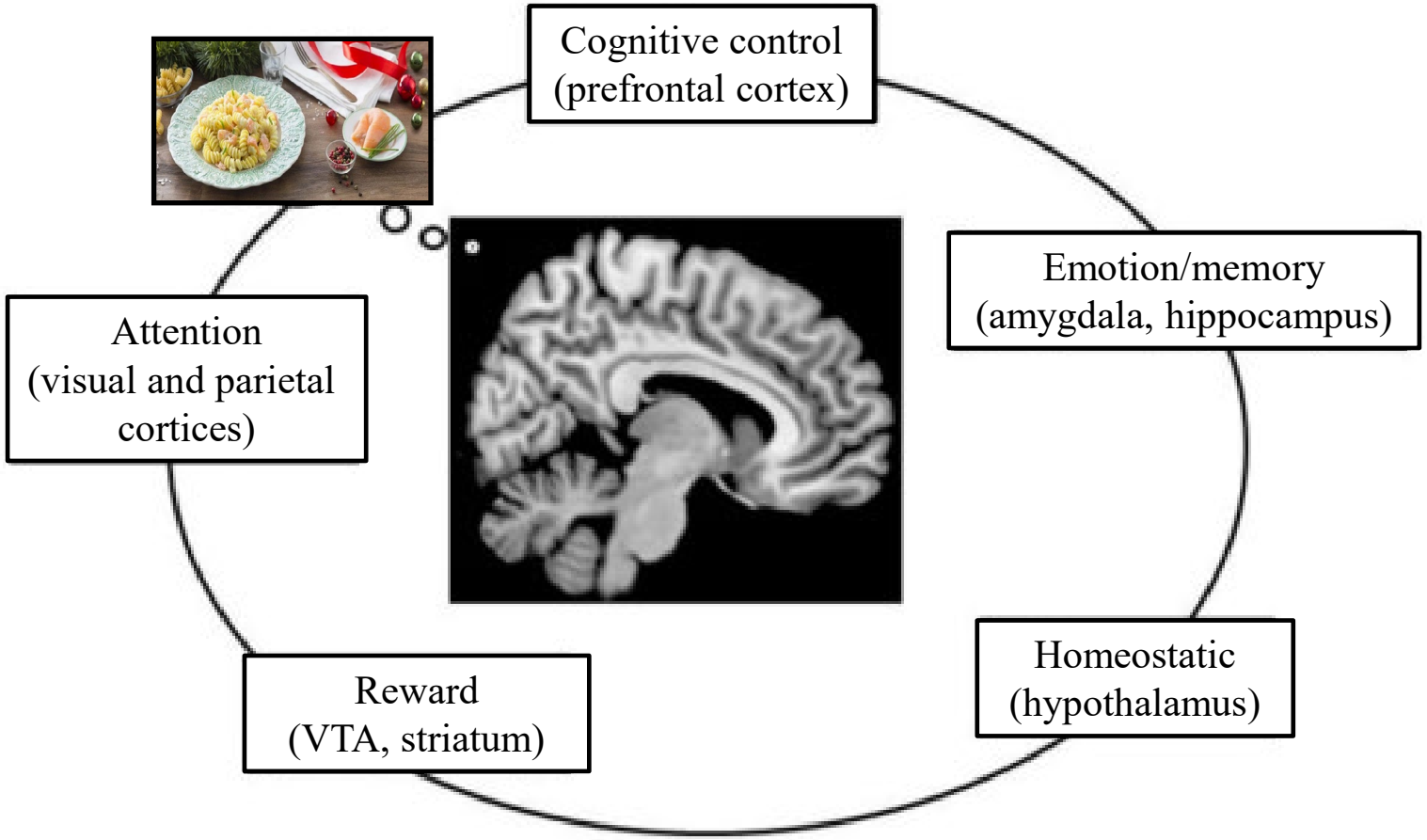
Effetti dell'esercizio fisico sulla regolazione cerebrale dell'appetito

Carmine G. Fanelli *(Perugia)*

Il dr. Carmine G. Fanelli dichiara di NON aver ricevuto negli ultimi due anni compensi o finanziamenti da Aziende Farmaceutiche e/o Diagnostiche

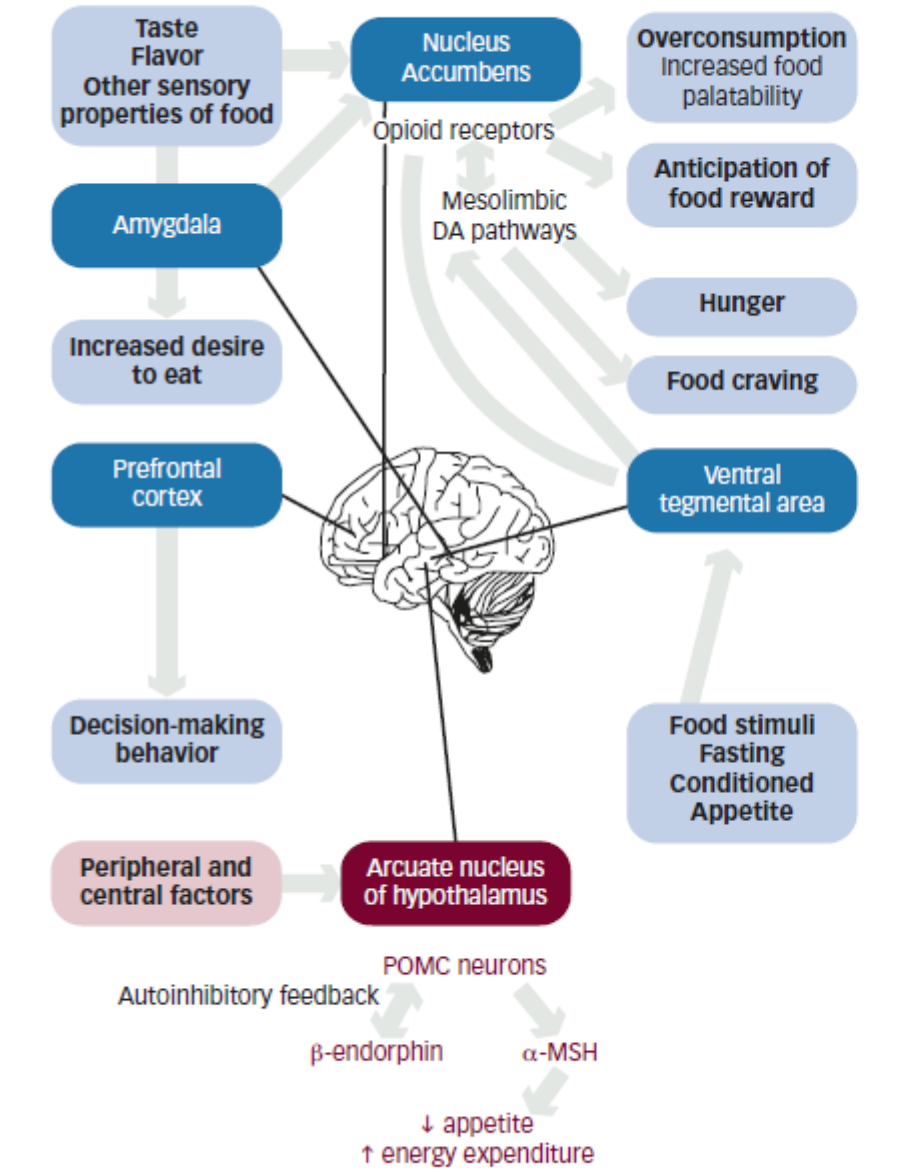
Dichiara altresì il proprio impegno ad astenersi, nell'ambito dell'evento, dal nominare, in qualsivoglia modo o forma, aziende farmaceutiche e/o denominazione commerciale e di non fare pubblicità di qualsiasi tipo relativamente a specifici prodotti di interesse sanitario (farmaci, strumenti, dispositivi medico-chirurgici, ecc.).

Control of eating in human brain



Farr O.M. et al. Metabolism. 2016; 65: 699–713

Central control of energy balance and eating behavior



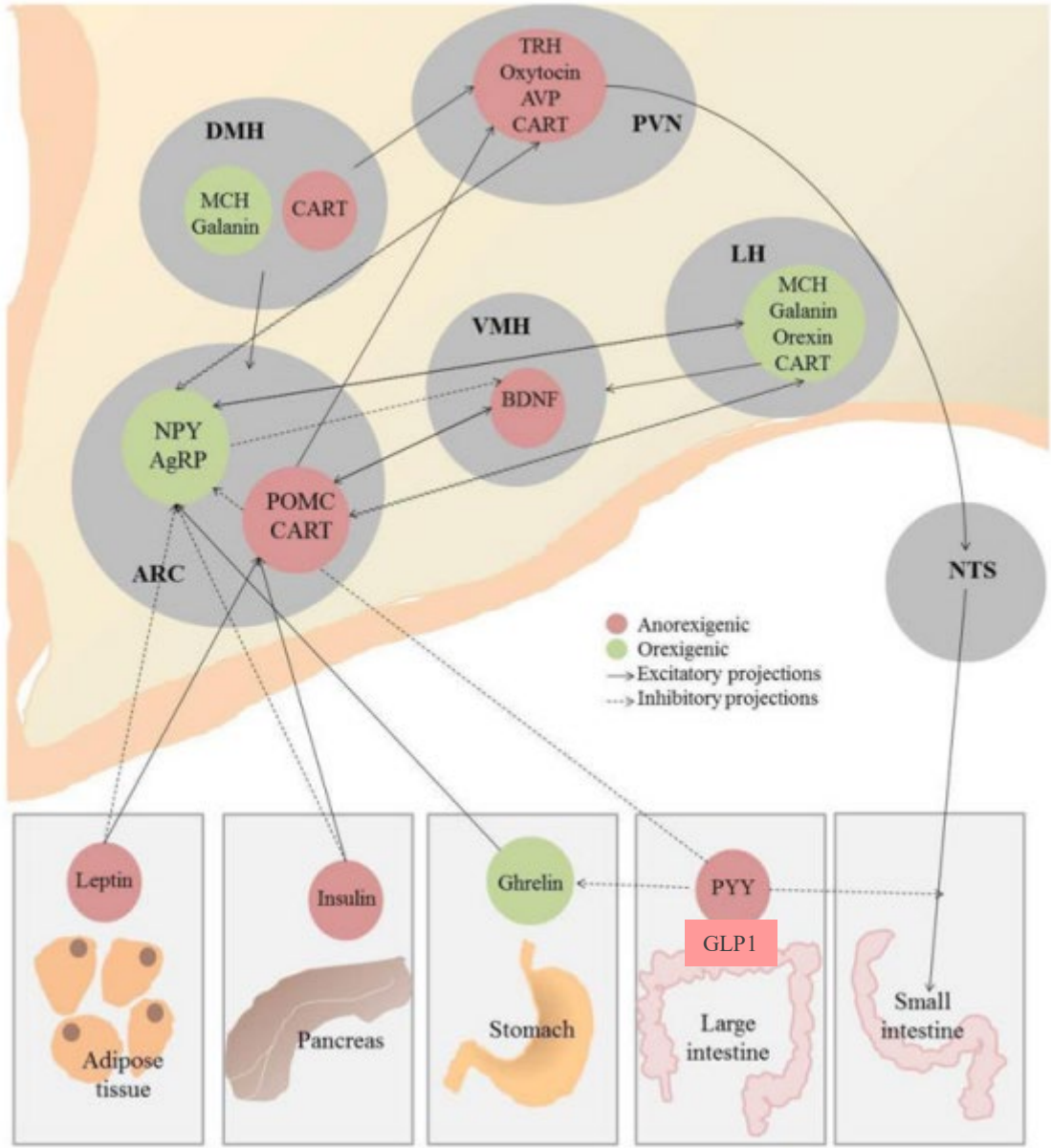
The reward system (blue) processes hedonic food behavior; energy balance regulation (red) involves the homeostatic regulation of energy balance. DA = dopamine.

Controllo edonistico

Controllo omeostatico

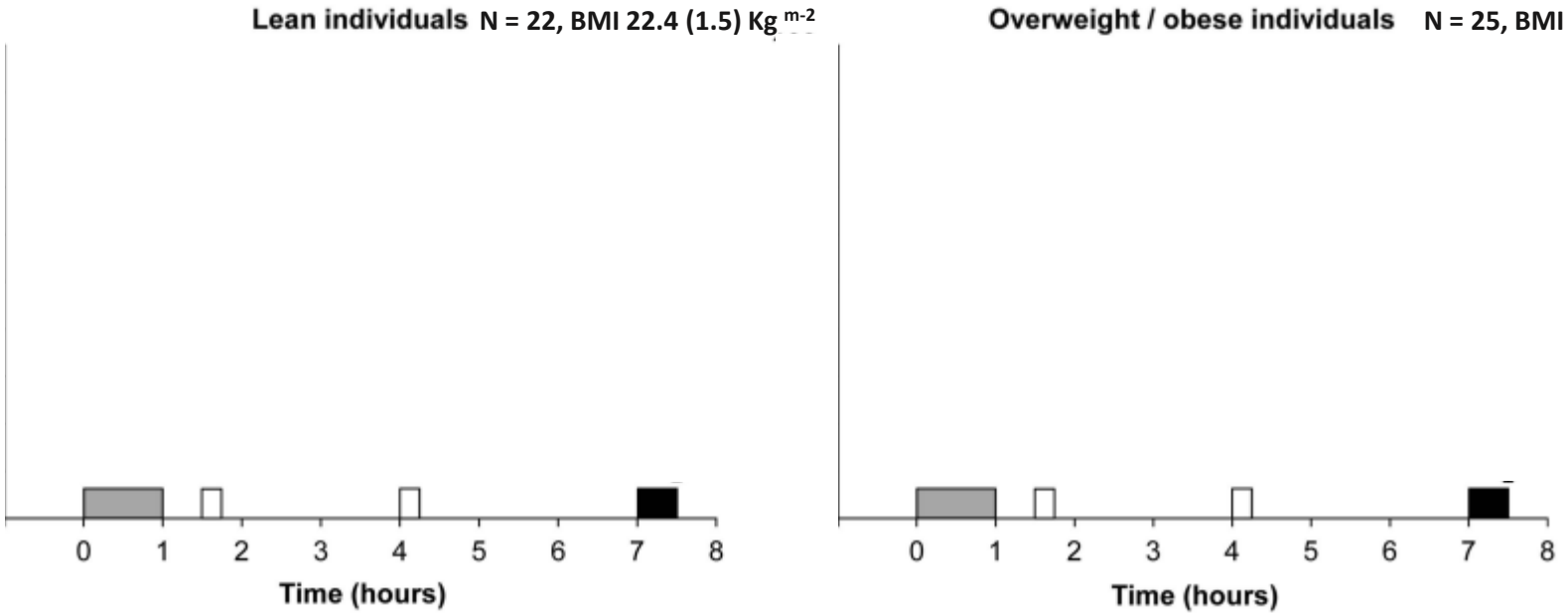
Fujioka K. US Endocrinology, 2014;10:53–8

Schematic of nuclei in the hypothalamus which contribute to the control of eating as well as inputs from the periphery



Farr O.M. et al. Metabolism. 2016; 65: 699–713

Acute effects of exercise on appetite, *ad libitum* energy intake and appetite-regulatory hormones in lean and overweight/ obese men and women



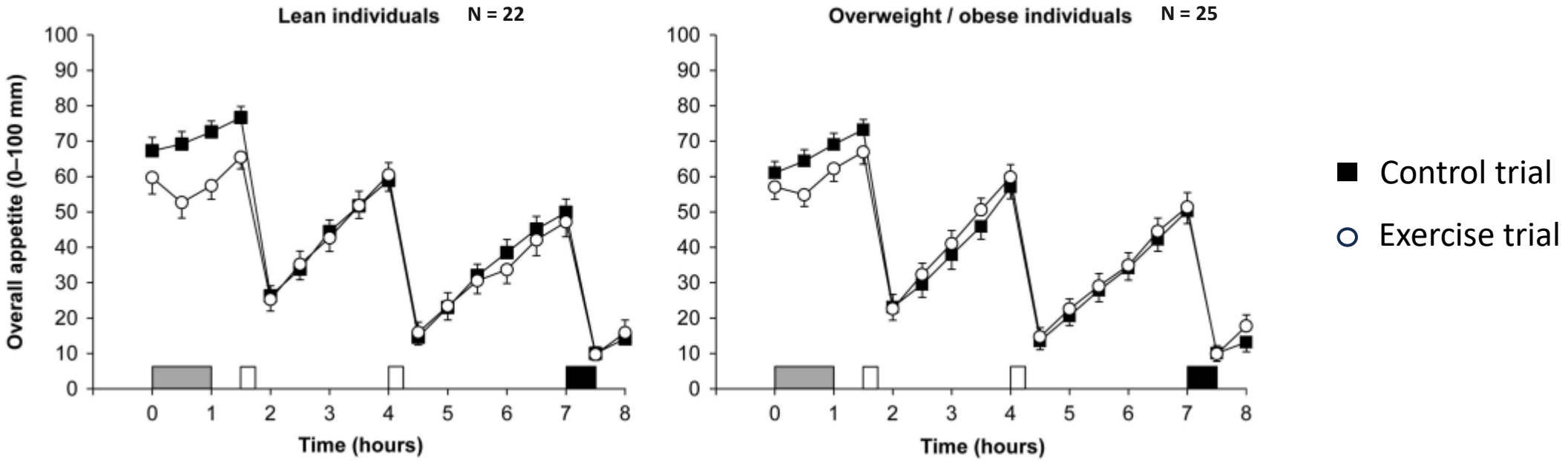
Exercise 60% peak O2

Standardized meals (640 Kcal)

ad libitum buffet meal

Douglas JA. Int J Obes. 2017; 41: 1737–1744

Overall appetite perception



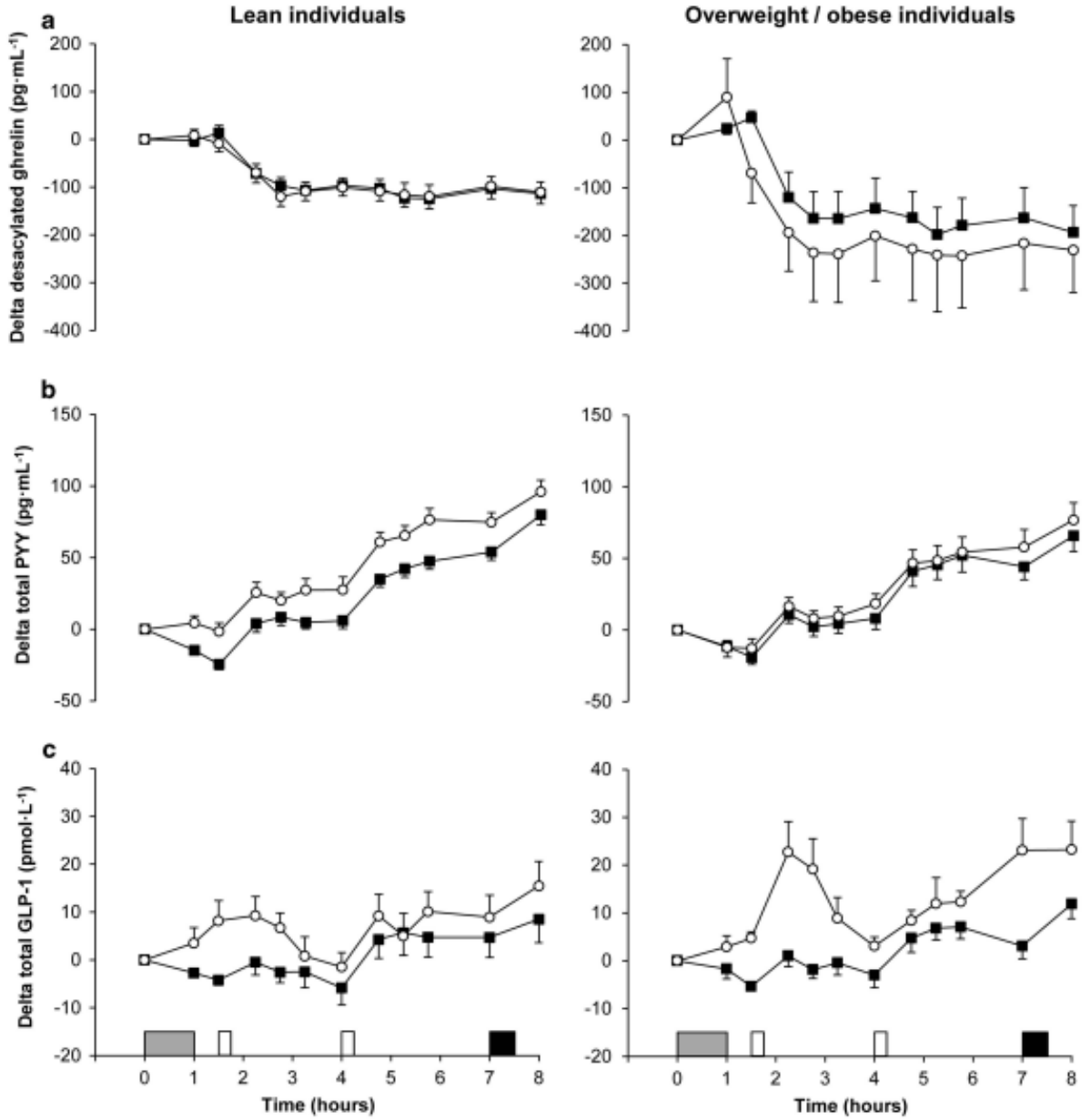
Douglas JA. Int J Obes. 2017; 41: 1737–1744

Plasma concentrations of ghrelin, PYY and GLP-1

Ghrelin

PYY

GLP-1



■ Control trial

○ Exercise trial

▭ Exercise 60% peak O2

▯ Standardized meals

▮ *ad libitum* buffet meal

Douglas JA. Int J Obes. 2017; 41: 1737–1744

Acute effects of exercise on appetite, *ad libitum* energy intake and appetite-regulatory hormones in lean and overweight/ obese men and women

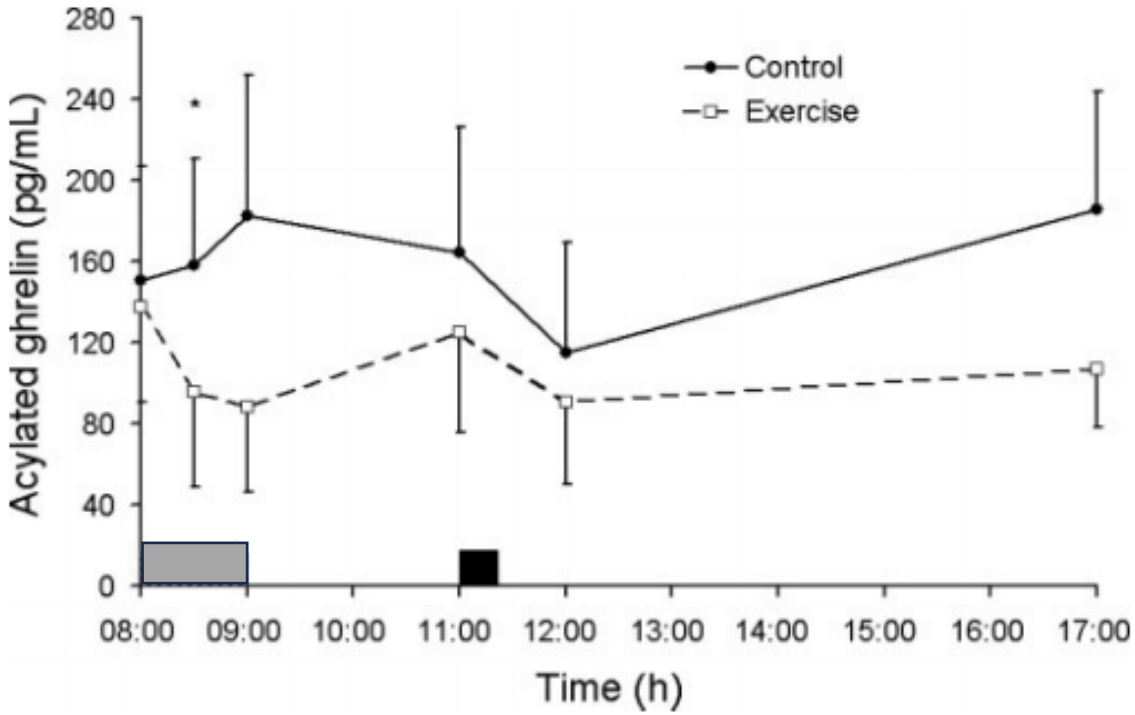
L'esercizio acuto di intensità moderata sopprime temporaneamente l'appetito e aumenta i livelli di PYY e il GLP-1 nelle ore successive all'esercizio, senza stimolare cambiamenti compensatori nell'appetito in individui magri o sovrappesi/obesi

Douglas JA. Int J Obes. 2017; 41: 1737–1744

Exercise-induced suppression of acylated ghrelin in humans

D. R. Broom, D. J. Stensel, N. C. Bishop, S. F. Burns, and M. Miyashita

School of Sport and Exercise Sciences, Loughborough University, Leicestershire, United Kingdom



Treadmil run 75% peak O2

Test meal

J Appl Physiol 102: 2165–2171, 2007

Differential Acylated Ghrelin, Peptide YY_{3-36}, Appetite, and Food Intake Responses to Equivalent Energy Deficits Created by Exercise and Food Restriction

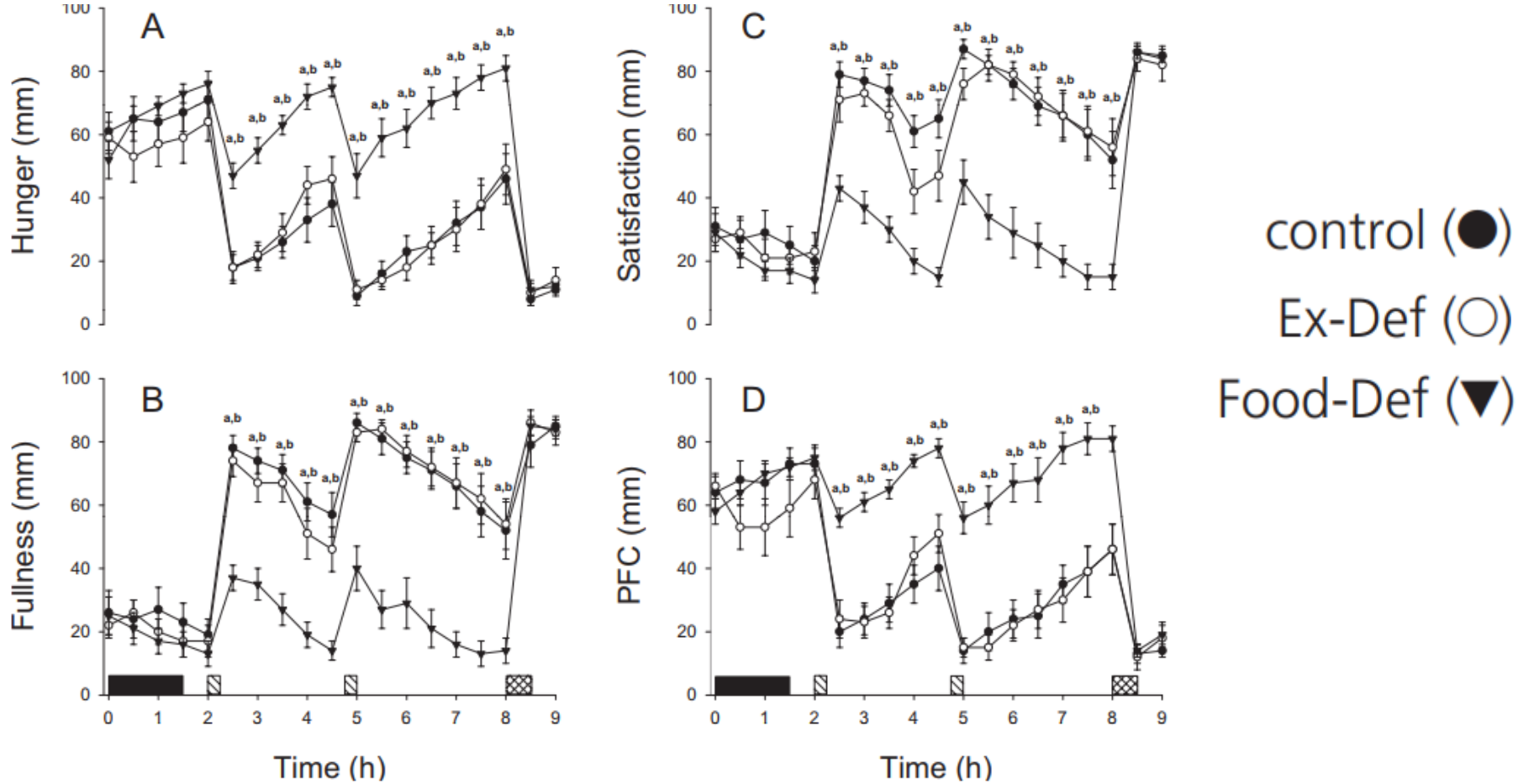


FIG. 1. Ratings of hunger (A), fullness (B), satisfaction (C), and prospective food consumption (D) in the control (●), Ex-Def (○), and Food-Def (▼) trials. Values are mean ± SEM (n = 12). *Black rectangle* indicates exercise, *diagonal rectangles* indicate test meals, and *hatched rectangle* represents the buffet meal. a, Food-Def different from control at $P < 0.05$; b, Food-Def different from Ex-Def at $P < 0.05$.

King JA et al. Clin Endocrinol Metab, 2011, 96 :1114 –1121

Differential Acylated Ghrelin, Peptide $YY_{3–36}$, Appetite, and Food Intake Responses to Equivalent Energy Deficits Created by Exercise and Food Restriction

control (●)

Ex-Def (○)

Food-Def (▼)

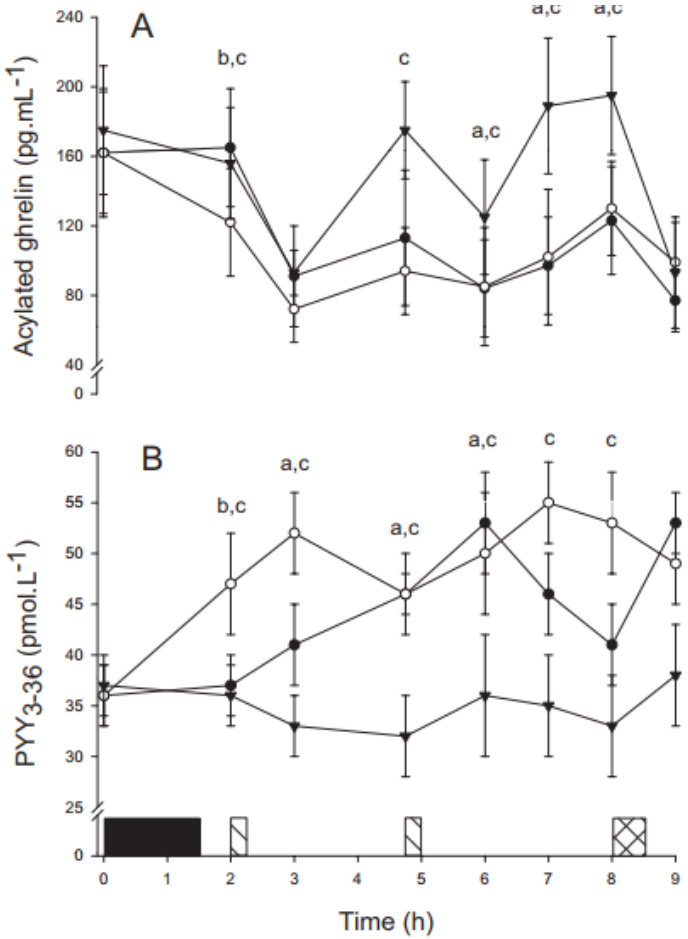


FIG. 2. Plasma concentrations of acylated ghrelin (A) and $PYY_{3–36}$ (B) in the control (●), Ex-Def (○), and Food-Def (▼) trials. Values are mean ± SEM (n = 12). *Black rectangle* indicates exercise, *diagonal rectangles* indicate test meals, and *hatched rectangle* represents the buffet meal. a, Food-Def different from control at $P < 0.05$; b, Ex-Def different from control at $P < 0.05$; c, Food-Def different from Ex-Def at $P < 0.05$.

Ad libitum energy and macronutrient intake in the control, Ex-Def, and Food-Def trials

	Control	Ex-Def	Food-Def
Energy (kJ)	4004 ± 427	4343 ± 653	6167 ± 318[a]
Fat (g)	34 ± 5	38 ± 5	63 ± 5[a,b]
Fat (%)	30.7 ± 3.3	33.4 ± 2.0	38.3 ± 1.7[a,b]
Protein (g)	40 ± 10	47 ± 15	67 ± 9[a]
Protein (%)	14.7 ± 2.1	15.0 ± 2.5	17.9 ± 1.8
Carbohydrate (g)	124 ± 12	129 ± 17	159 ± 10[a]
Carbohydrate (%)	54.6 ± 4.4	51.6 ± 3.1	43.8 ± 2.5[a,b]

Values are mean ± SEM (n = 12).

[a] Different from control ($P < 0.05$).

[b] Food-Def different from Ex-Def ($P < 0.05$).

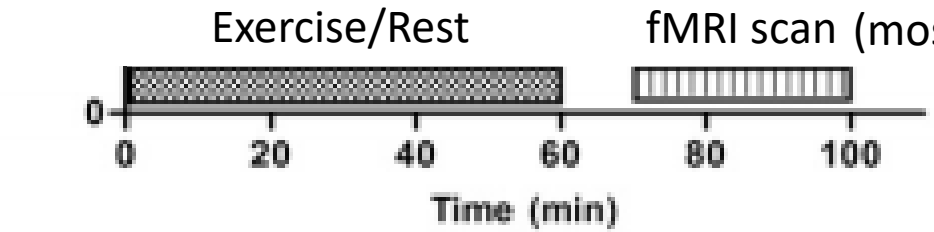
King JA et al. Clin Endocrinol Metab, 2011, 96 :1114 –1121

The effects of high-intensity exercise on neural responses to images of food

Obiettivo: confrontare le risposte neurali agli stimoli visivi del cibo dopo un esercizio intenso e riposo utilizzando la risonanza magnetica funzionale (fMRI)

15 lean healthy men

- Exercise (70% VO2 max)
- Rest



(mostrate immagini di cibi ad alto e basso contenuto calorico)

Crabtree DR et al. Am J Clin Nutr 2014;99:258–67

The effects of high-intensity exercise on neural responses to images of food

Food presented	Portion size (g)	Energy content (kcal)	Energy density (kcal/g)	CHO (g)	Sugars (g)	Fat (g)	Sweet (Yes/No)
Ice Cream	200.0	454.0	2.3	45.6	45.6	28.4	Yes
Brownies	288.0	1204.0	4.2	150.4	126.8	60.8	Yes
Cream Cake	125.0	491.0	3.9	73.0	45.6	21.1	Yes
Cheesecake	700.0	1694.0	2.4	231.0	155.4	74.2	Yes
Iced Doughnut	100.0	383.0	3.8	55.1	30.7	17.5	Yes
Muffin	140.0	591.0	4.2	66.5	34.2	33.2	Yes
Chips	100.0	189.0	1.9	30.1	0.6	6.7	No
Fried Chicken	604.0	1480.0	2.5	68.0	0.0	80.0	No
Pizza	630.0	1470.0	2.3	154.8	30.0	61.8	No
Cheeseburger	170.0	445.0	2.6	32.0	9.0	22.0	No
Crisps	50.0	256.0	5.1	26.0	6.2	15.0	No
Sausage rolls	180.0	714.0	4.0	45.0	4.1	52.2	No
Mean ± SD	**273.9 ± 323.2**	**780.9 ± 531.3**	**3.3 ± 1.0**	**81.5 ± 63.6**	**40.7 ± 50.2**	**39.4 ± 25.1**	

high-calorie food item presented during each fMRI assessment.

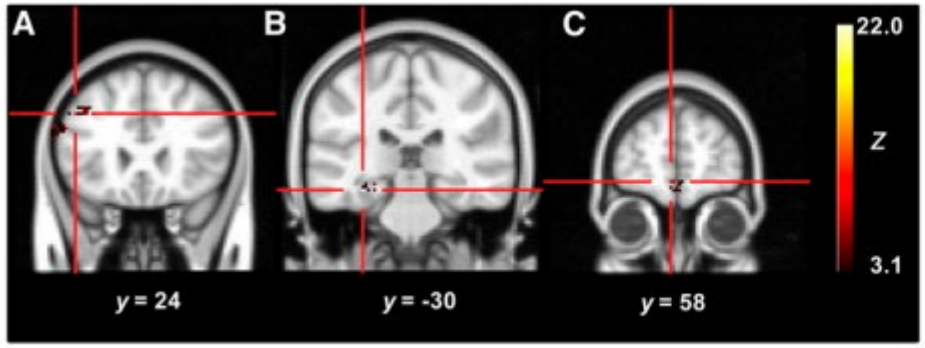
Online Supplemental Material

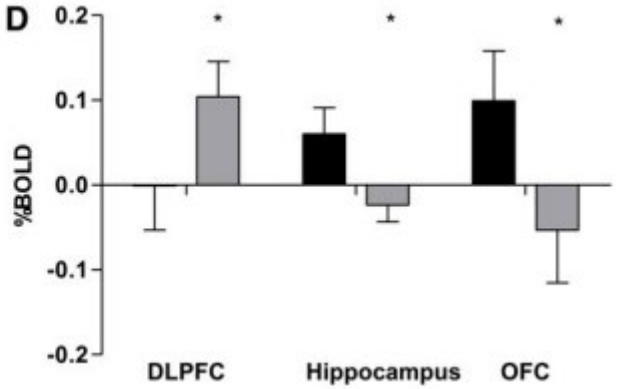
Food presented	Portion size (g)	Energy content (kcal)	Energy density (kcal/g)	CHO (g)	Sugars (g)	Fat (g)	Sweet (Yes/No)
Strawberry	10.0	2.7	0.3	0.6	0.6	0.0	Yes
Cherries	20.0	7.8	0.4	1.9	1.9	0.0	Yes
Grapes	500.0	300.0	0.6	72.0	69.0	0.5	Yes
Kiwi	50.0	21.0	0.4	4.6	4.5	0.2	Yes
Bananas	800.0	496.0	0.6	115.0	110.4	1.6	Yes
Red Apple	100.0	59.0	0.6	14.0	11.2	0.3	Yes
Peas	50.0	24.5	0.5	2.8	1.5	0.5	No
Cucumber	25.0	2.5	0.1	0.4	0.4	0.0	No
Sweet Corn	100.0	66.0	0.7	11.6	1.4	1.4	No
Carrots	300.0	90.0	0.3	18.0	13.8	1.5	No
Lettuce	400.0	56.0	0.1	6.8	6.8	2.0	No
Brown bread	56.0	138.0	2.5	23.2	3.2	1.8	No
Mean ± SD	**200.9 ± 249.5**	**105.3 ± 148.4**	**0.6 ± 0.6**	**22.6 ± 35.1**	**18.7 ± 34.6**	**0.8 ± 0.8**	

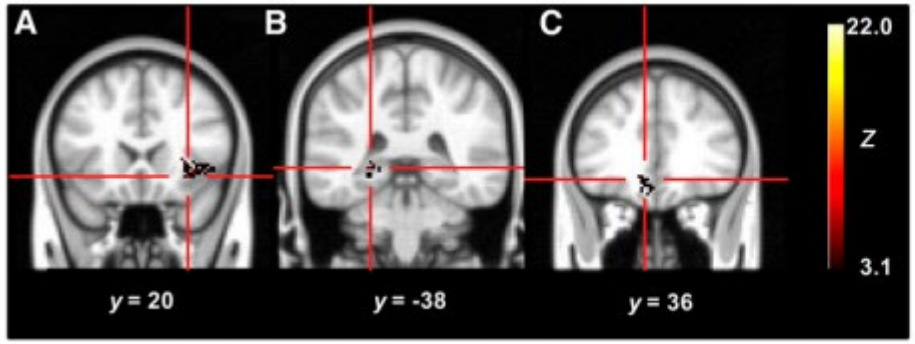
low-calorie food item presented during each fMRI assessment.

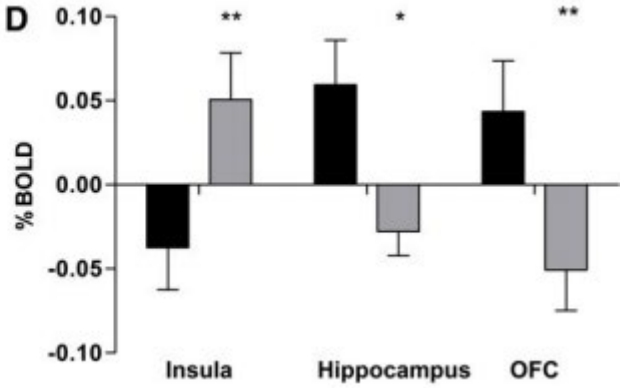
Crabtree DR et al. Am J Clin Nutr 2014;99:258–67

The effects of high-intensity exercise on neural responses to images of food





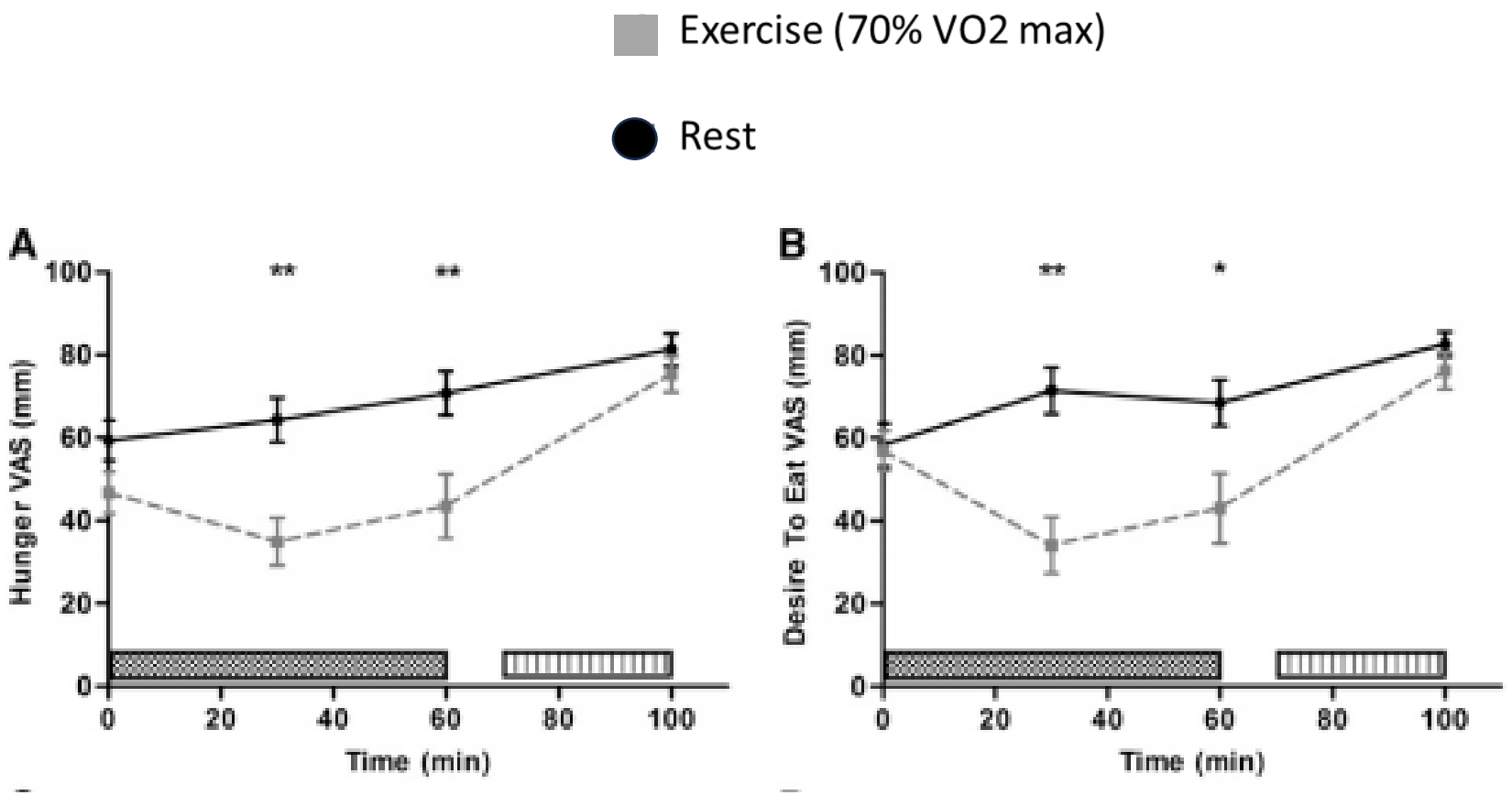




L'esercizio aumenta le risposte neurali nelle regioni del cervello legate alla ricompensa in risposta a immagini di cibi ipocalorici e sopprime l'attivazione durante la visione di cibi ipercalorici

Crabtree DR et al. Am J Clin Nutr 2014;99:258–67

The effects of high-intensity exercise on neural responses to images of food

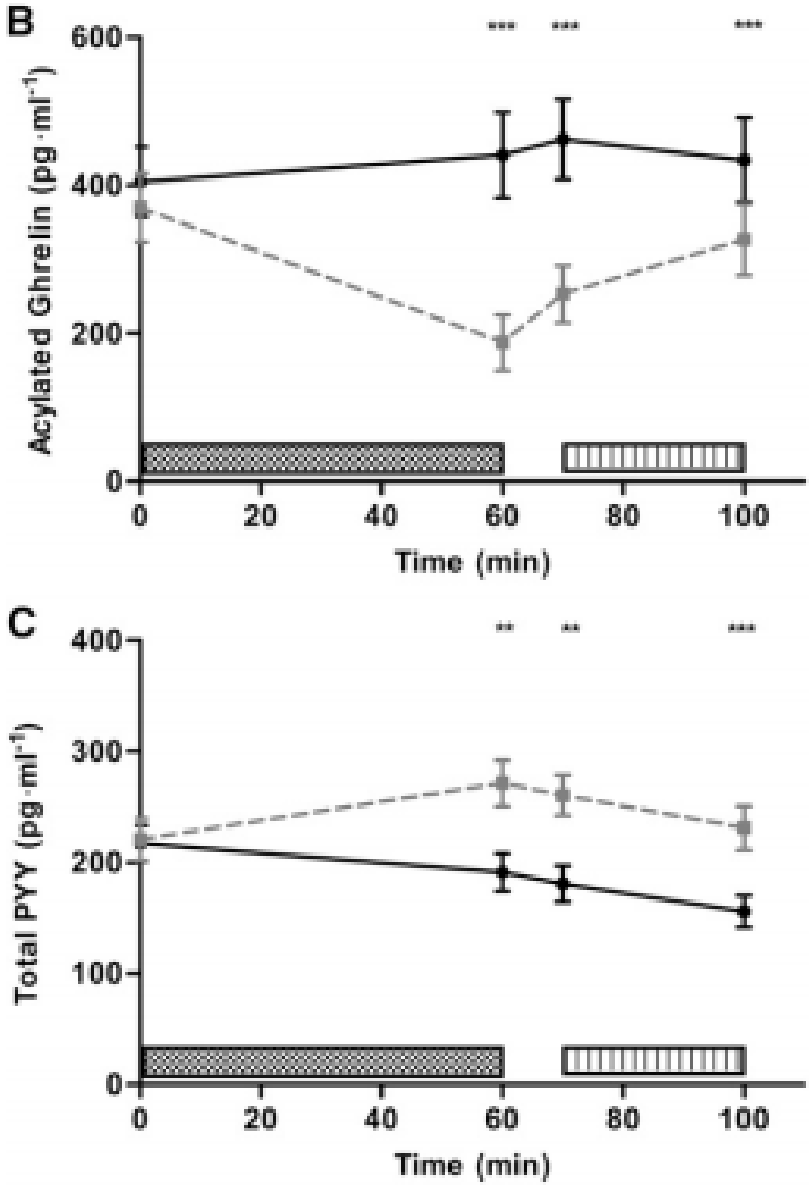


Crabtree DR et al. Am J Clin Nutr 2014;99:258–67

The effects of high-intensity exercise on neural responses to images of food

Exercise (70% VO2 max)

Rest



Crabtree DR et al. Am J Clin Nutr 2014;99:258–67

The effects of high-intensity exercise on neural responses to images of food

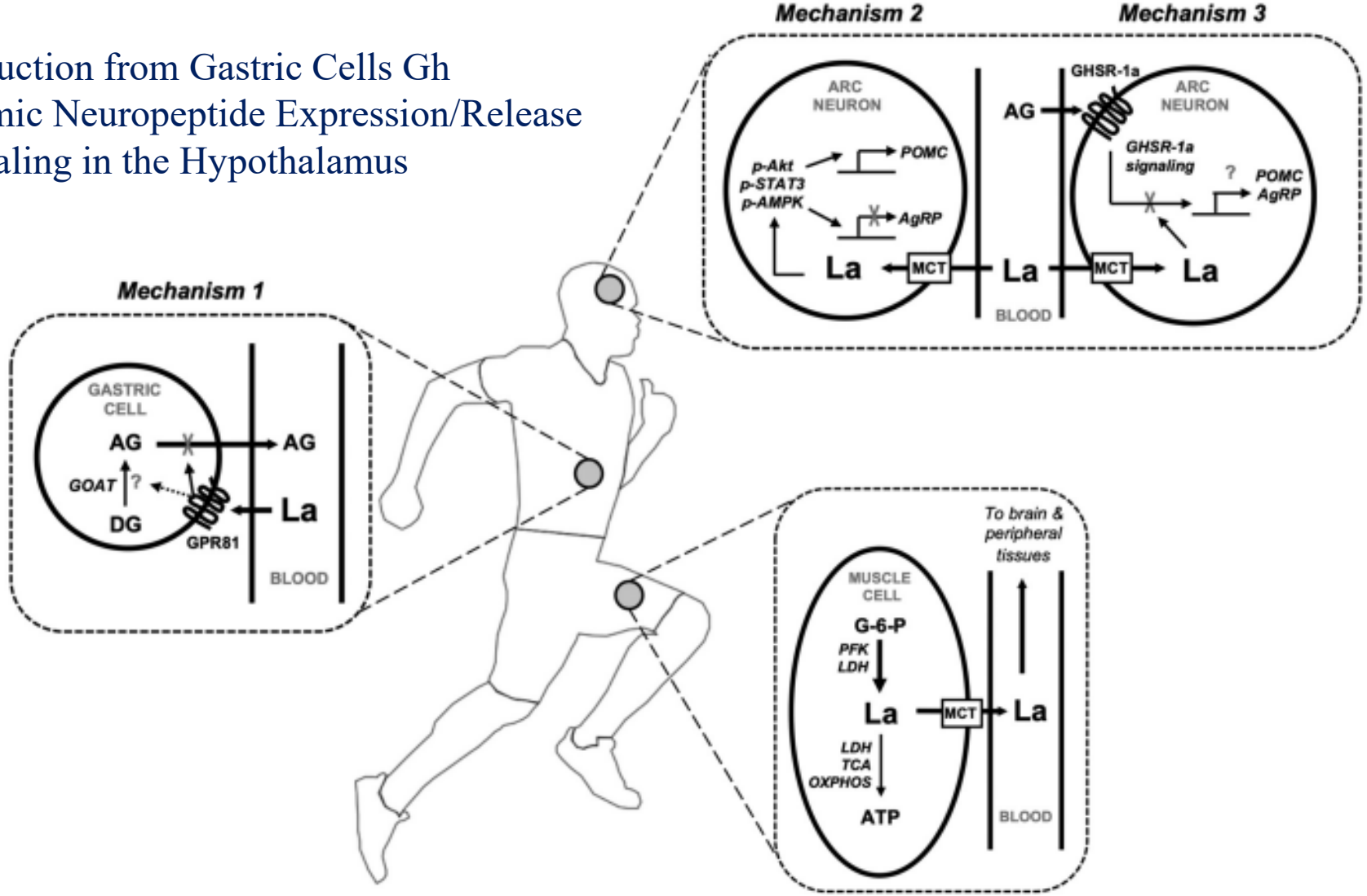
L'attivazione del sistema di ricompensa aumenta in risposta alle immagini di cibi a basso contenuto calorico dopo esercizio ad alta intensità, mentre si sopprime in risposta alle immagini di cibi a alto contenuto calorico

Queste risposte neurali centrali sono associate a variazioni negli ormoni regolatori dell'appetito indotte dall'esercizio fisico

Crabtree DR et al. Am J Clin Nutr 2014;99:258–67

The emerging role of lactate as a mediator of exercise-induced appetite suppression

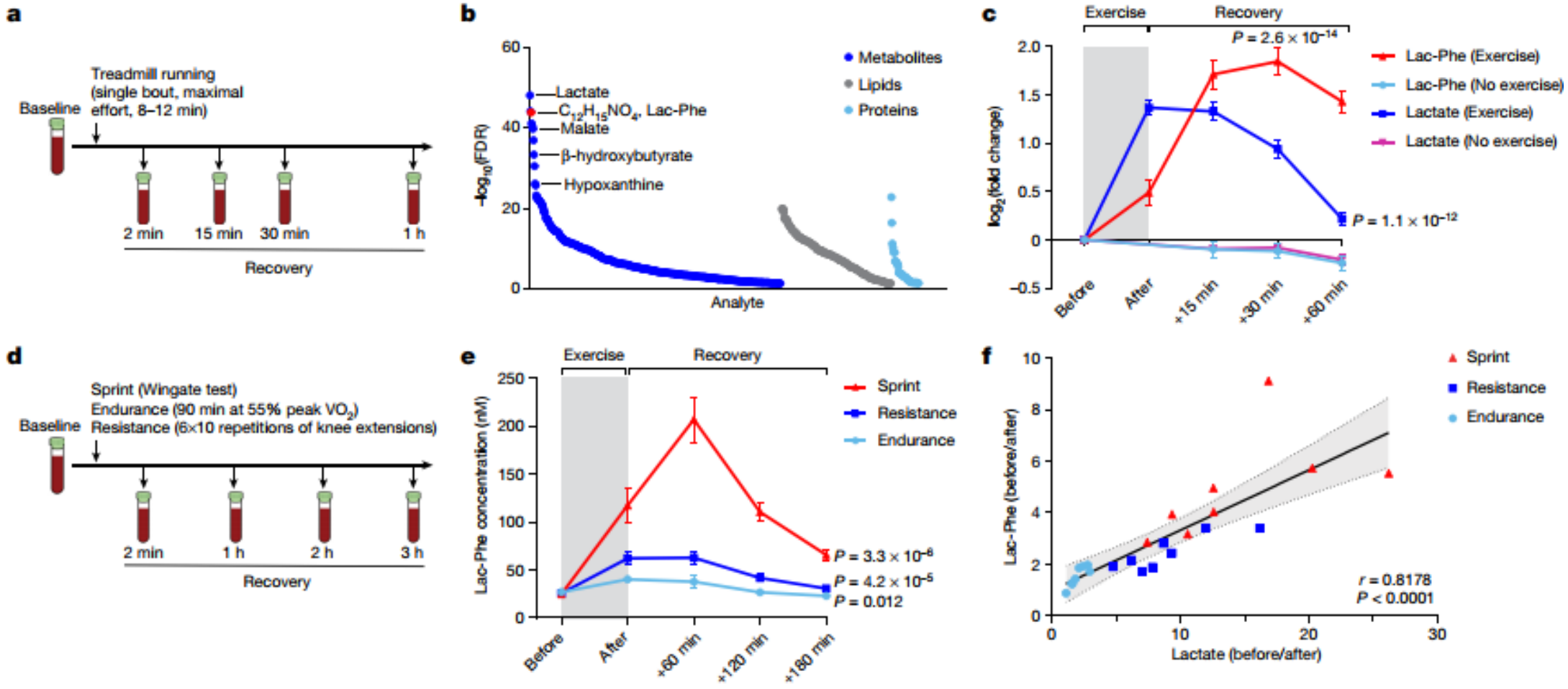
1. Inhibition of Ghrelin Production from Gastric Cells Gh
2. Modulation of Hypothalamic Neuropeptide Expression/Release
3. Inhibition of Ghrelin Signaling in the Hypothalamus



McCarthy SF et al. Am J Physiol Endocrinol Metab 319: E814–E819, 2020

An exercise-inducible metabolite that suppresses feeding and obesity

Sustained increases in Lac-Phe (N-lactoyl-phenylalanine) following human exercise



Li VL et al. Nature. 2022;606:785-790

Appetito e esercizio fisico acuto

(intensità moderata-elevata - tipicamente ≥60% del picco di consumo di ossigeno)
(corsa, ciclismo, nuoto, esercizi di resistenza ed esercizi a intervalli ad alta intensità)

- Riduzione della sensazione di appetito valutata mediante scale visuoanalogiche
- Soppressione delle concentrazioni dell'ormone oressigeno grelina
- Aumento delle concentrazioni degli ormoni di sazietà: peptide YY (PYY) e del GLP-1

Queste risposte di appetito e ormonali:

- ritornano tipicamente ai valori di controllo a riposo nelle ore successive all'esercizio
- non alterano l'apporto energetico lo stesso giorno dell'esercizio

Dorling J. et al. (2018). Nutrients, 10, 1140
Schubert M.M. et al. (2014) Sports Medicine, 44, 387–403.
Schubert M.M. et al.(2013). Appetite, 63, 92–104
Thackray A.E. (2016). Nutrients, 8, 583
Douglas J.A. et al. (2017). International Journal of Obesity, 41, 1737–1744

Appetito e esercizio fisico acuto

(intensità moderata-elevata - tipicamente ≥60% del picco di consumo di ossigeno)
(corsa, ciclismo, nuoto, esercizi di resistenza ed esercizi a intervalli ad alta intensità)

- L'attivazione del sistema di ricompensa centrale dopo esercizio ad alta intensità promuove il desiderio di alimenti a più basso contenuto calorico

- Ruolo del lattato nel mediare la soppressione dell'appetito e dei livelli di grelina

- Diverse molecole (Lac-Phe, Interleuchina-6, GDF15) con effetto anoressizzante (ruolo?)

Crabtree DR et al. Am J Clin Nutr 2014;99:258–67
McCarthy SF et al. Am J Physiol Endocrinol Metab 319: E814–E819, 2020
Li VL et al. Nature. 2022;606:785-790

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SUPPLEMENT ARTICLE

OBESITY Reviews WILEY

Effect of exercise training interventions on energy intake and appetite control in adults with overweight or obesity: A systematic review and meta-analysis

Kristine Beaulieu[1] | John E. Blundell[1] | Marleen A. van Baak[2] | Francesca Battista[3] | Luca Busetto[4,5] | Eliana V. Carraça[6] | Dror Dicker[4,7] | Jorge Encantado[8] | Andrea Ermolao[3] | Nathalie Farpour-Lambert[4,9] | Adriyan Pramono[2] | Euan Woodward[4] | Alice Bellicha[10,11] | Jean-Michel Oppert[12]

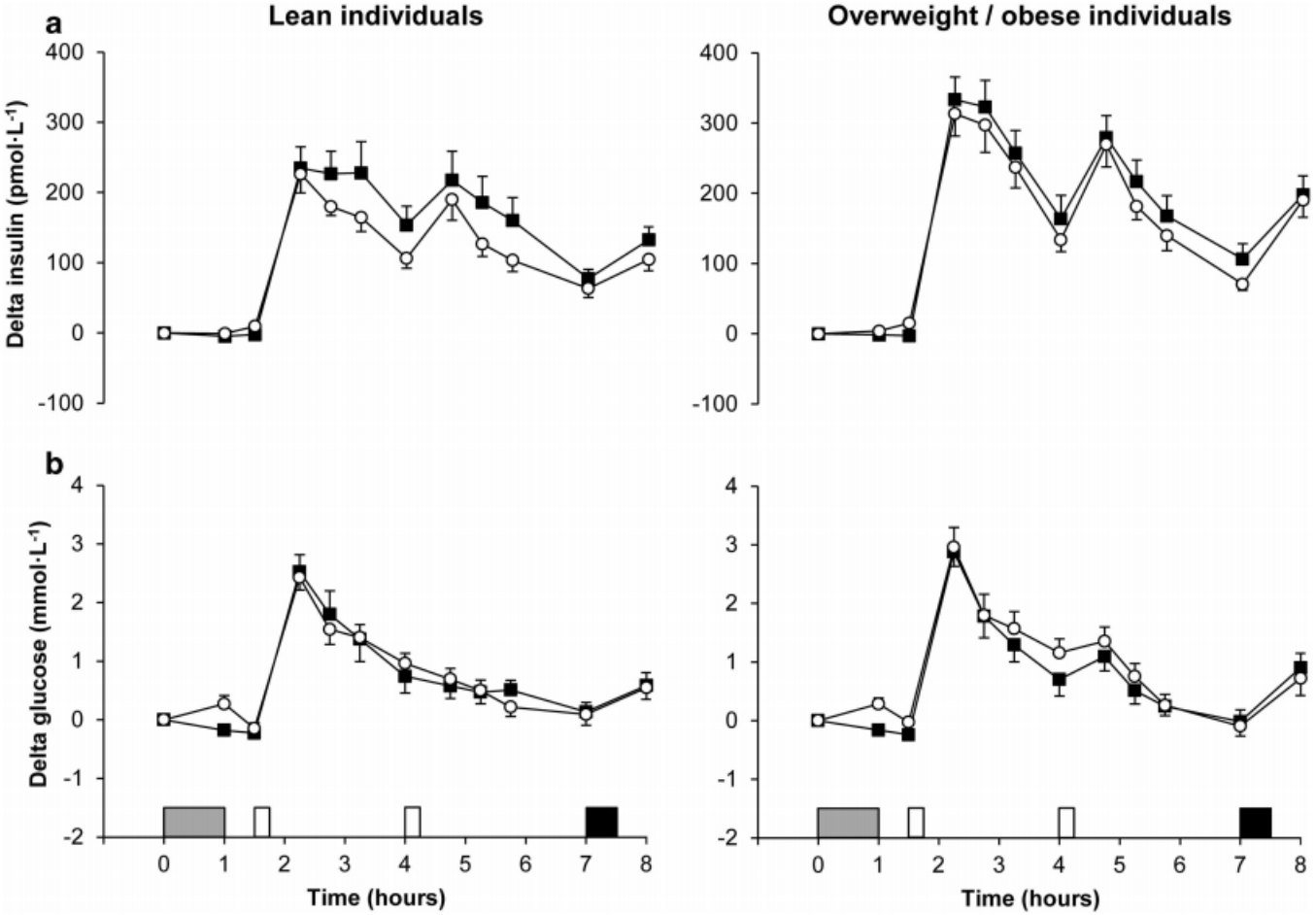
The outcomes of this systematic review with meta-analysis suggest that the imposition of an exercise training regime (median 24 weeks) in people with overweight or obesity does not—on the average—induce any substantial change in food intake or appetite during the period of training.

Grazie per l’attenzione

Plasma concentrations of delta insulin and glucose

Insulin

Glucose



Control trial

Exercise trial

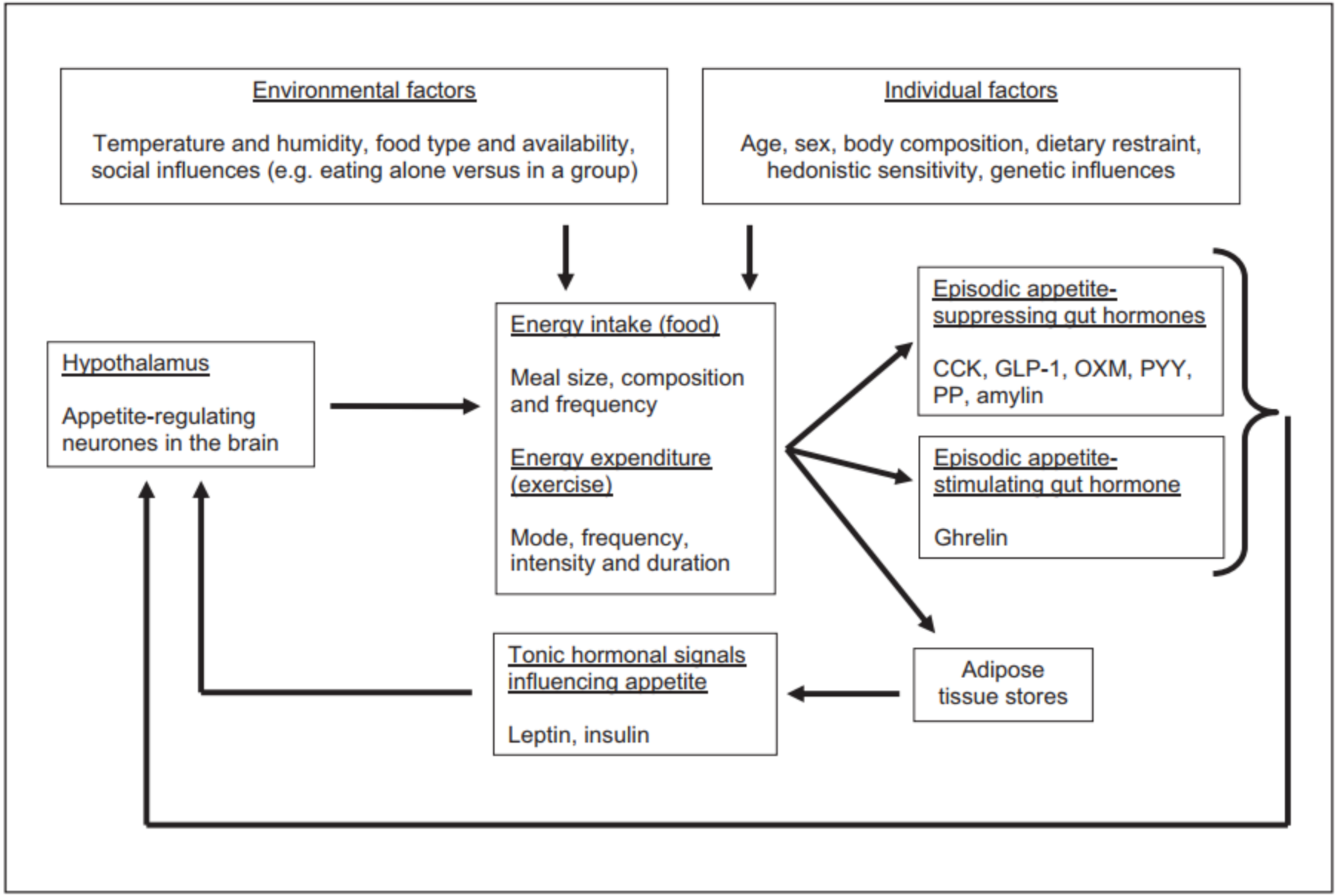
Exercise 60% peak O2

Standardized meals

ad libitum buffet meal

Douglas JA. Int J Obes. 2017; 41: 1737–1744

Major hormonal factors influencing energy balance and their possible interaction with exercise



Stensel D. Ann Nutr Metab 2010;57(suppl 2):36–42