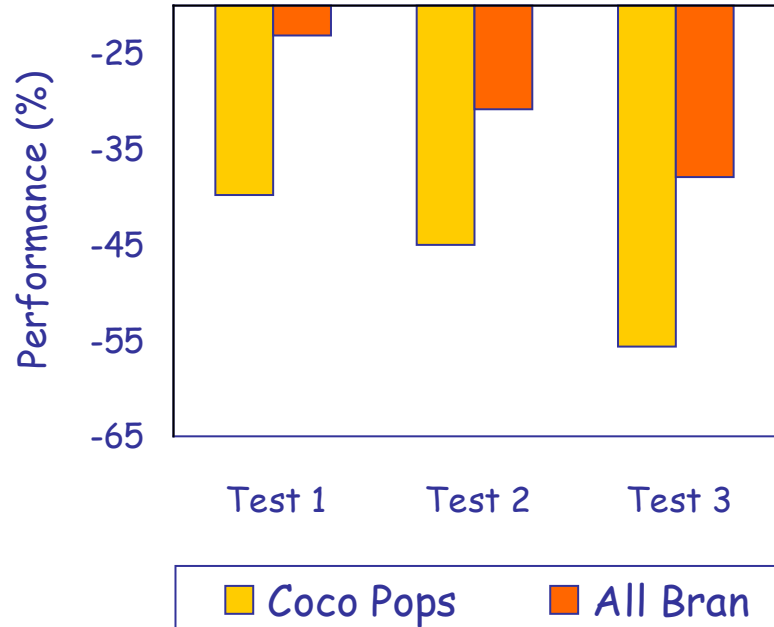
📌 (3 x 2 x 3) ANOVA

(assessment x breakfast x age group)

Results

- 📌 Older children perform better than younger children
- 📌 Decline in performance throughout the morning

Episodic Memory

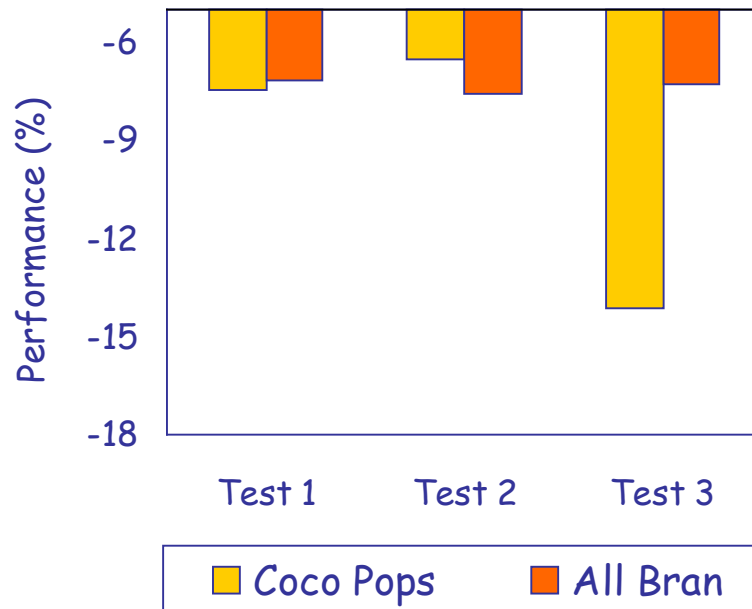


Main effect of Breakfast
 $F(1,61) = 5.313, p < 0.05$

Significantly smaller
decline in performance
after consumption of low
GI All Bran compared to
high GI Coco Pops

Fig. 4: Performance on Episodic Memory

Sustained Attention



Breakfast * Assessment Time
 $F(2,122) = 3.820, p < 0.05$

Significantly decline in performance on Test 3 after consumption of high GI Coco Pops compared to low GI All Bran

Fig. 4: Performance on Sustained Attention

Discussion

Aims

- a) Can the Glycaemic Index of breakfast affect children's cognition?
- b) Are the effects found across all cognitive functions or restricted to particular processes?

Discussion

- ✚ Significantly less decline on Episodic Memory and Sustained Attention across the morning after consumption of Low GI (All Bran) compared to high GI (Coco Pops)
- ✚ Changes in cognitive performance may be a reflection of changes in blood glucose levels, in this case triggered by glycaemic index

- ✎ Effect of GI may be different for different cognitive processes
- ✎ Micronutrients and other macronutrients can also influence cognitive performance (Lieberman et al, 1986)
- ✎ Are there similar findings for a mid-morning snack?
- ✎ Does a mid-morning snack have a beneficial effect on cognitive performance?

Experiment 2

- ✎ Busch et al. (2002) Attention significantly better following consumption of a confectionary snack vs. placebo drink.
- ✎ Muthayya, Thomas, Srinivasan, Rao, Kurpad, van Klinken, Owen and de Bruin (2007) found no effect of snack on sustained attention or on psychomotor speed. Smaller decline in immediate and delayed memory (Low SES children)
- ✎ Benton et al. (1987) showed that 7-year-olds showed better performance, in terms of attention, following a glucose drink compared to a placebo

Participants

- ✦ 30 children aged 12 to 13 years (mean age = 12:10, range: 12:5-13:3) were recruited. 21 were females (mean BMI = 16) and 9 were males (mean BMI = 18).
- ✦ All children consumed the same breakfast (toast)



Treatments

Children consumed an apple (approx. 160g), a banana (approx. 170g, medium ripe) or no snack.

Table 1: Nutritional characteristics of a 160g apple and a 170g banana. The GI value is taken from an international table of glycaemic index (Foster Powell et al., 2002) and the nutritional values are taken from USDA National Nutrient Database for Standard Reference (2006).

Nutrient	Units	Apple (160g)	Banana (170g)
Energy	kcal	83	151
Protein	g	0.42	1.85
Fat	g	0.27	0.56
Fibre	g	3.8	4.4
Carbohydrate	g	22.10	38.83
Sugars	g	16.62	20.79
Starch	g	0.08	9.15
Glycaemic Index	GI	38	52

Measures

- ✚ *Simple Reaction Time*
- ✚ *Choice Reaction Time*
- ✚ *Corsi Blocks* (measure of spatial working memory)
- ✚ *RVIP* (measure of visual sustained attention)
- ✚ *Odd-one-Out* (measure of working memory)



Procedure



Results

Measure	Condition	Pre-snack	Post-snack
Simple reaction time (msec)	Apple	338.08 (53.89)	356.31 (75.28)
	Banana	351.67(34.31)	352.58(60.71)
	No Snack	415.91 (59.22)	439.53(64.32)

Measure	Condition	Pre-snack	Post-snack
Choice Reaction time (msec)	Apple	581.73 (147.27)	556.38 (119.52)
	Banana	533.40 (63.71)	529.47 (76.21)
	No Snack	631.57 (115.91)	652.29 (165.40)

Measure	Condition	Pre-snack	Post-snack
Corsi Blocks (# correct)	Apple	19.10 (2.60)	19.30 (4.57)
	Banana	19.30 (1.06)	18.60 (3.60)
	No Snack	19.60 (3.24)	19.70 (3.86)

Measure	Condition	Pre-snack	Post-snack
RVIP (d')	Apple	3.83 (1.04)	3.98 (1.01)
	Banana	4.42 (1.25)	4.49 (1.09)
	No Snack	4.16 (1.24)	3.54 (1.07)

Measure	Condition	Pre-snack	Post-snack
Odd one out Recall (# correct)	Apple	20.10 (4.07)	19.20 (4.10)
	Banana	19.10 (3.21)	19.70 (3.56)
	No Snack	18.30 (4.69)	19.00 (4.35)

A one-way Annova revealed no significant differences between the pre-snack scores (with the exception of Simple Reaction Time.)

Annova's or Ancova revealed no significant differences between pre-snack scores and post-snack scores on any of the measures.

Discussion

- ✎ Contrary to Busch et al. (2002) & Muthayya et al. (2007), Benton & Jarvis (2007) present study showed no effect of mid-morning snack on cognitive processes.
- Controlled for breakfast composition
- Overnight fasting
- SES
- Parental Education
- School Attendance
- Same environment

Discussion

- ✎ Some evidence for positive effect of low GI breakfast on cognition
- ✎ No effect of snack (mid-morning)
- ✎ Differences between studies
- ✎ Biological differences between individuals

Acknowledgments

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