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5th International Whey Conference

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# High-protein diets in weight management; short and long term effects; significance of protein quality

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Photo - JPEG decompressor  
are needed to see this picture.





# High-protein diets in weight management

- ~ **Relatively elevated, yet absolutely sustained protein intake plays a key role in body weight management, since despite a negative energy - balance,**
- ~ **it provides**
  - è **sustained satiety**
  - è **sustained thermogenesis**
  - è **sustained fat free mass at the cost of fat mass**

*Westerterp-Plantenga MS et al., Obes Relat Metab Disord 28:57-64, 2004.*

*Lejeune MPMG et al., Br J Nutr 93: 281-289, 2005.*



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# Absolute or relative 'normal' and 'high' protein diets

## Relative energy % of protein

### Energy balance:

Normal: 10 - 15 % (WHO)

High: 18 - 30% (ref)

### Negative energy-balance:

Normal: 10 - 15 %

High: 47 % (VLED)

### Positive energy-balance after weight-loss: e.g. 8 MJ/d

Normal: 10 - 15 %

High: 18 - 30% (ref)

## Absolute g protein

e.g. 12 MJ/d

1.2 - 1.8 MJ/d = 67 - 100 g/d

2.2 - 3.6 MJ/d = 120 - 200 g/d

e.g. 2 MJ/d

0.2 - 0.3 MJ/d = 11 - 17 g/d

0.9 MJ/d = 52 g/d

0.8 - 1.2 MJ/d = 44 - 67 g/d

1.4 - 2.2 MJ/d = 80 - 120 g/d

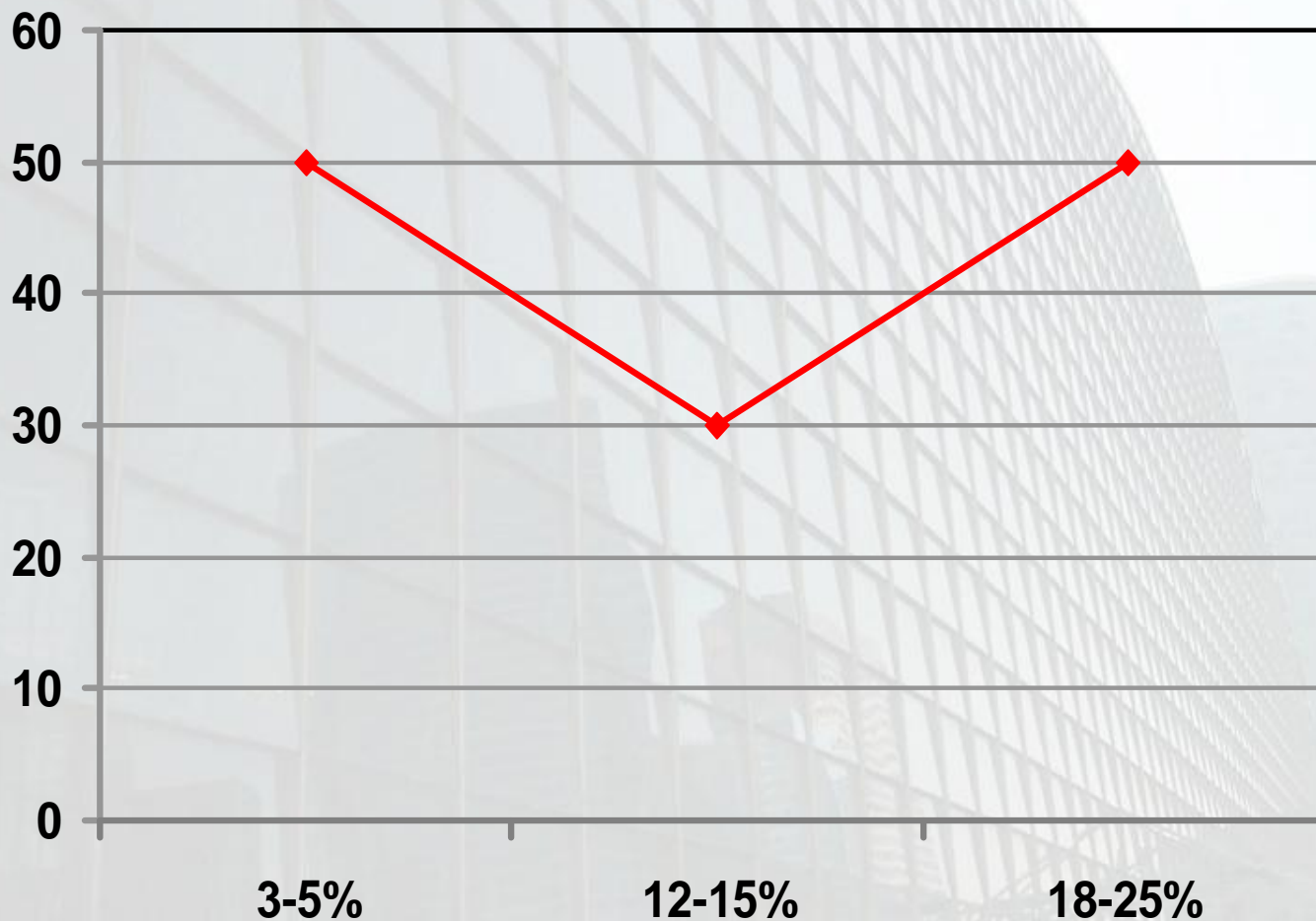


# Energy-efficiency during overfeeding

Stock hypothesis, IJO, 1999

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**MJ EI/  
kg  
weight  
gain**

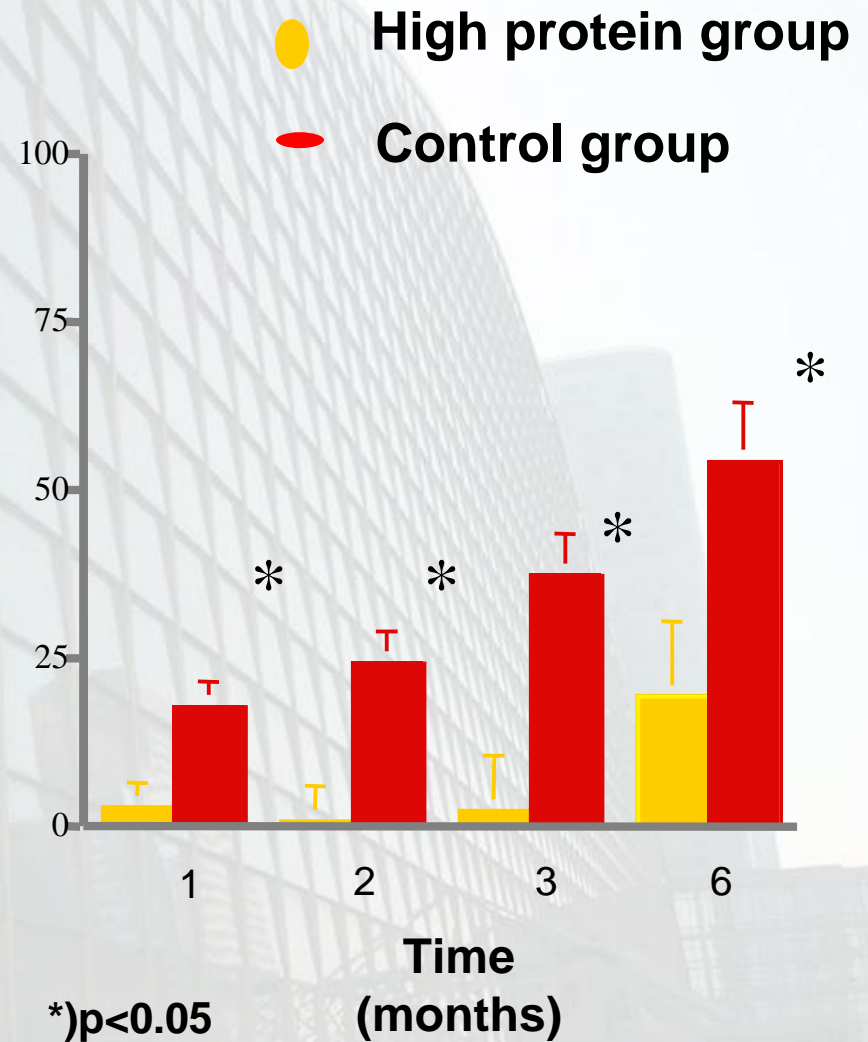
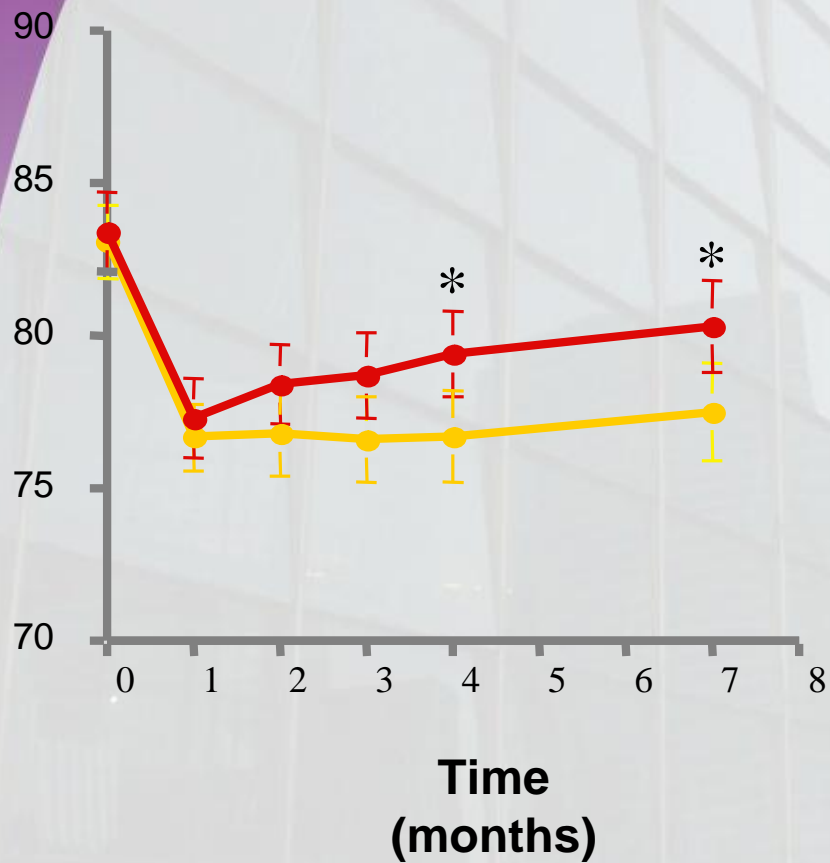




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# Additional protein intake limits weight regain after weight loss in humans

Lejeune et al., Br J Nutr 93,2005



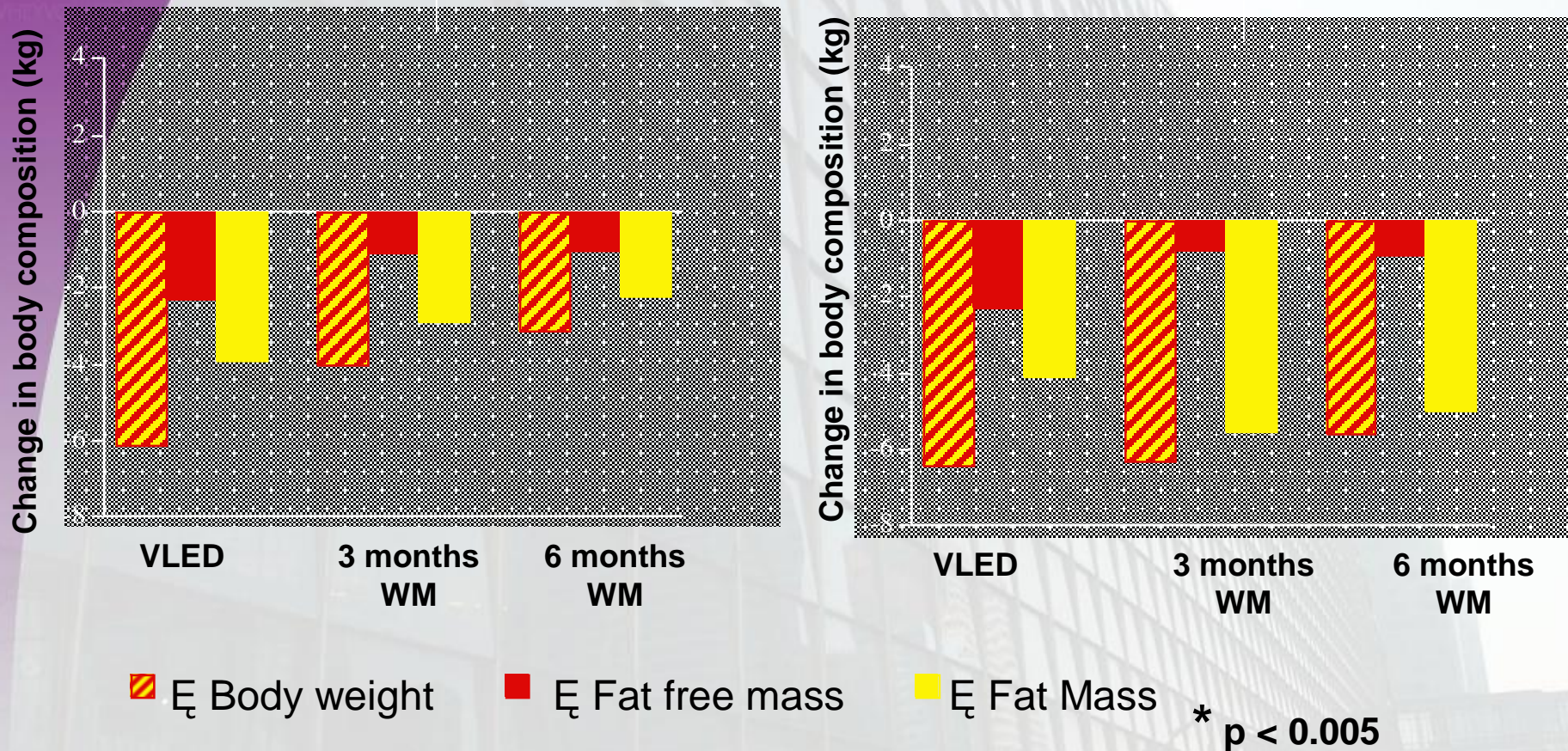
\*)p<0.05

# Additional protein intake limits weight regain after weight loss in humans

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Control group

\* Protein group



## Additional protein intake limits weight regain after weight loss in humans

Lejeune et al., Br J Nutr 93,2005

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### During weight maintenance high protein vs control

|  |       |      |
|--|-------|------|
| Weight regain (kg)                                       | 0.8*  | 3    |
| Waist (cm)   | -1.2* | 0.5  |
| Satiety (mmVAS)  | 13.0* | 1.6  |
| Thermogenesis (MJ/d)                                     | +4.5  | +4.2 |
| Sustained fat free mass<br>at the cost of fat mass (%BF) | -4*   | -1.6 |
| No differences in:                                       |       |      |
| Dietary restraint (F1, TFEQ)                             | +2.2  | +1.8 |
| physical activity;PAL=                                   | 1.6   | 1.6  |



# Protein -induced satiety

## Quantity of protein

C/P/F 60/30/10 vs 30/10/60 En %

*Westerterp-Plantenga et al., EJCN, 1999*

C/P/F 40/30/30 vs 60/10/30 En %

*Lejeune et al., AJCN, 2006*

## Type of protein

C/P/F 55/25/20 vs 55/10/35 En %

P = casein, whey, soy, alpha-lac, gelatin.

*Veldhorst et al., in press; submitted*

*Nieuwenhuizen et al., submitted*





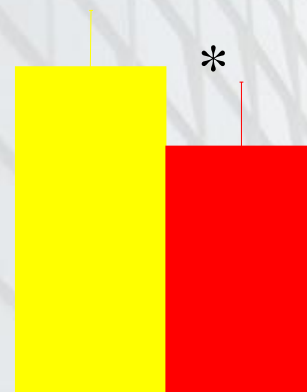
# High vs normal protein diet in women, in EB



C/P/F 60/30/10 vs 30/10/60 En %  
Westerterp-Plantenga et al., 1999  
C/P/F 40/30/30 vs 60/10/30 En %  
Lejeune et al., 2006



Hunger



Satiety



Satiety and DIT:  
R=0.6; p<0.05

NP

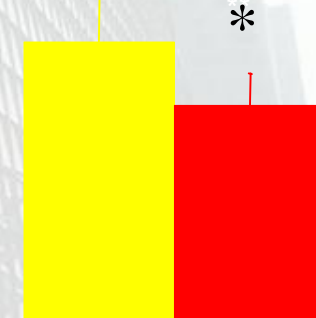
HP

\*0 p<0.01

DIT



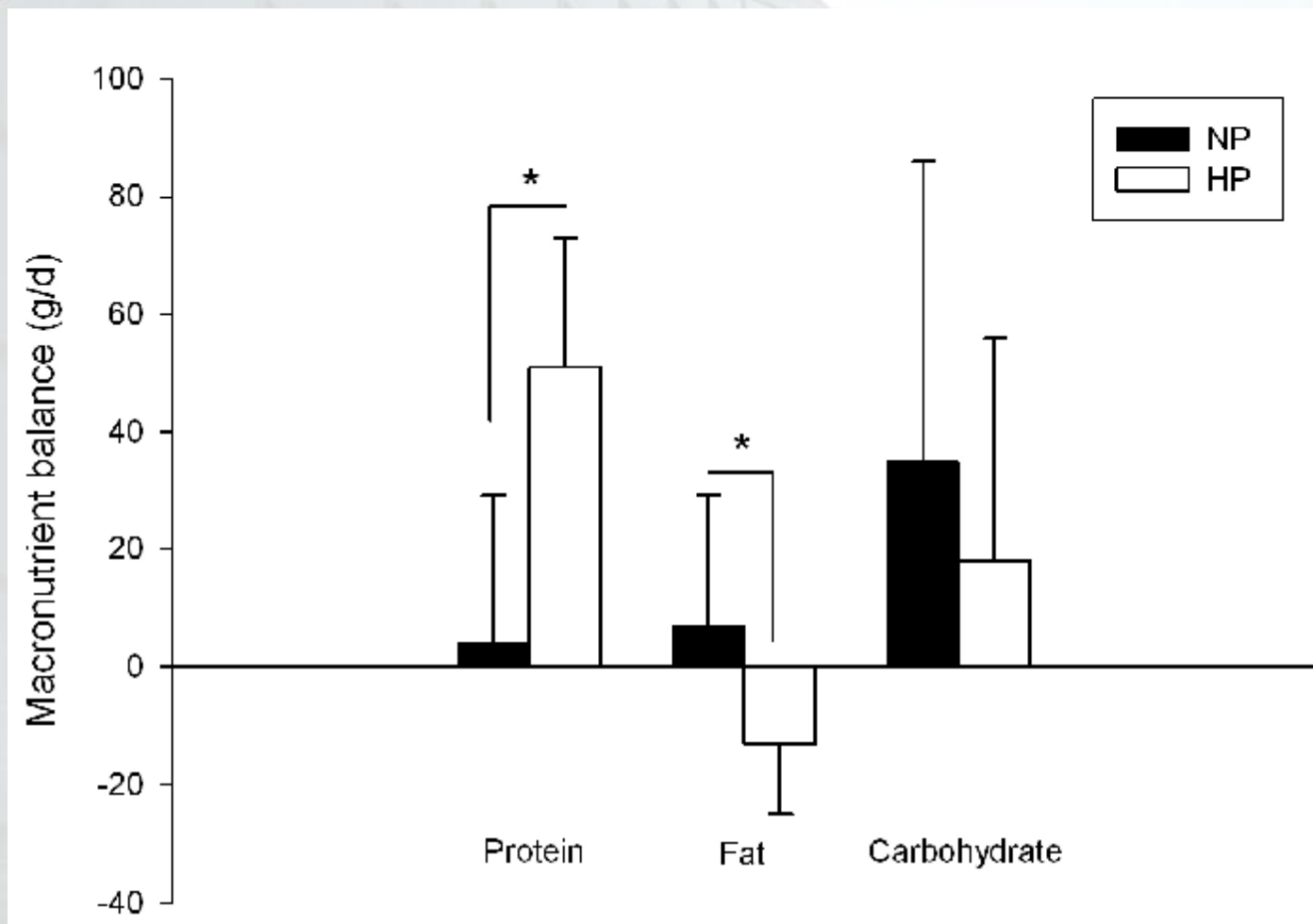
RQ





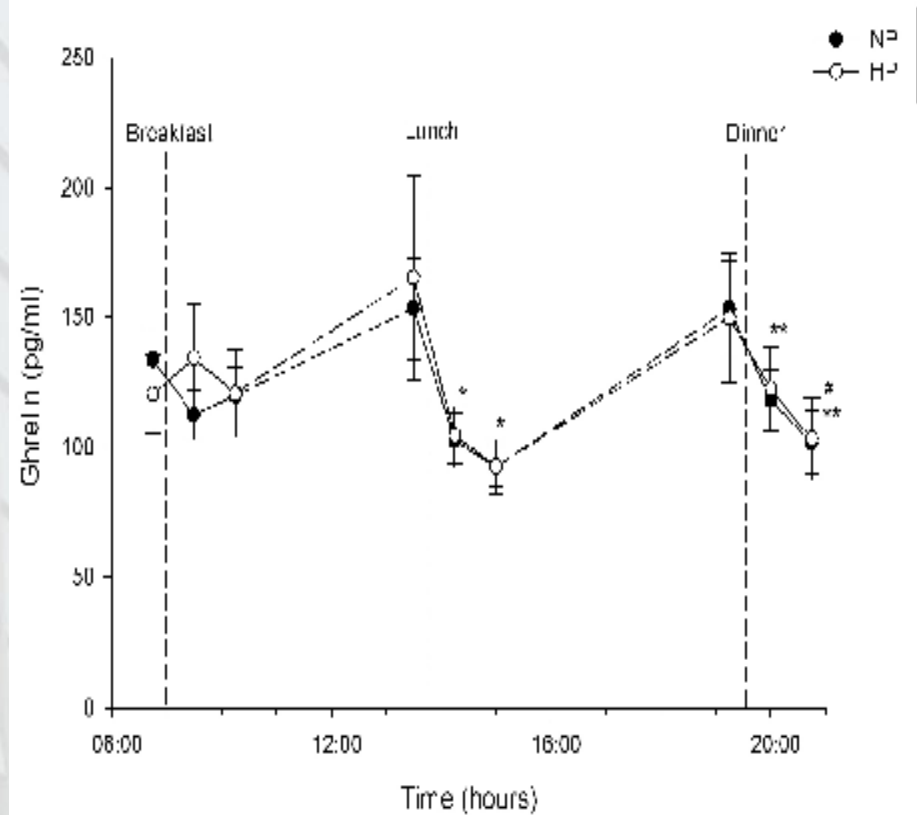
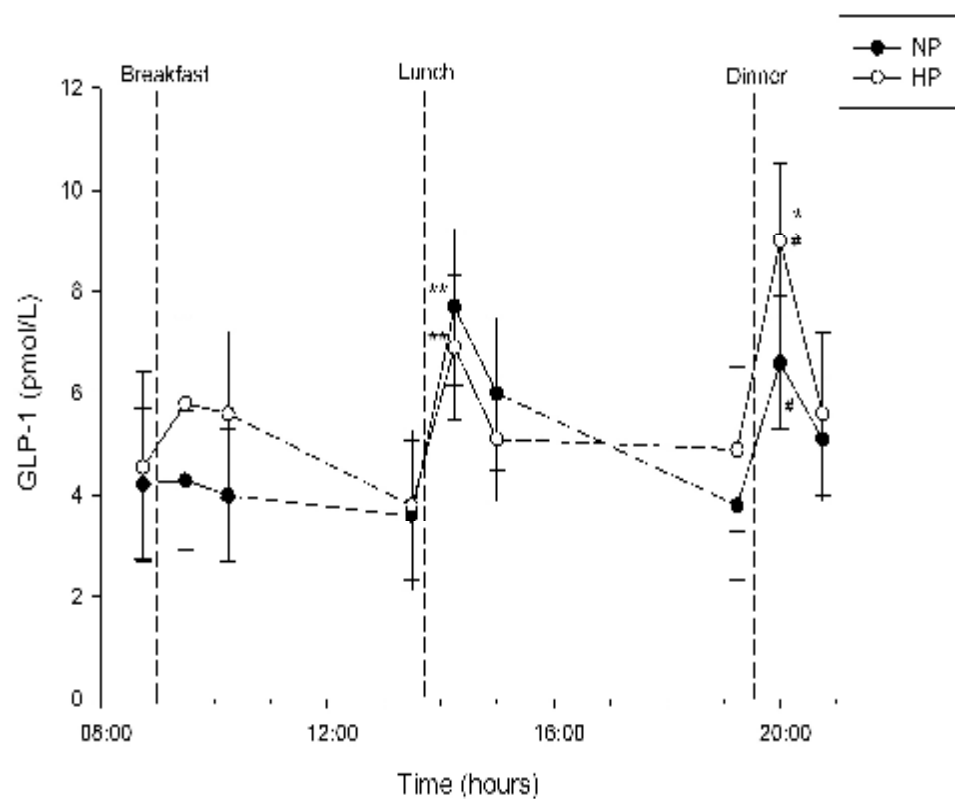
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# Macronutrient-balances



**HP vs NP** *Lejeune et al., AJCN, 2006*

# Satiety'- and 'orexigenic' hormones



#)p<0.05, treatment over time

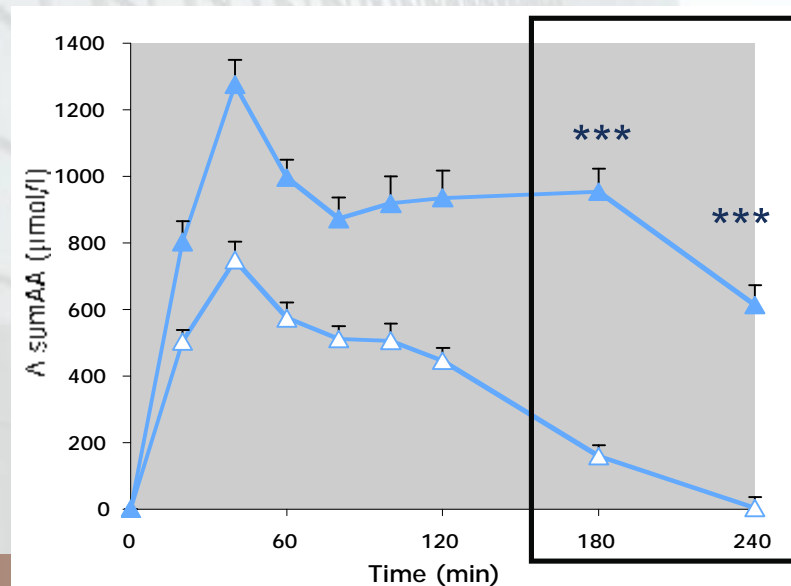
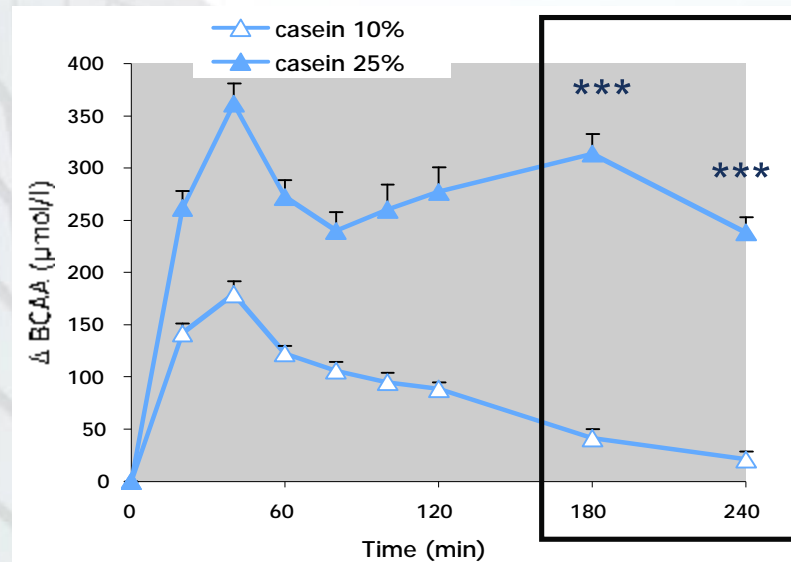
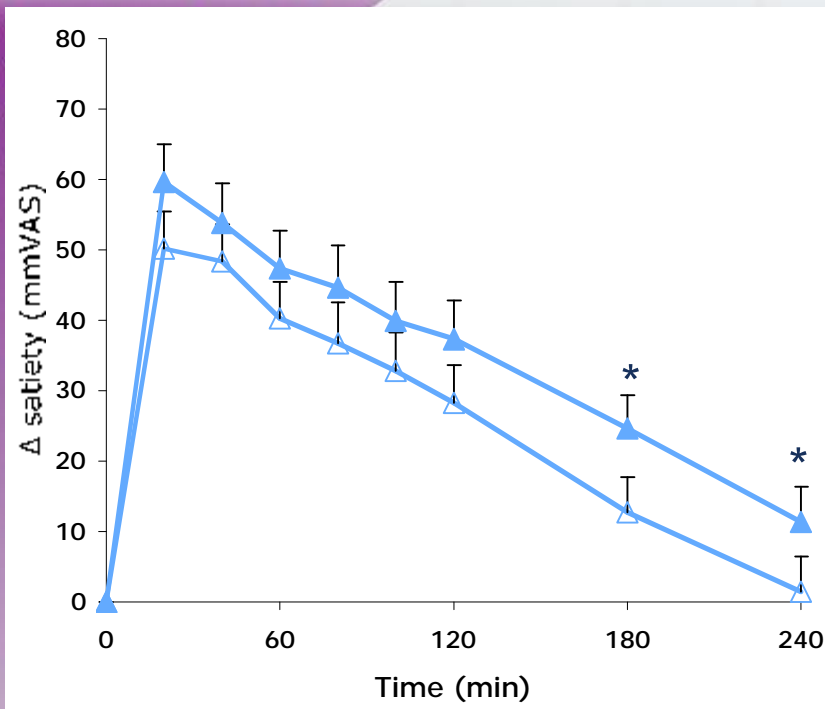
no treatment over time effect

HP vs NP

*Lejeune et al., AJCN, 2006*



# 25% vs. 10% casein



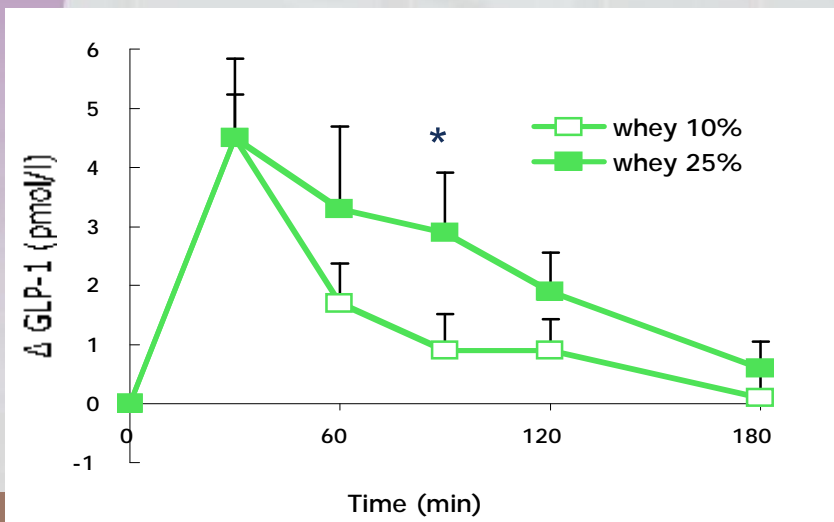
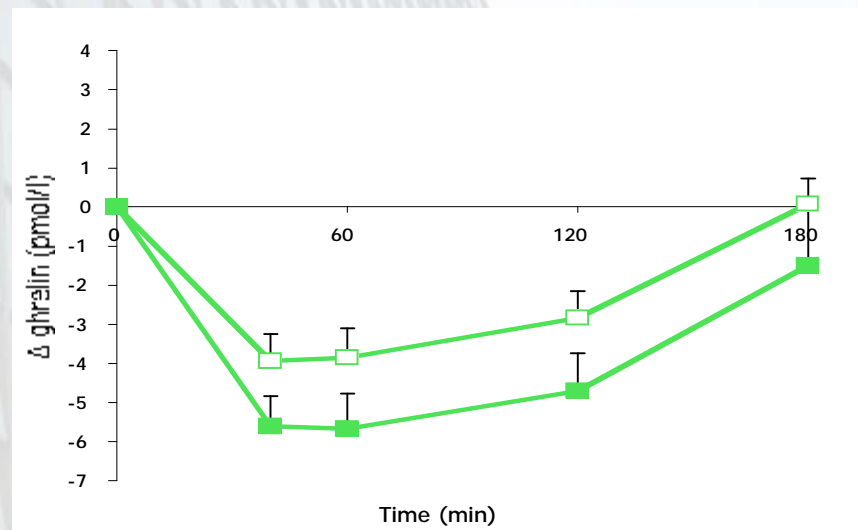
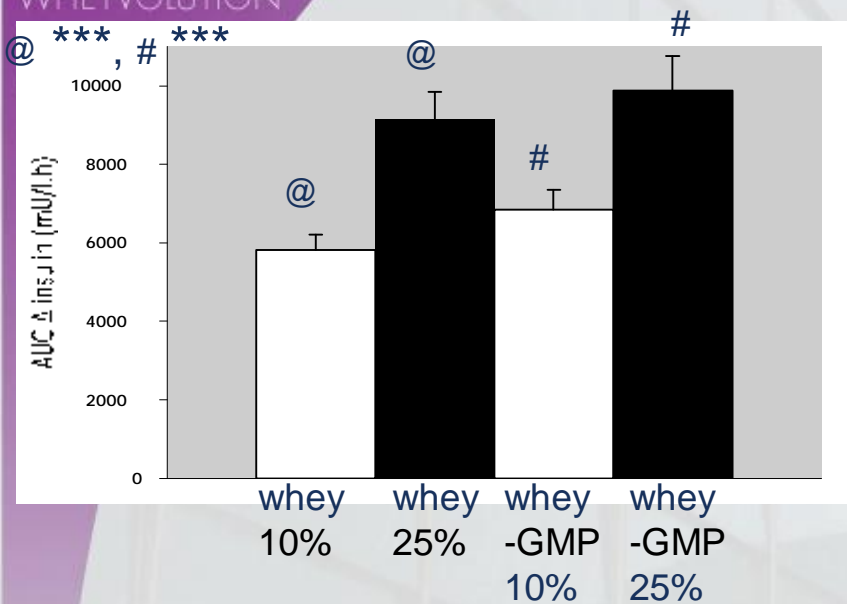
Increased satiety coincided with elevated BCAA and sum AA

\*p<0.05, \*\*\*p<0.001



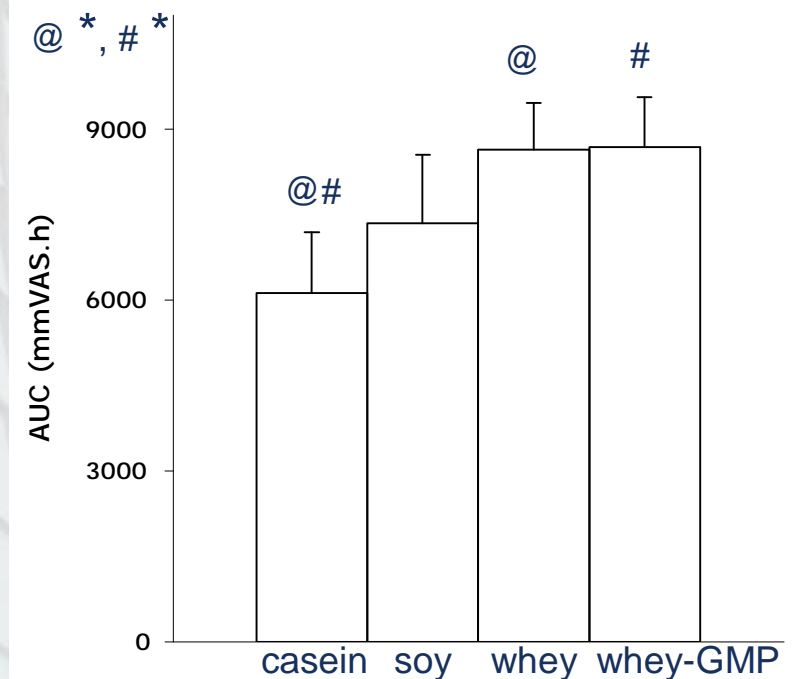
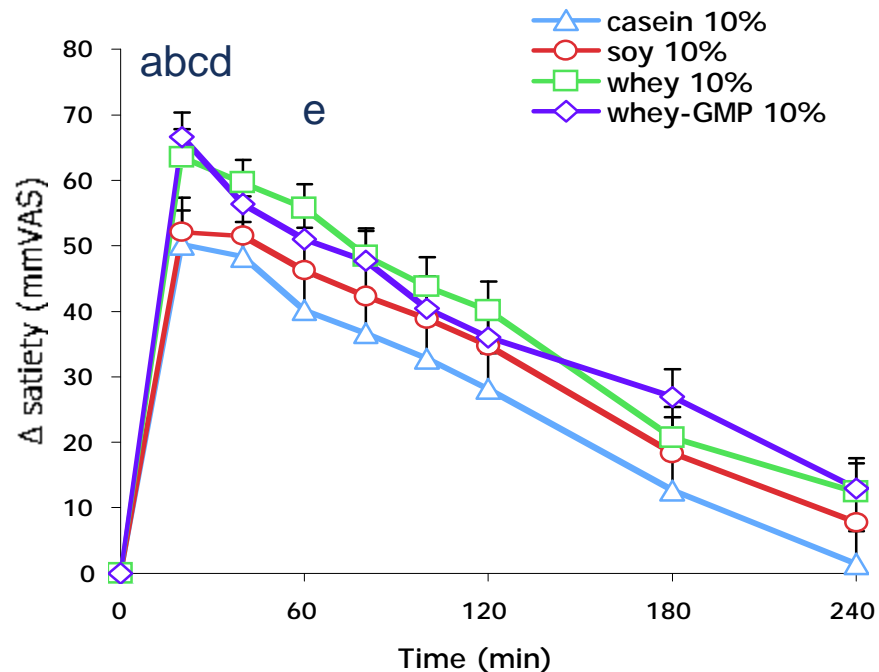
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# 25% vs. 10% whey



\*p<0.05, \*\*p<0.01, \*\*\*p<0.001

# 10% casein, soy, whey

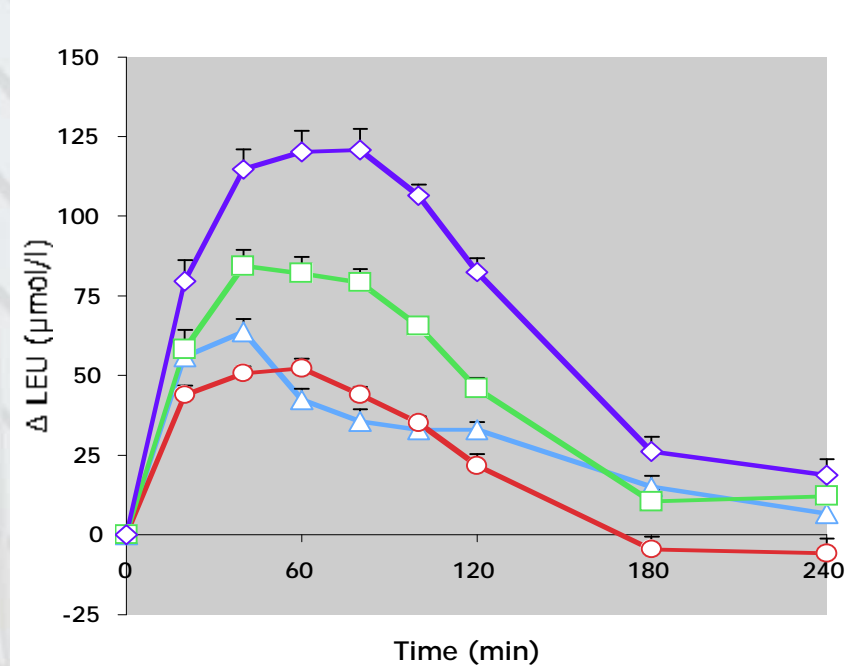
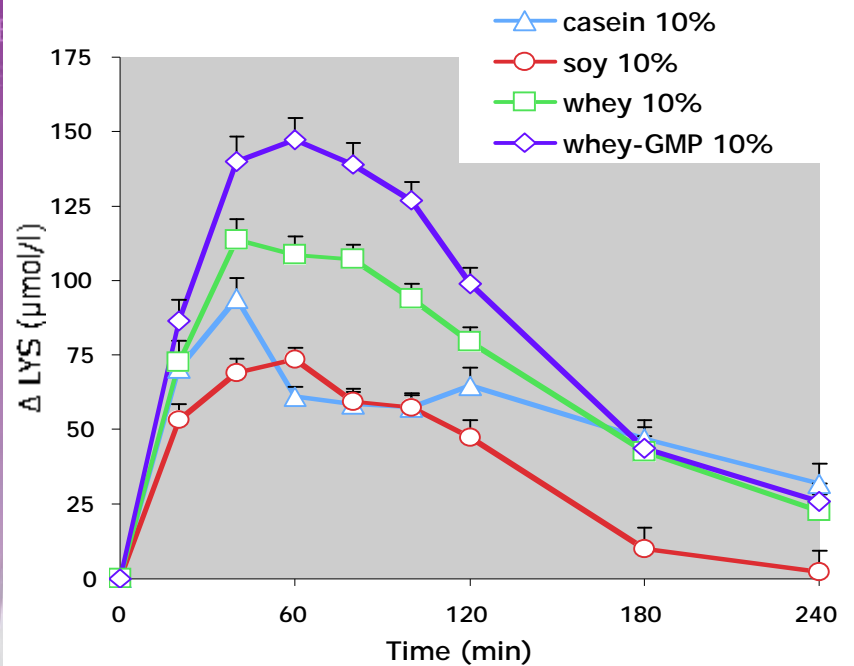


- a whey-casein \*
- b whey-casein \*\*
- c whey-soy \*
- e whey-casein \*\*

\*p<0.05, \*\*p<0.01



# Lysine and leucine responses after casein, soy, whey

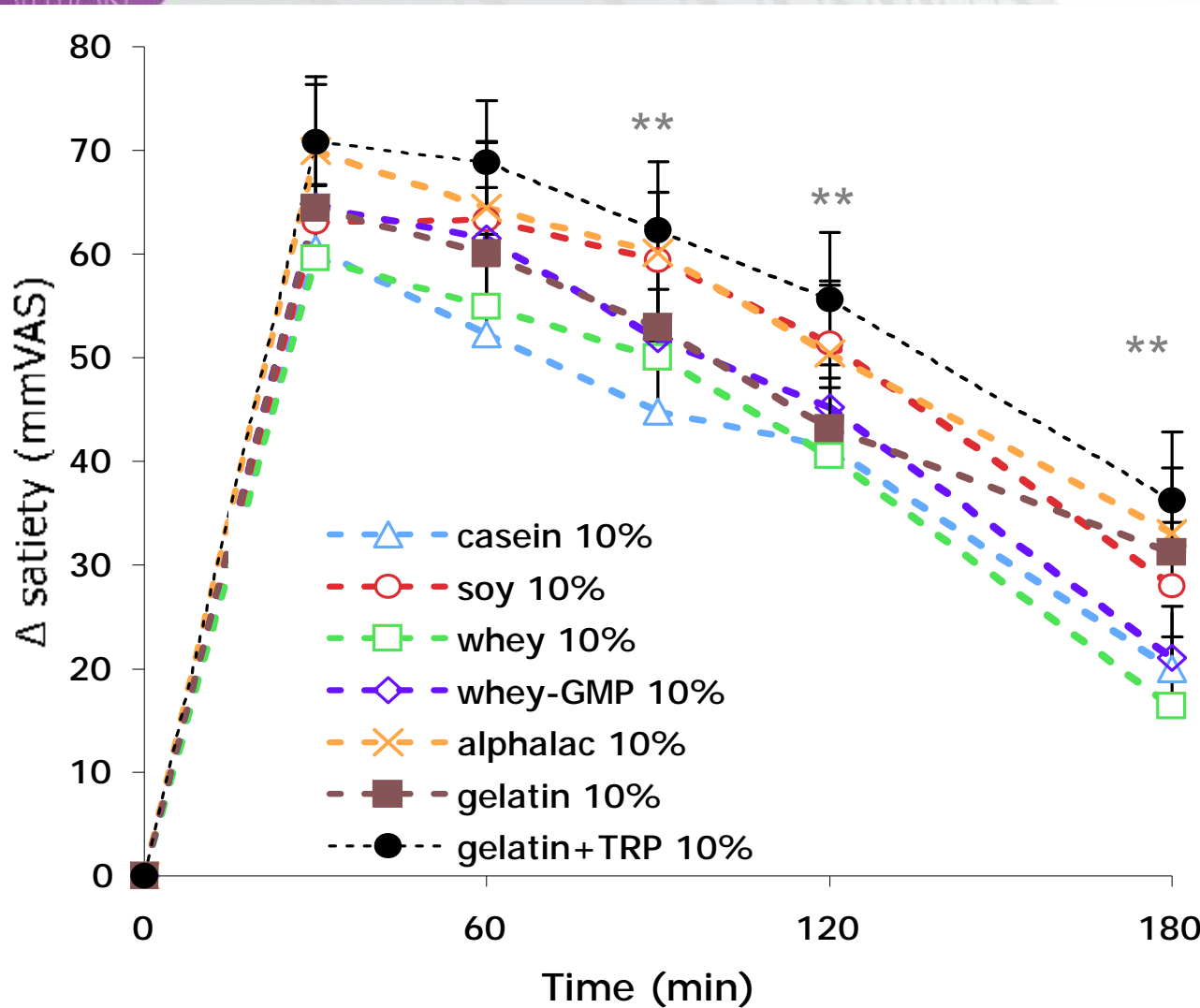


**Responses after whey are increased vs. casein/soy:  
AUC + various time points  $p < 0.001$   
Increased satiety after whey 10% vs. casein or soy, coincided with increased lysine and leucine responses**



# Satiety (10%)

Magnitude of differences  
30-50%

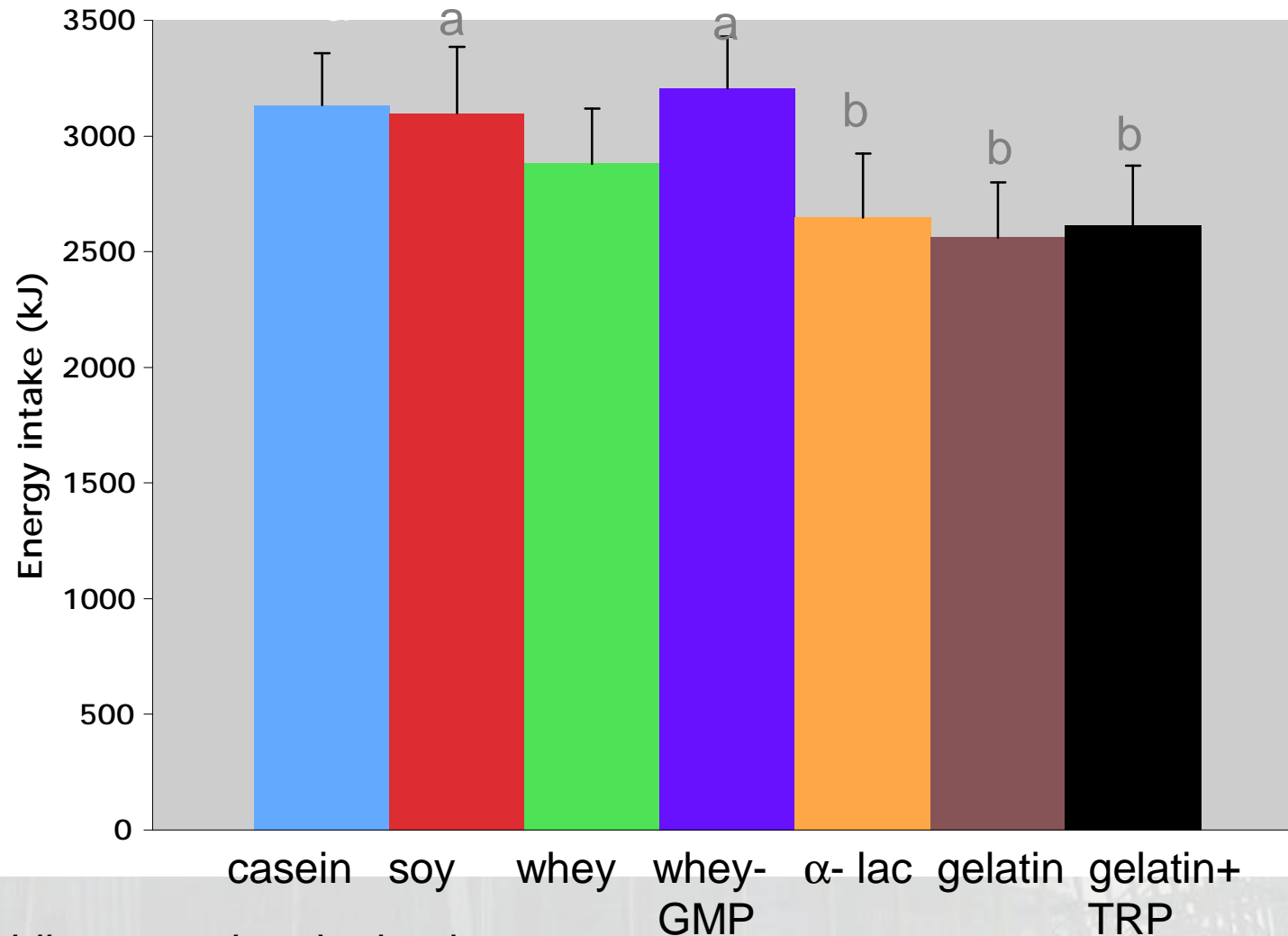






# Energy intake (10%)

a different from b,  $p < 0.01$

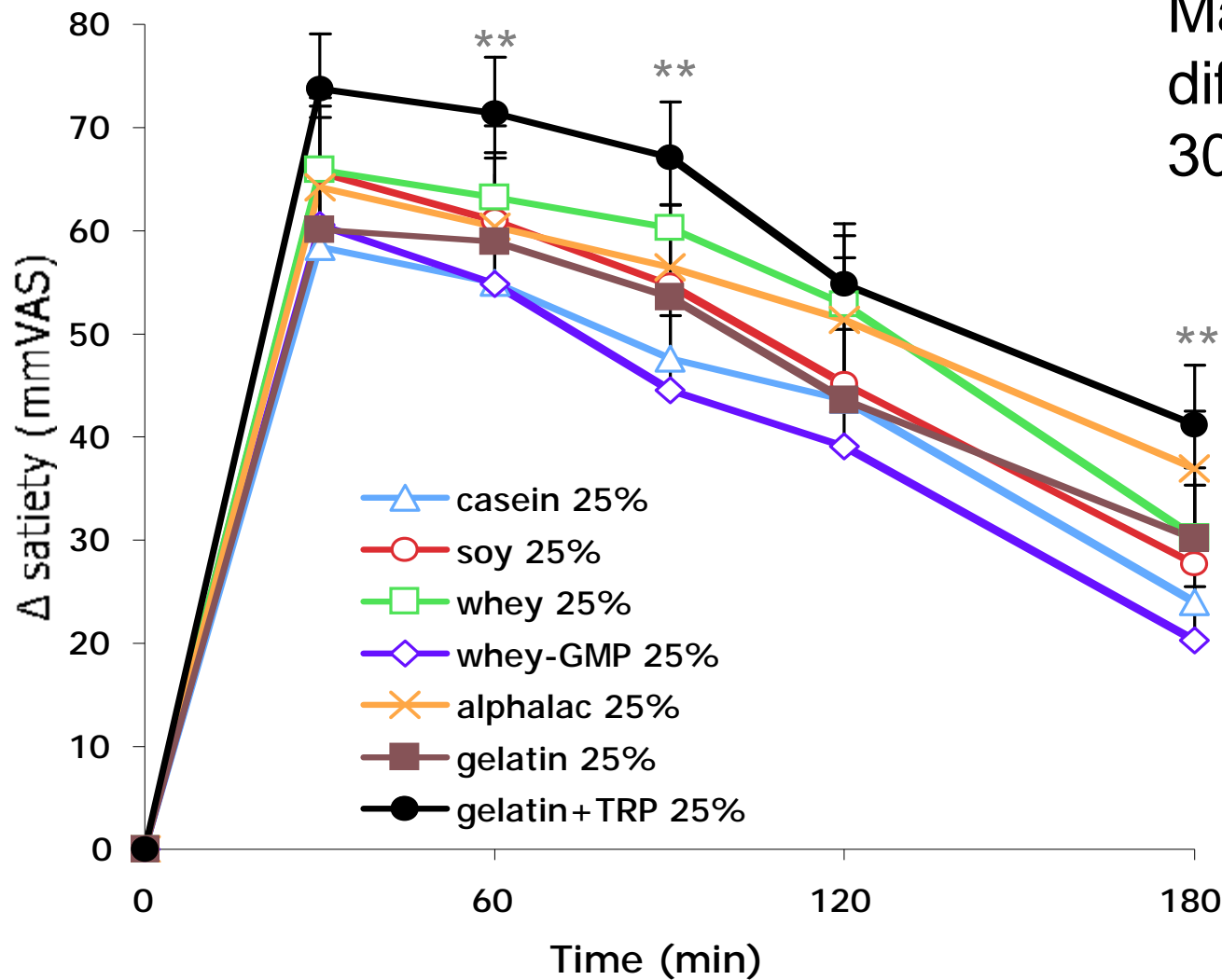


Magnitude of  
differences  
~17%



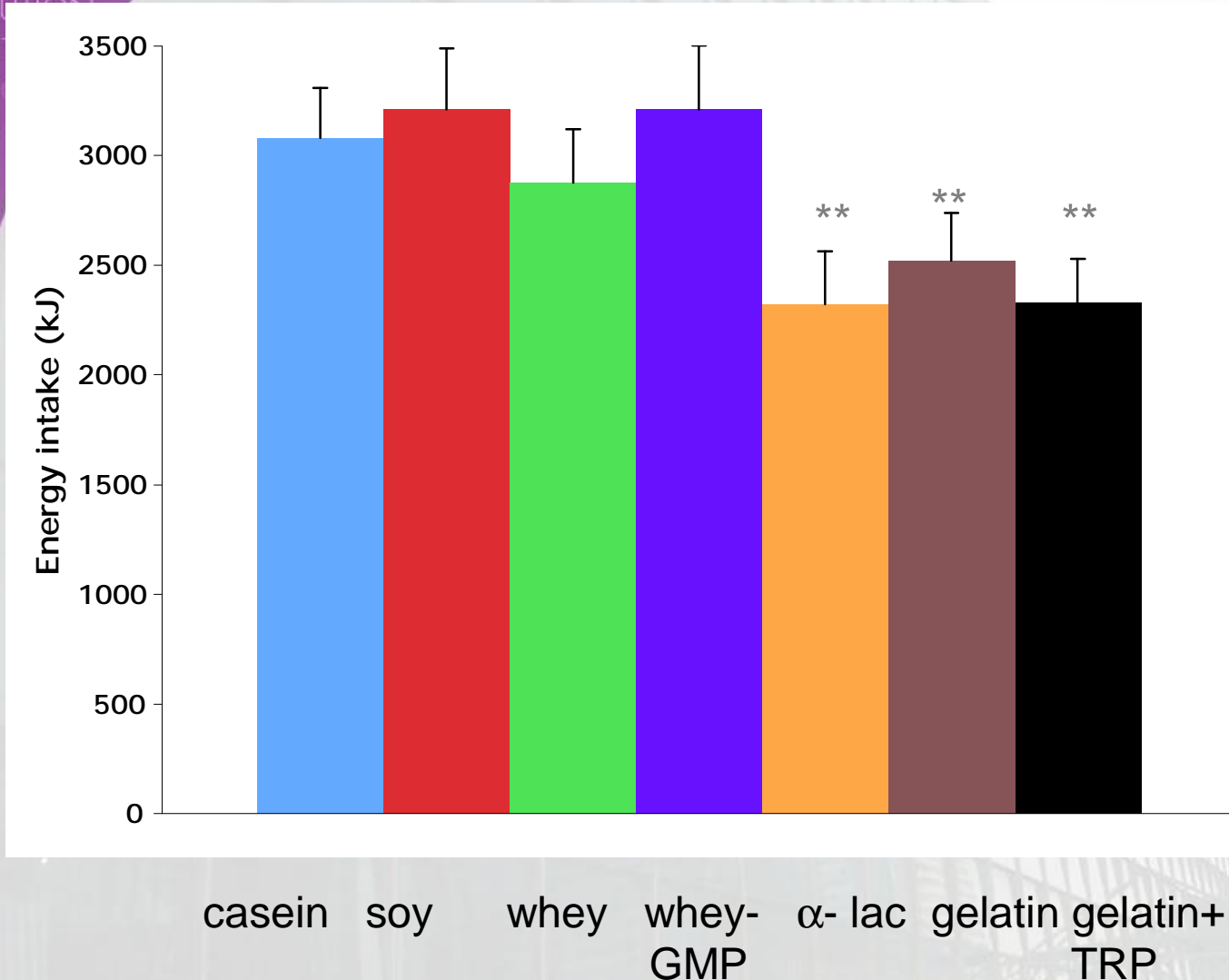
# Satiety (25%)

Magnitude of differences  
30-50%





# Energy intake (10%)



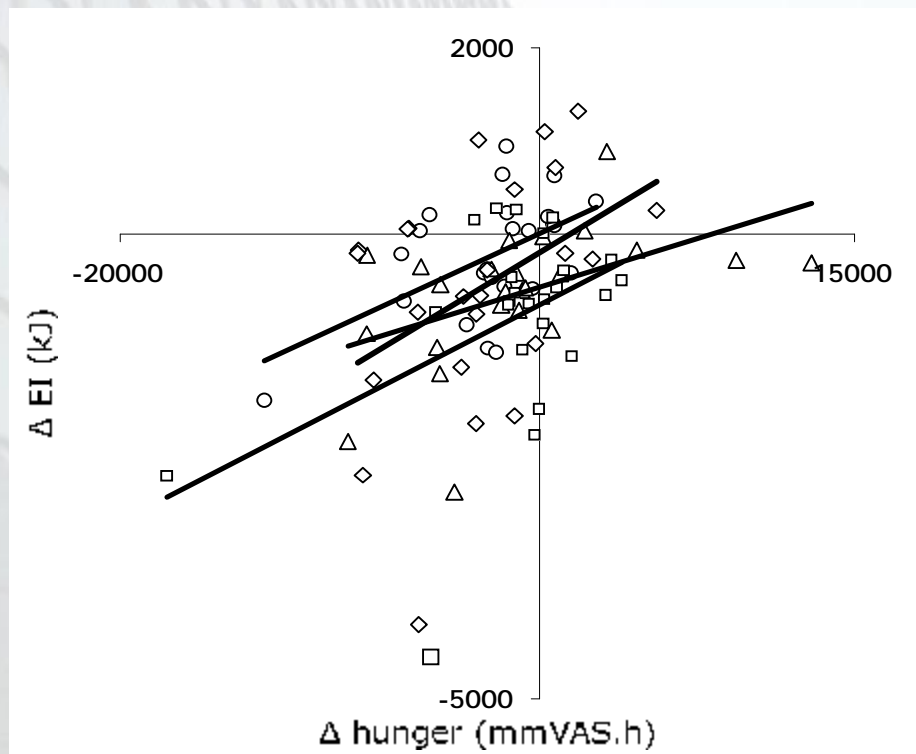
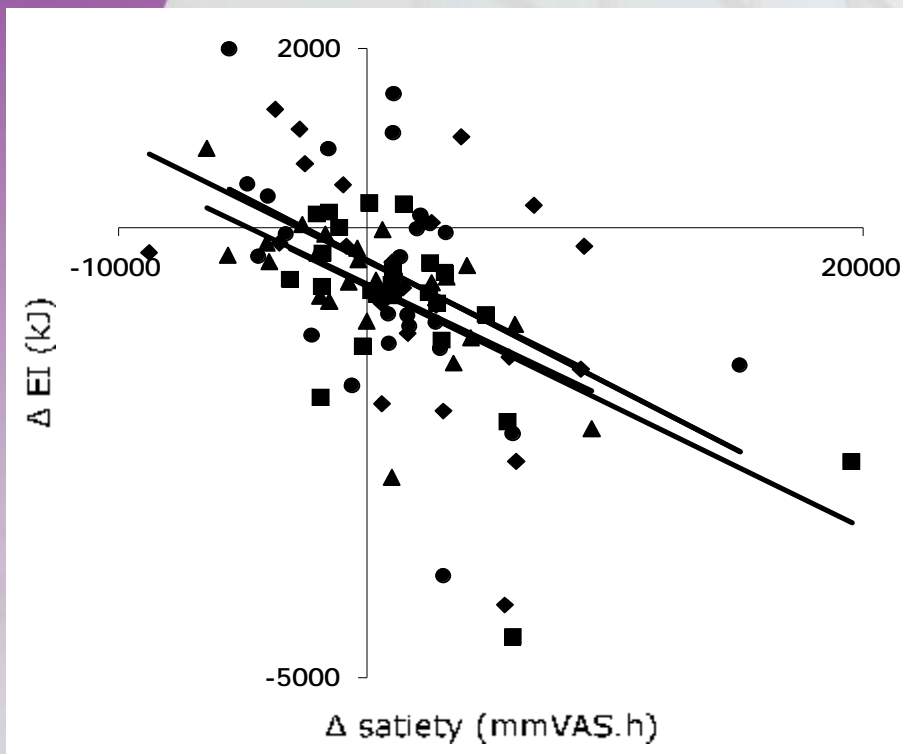
\*\* )  $p < 0.01$

Magnitude of differences  
~19-24%



# Difference in EI is related to difference in satiety and/or hunger

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$R^2 = 0.4, p < 0.01$

Veldhorst  
et al., submitted



## Conclusion

- ~ Alpha-lactalbumin, gelatin, and gelatin+TRP are (30-50%) more satiating than casein, soy, whey, and whey-GMP
- and
- ~ induce a related reduction (~20%) of subsequent energy intake.



## *High protein-intake induced*

- ~ weight maintenance after weight loss is due to satiety, thermogenesis and sparing fat free mass.
- ~ satiety is due to thermogenesis, and 'satiety hormone' concentrations.
- ~ satiety by different proteins coincides with specific amino acid concentrations.
- ~ satiety results in a lower subsequent energy intake after incomplete vs complete proteins.

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