VU UNIVERSITY AMSTERDAM

move research institute amsterdam

Science & Cycling
1 & 2 Juli 2015, Utrecht

TNO innovation for life

Heat balance in mountain cycling - effects of heat acclimation

Prof. Dr. Hein Daanen

Outline

- Background
- Heat balance
- Heat balance in mountain cycling
- Performance in the heat
- How to reduce performance loss in the heat
    - Selection
    - Heat acclimation
    - (pre)cooling
    - Pacing

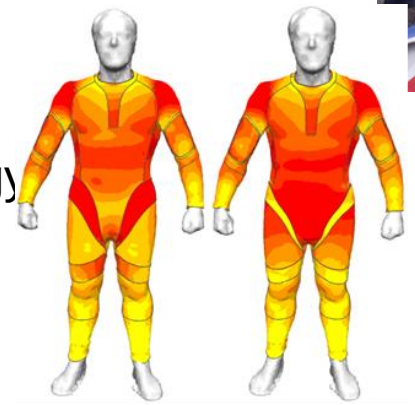
Background

Specialized in thermal physiology and 3D anthropometry

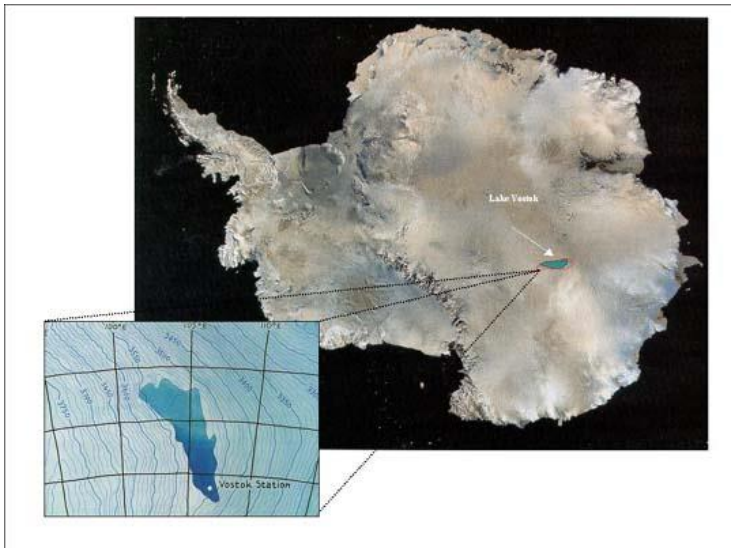
TNO: Applied Scientific Research

Thermal Physiology –VU University

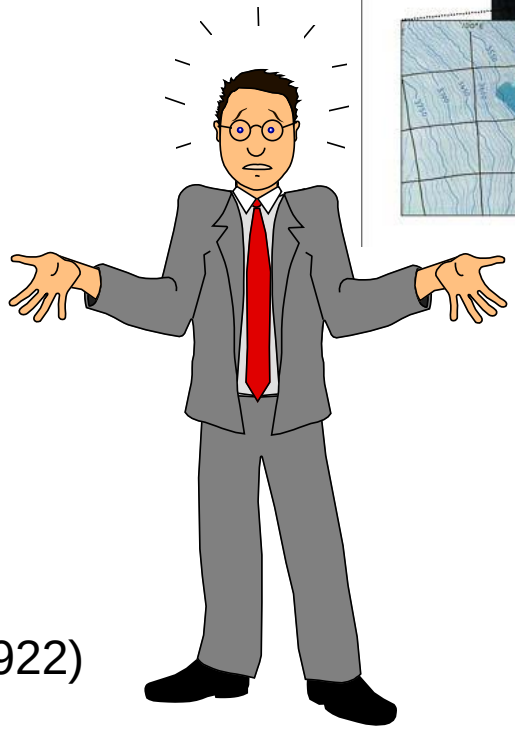
Fashion Research & Technology – Amsterdam University of Applied Sciences



Human surroundings



57.8°C (September 1922)



-89.5°C (July 1983)

Mechanisms to cope with thermal extremes

Heat: **vasodilation**

sweat loss (max. 2500 W)

Cold: **vasoconstriction**

shivering (max. 400 W)

fur coat

brown fat

Heat balance

M ± R ± C - E = S:

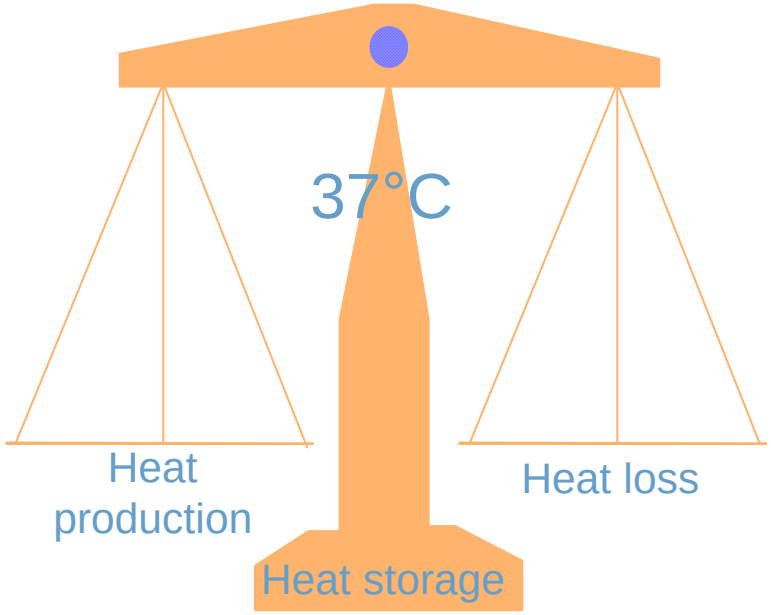
M: Metabolism

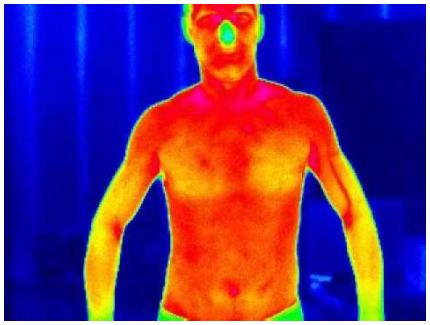
R: Radiation

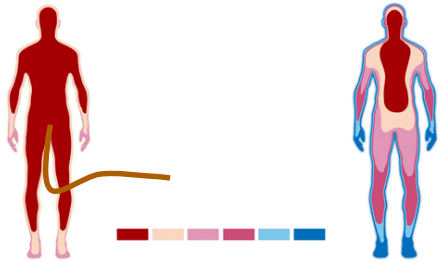
C: Convection/Conduction

E: Evaporation

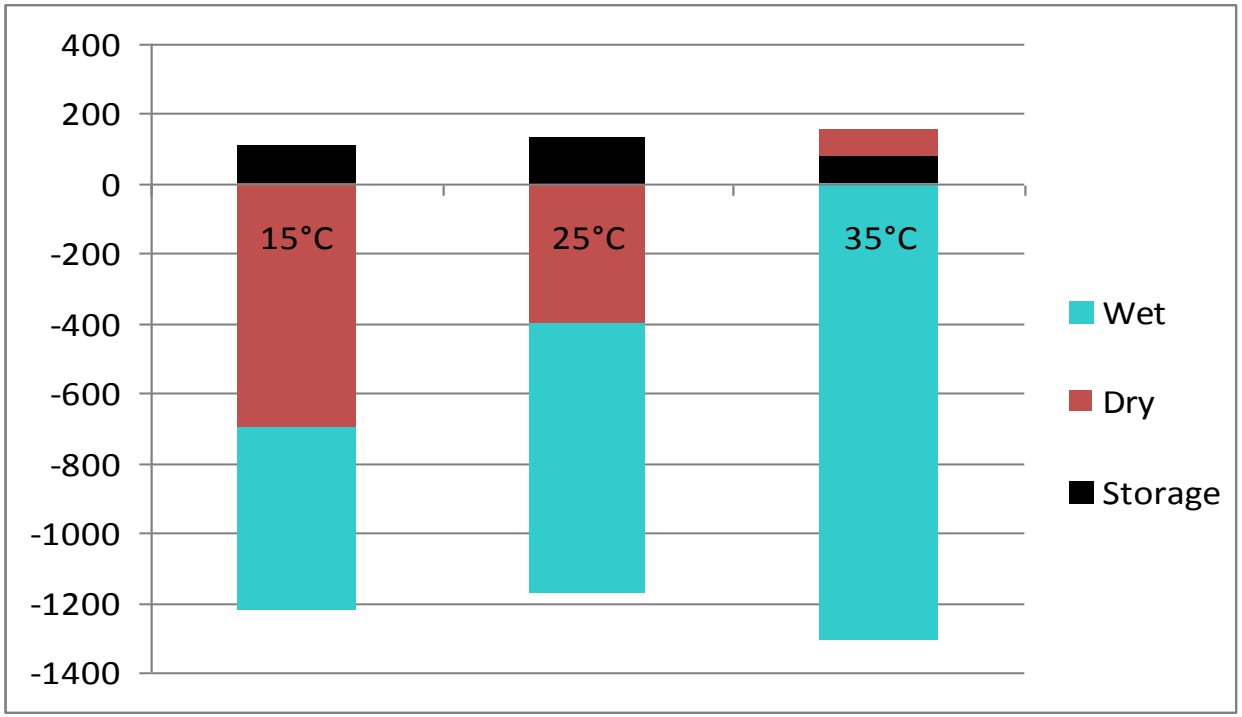
S: Storage





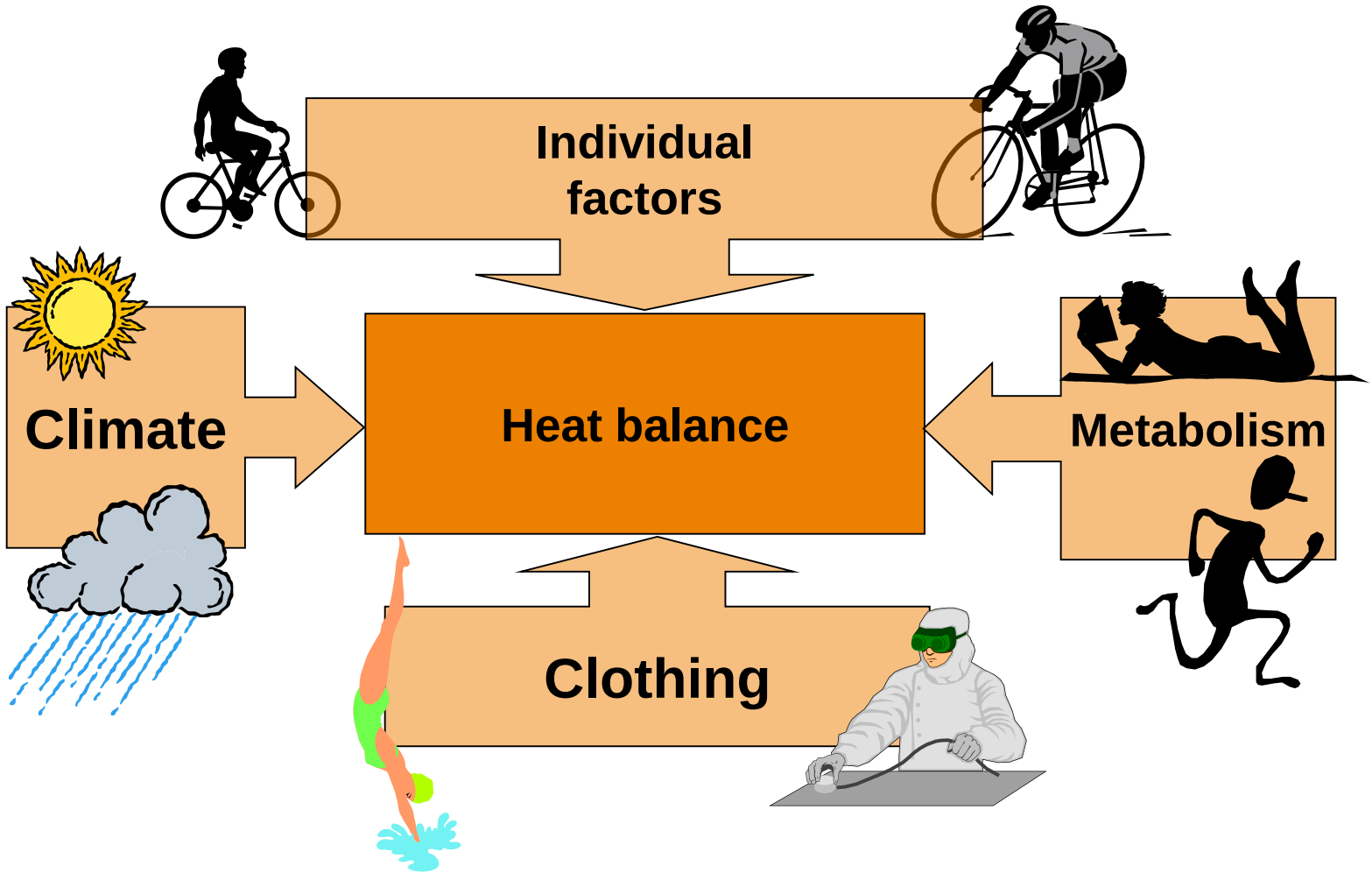


Thermal Balance during exercise – 8 km run

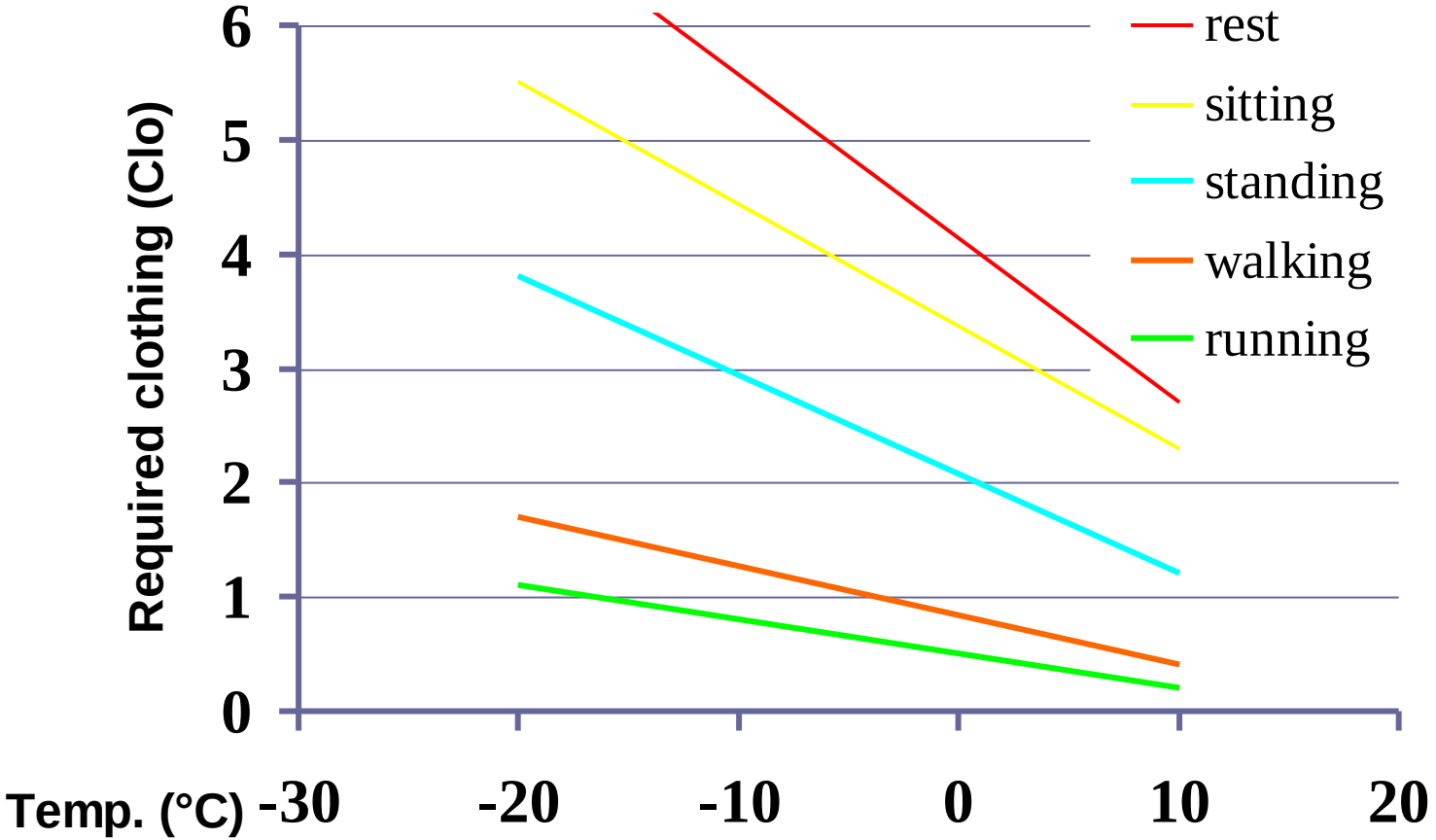


(Marino et al., EJAP, 2000)

Heat balance factors



Required clothing for thermal neutrality



Heat balance in cycling

Mountain 1600 m high

Energy: m*g*h= 1440 kJ

Time: 2 hours

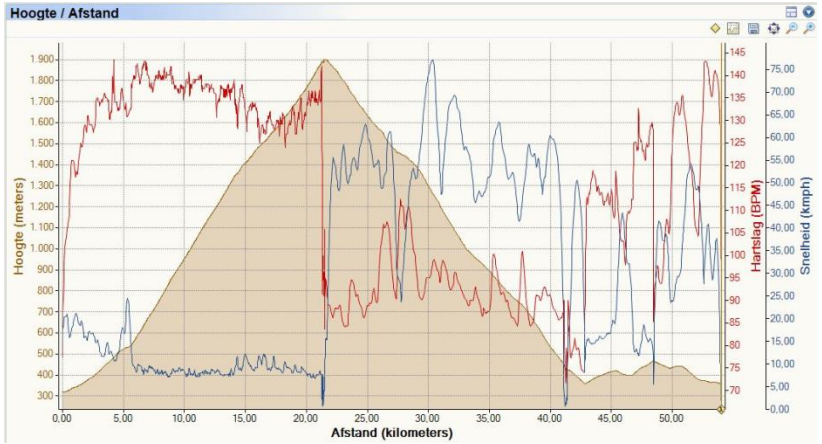
Power: 200 W

Efficiency: 20%

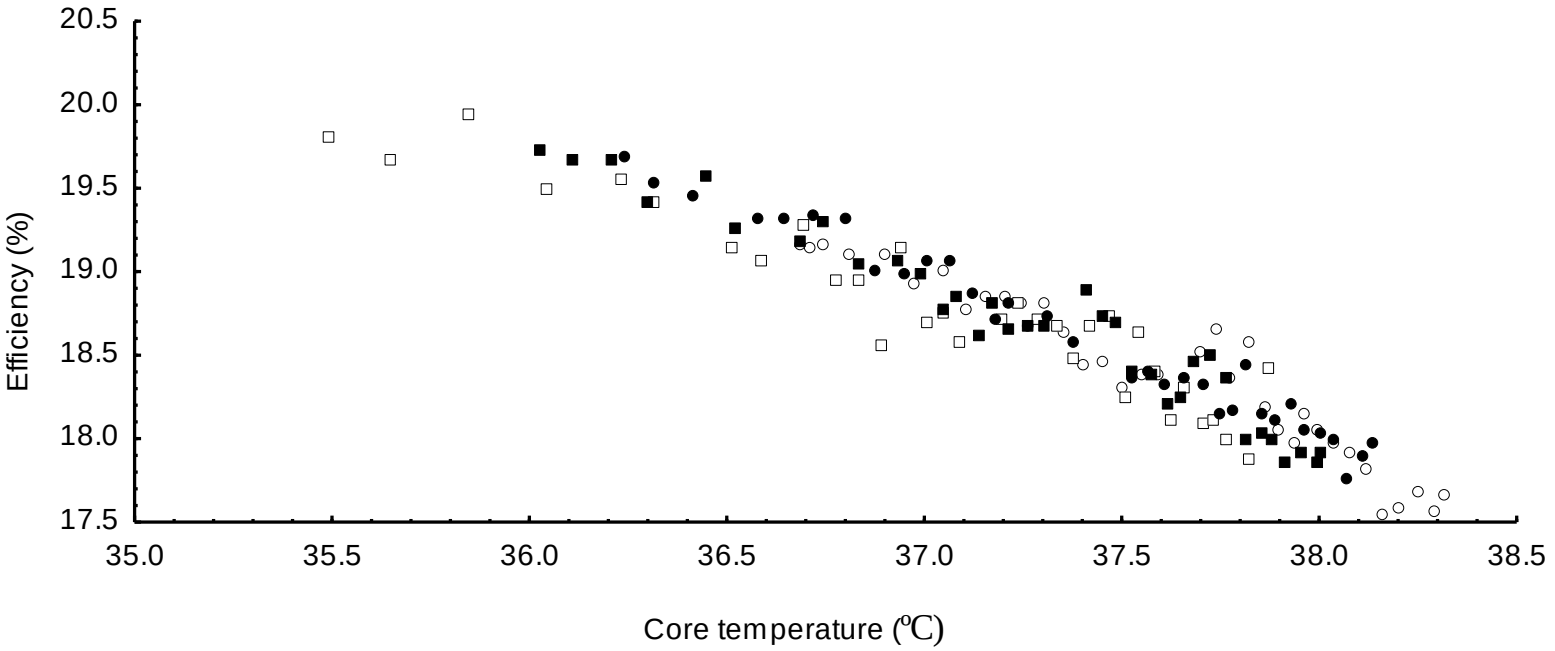
Heat loss: 800 W

Ambient temp: 35°C

Sweat needed: 2.4 l



Performance decrease in the heat

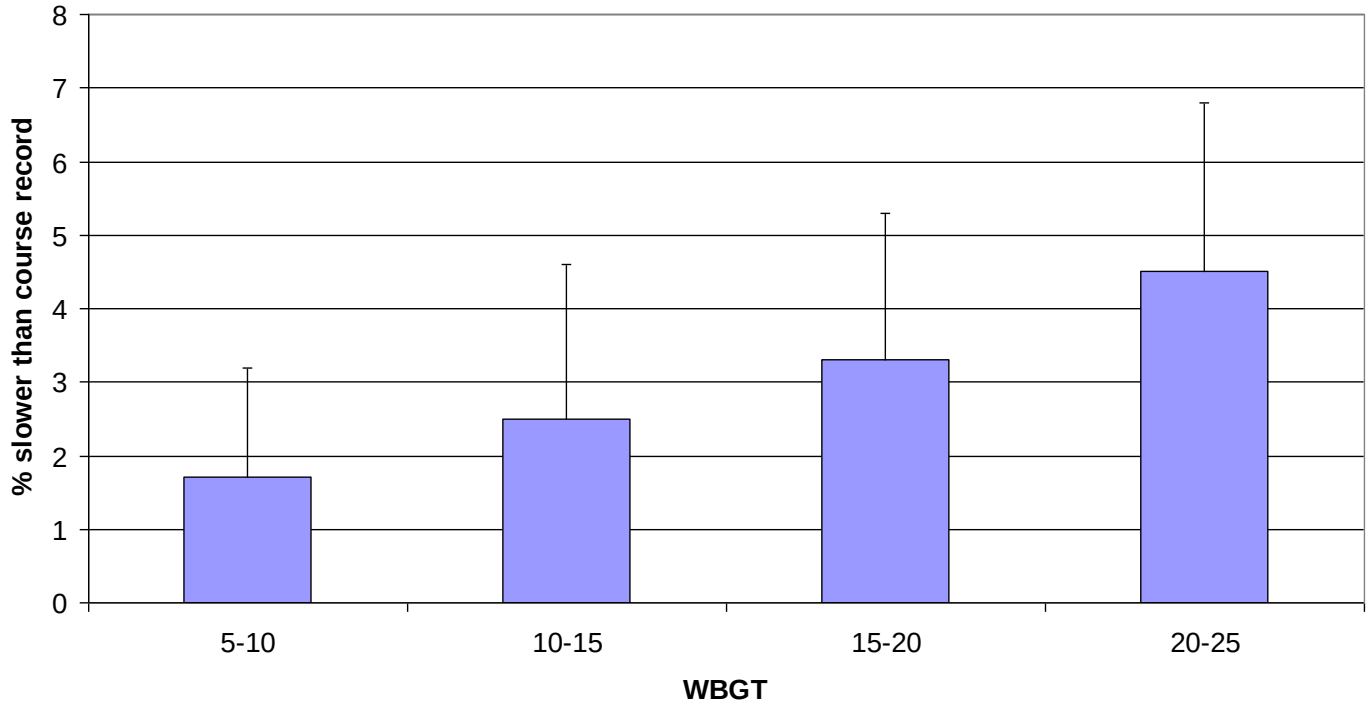


Reduced gross efficiency

Daanen et al. IJSM 2006

Performance decrease in the heat

Performance decrease related to WBGT for 7 marathons in US/Canada



Ely et al., MSSE, 2007

How to reduce performance decrease in the heat

Selection e.g. Africans versus Caucasians

Physiological adaptations - Acclimatization or acclimation

Physical training (cross acclimatisation)

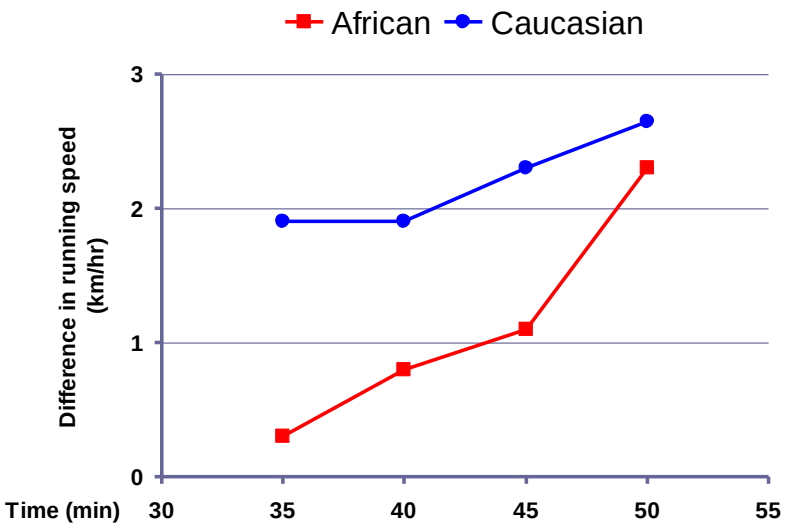
Cooling (prior, during and after exercise)

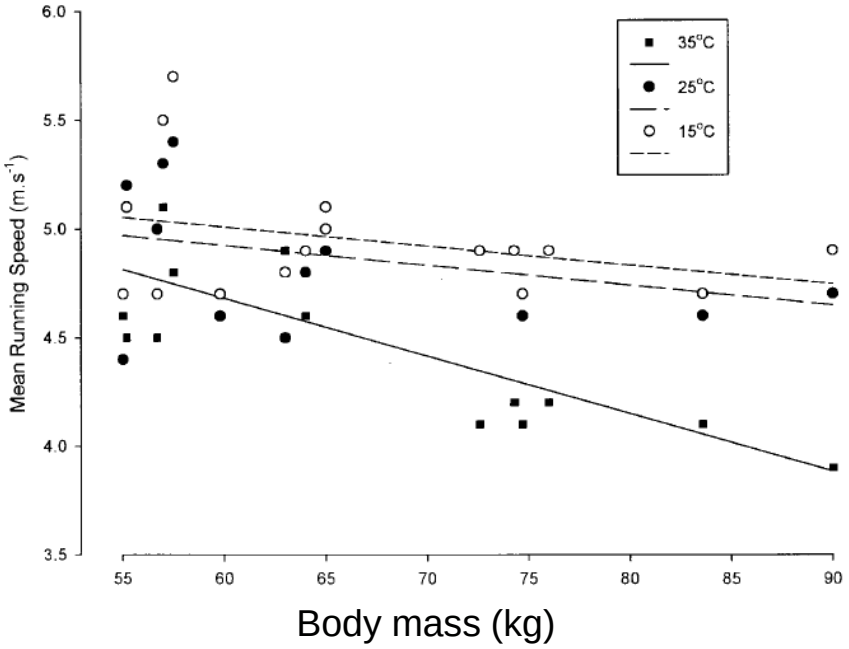
Drinking

Pacing strategy

Selection

Difference in running speed between 15°C en 35°C for 6 well trained Africans and Caucasians

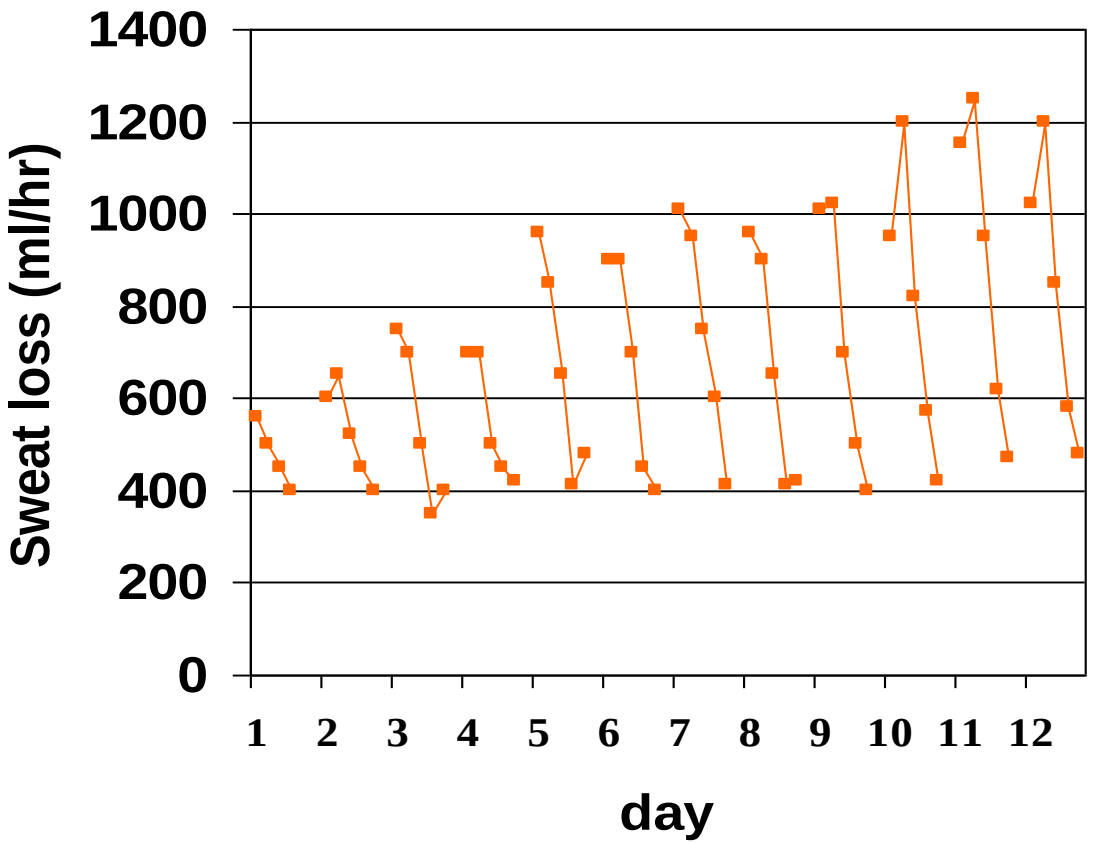




From: Marino et al., JAP 2004

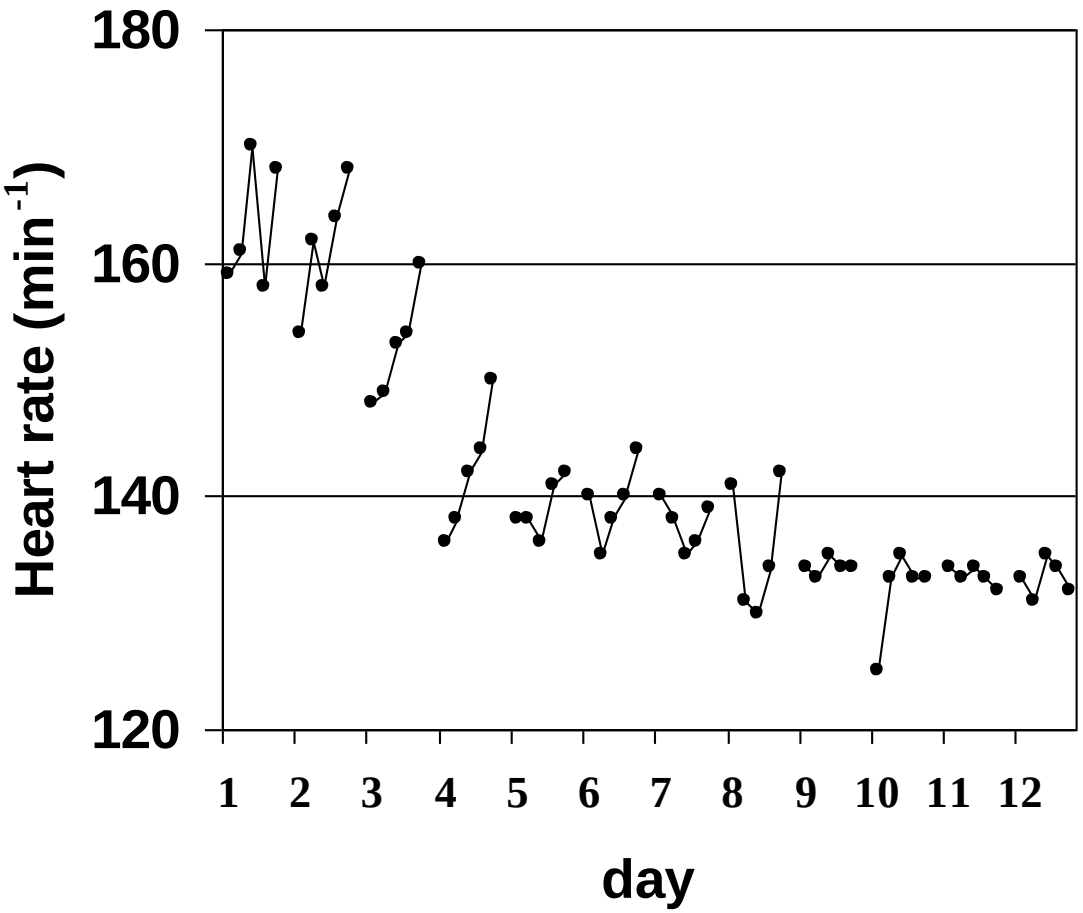
Marino et al., EJAP 2000

Acclimation to heat



(Strydom et al., JAP 21(2): 636-642, 1966)

Acclimation to heat



(Strydom et al., JAP 21(2): 636-642, 1966)

Insufficient recovery..

822 Physiology & Biochemistry

Optimising the Acquisition and Retention of Heat Acclimation

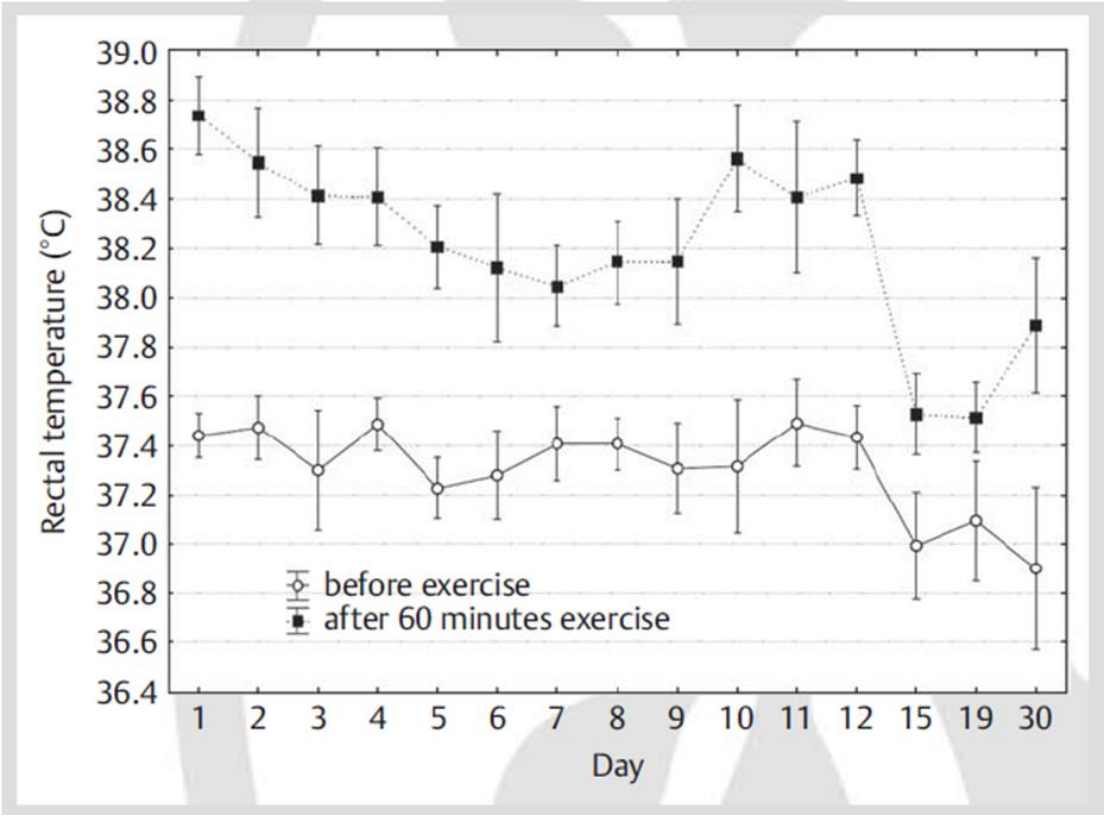
Authors: H. A. M. Daanen[1,2], A. G. Jonkman[1], J. D. Layden[1], D. M. Linnane[3], A. S. Weller[3]

Affiliations:
[1] TNO Defence, Security and Safety, Department of Human Performance, Soesterberg, The Netherlands
[2] Research Institute MOVE, Faculty of Human Movement Sciences, VU University Amsterdam, The Netherlands
[3] Qinetiq, Human Protection and Performance Enhancement, Farnborough, United Kingdom

- 15 male subjects
- 60 min bicycle exercise at 45% VO_2max
- Followed by incremental max test of about 45 min
- 9 days HA in 35ºC, 29% RH; 3 days HA in 41ºC, 33% RH
- Retest in 35ºC, 29% RH after day 3, 7 and 18

Insufficient recovery

Adaptations occurred after HA period



De- and Re-acclimation

Eur J Appl Physiol (2007) 102:57–66
DOI 10.1007/s00421-007-0563-z

ORIGINAL ARTICLE

Quantification of the decay and re-induction of heat acclimation in dry-heat following 12 and 26 days without exposure to heat stress

Andrew S. Weller · Denise M. Linnane · Anna G. Jonkman · Hein A. M. Daanen

16 male subjects

100 min treadmill exercise in 46ºC, 18% RH

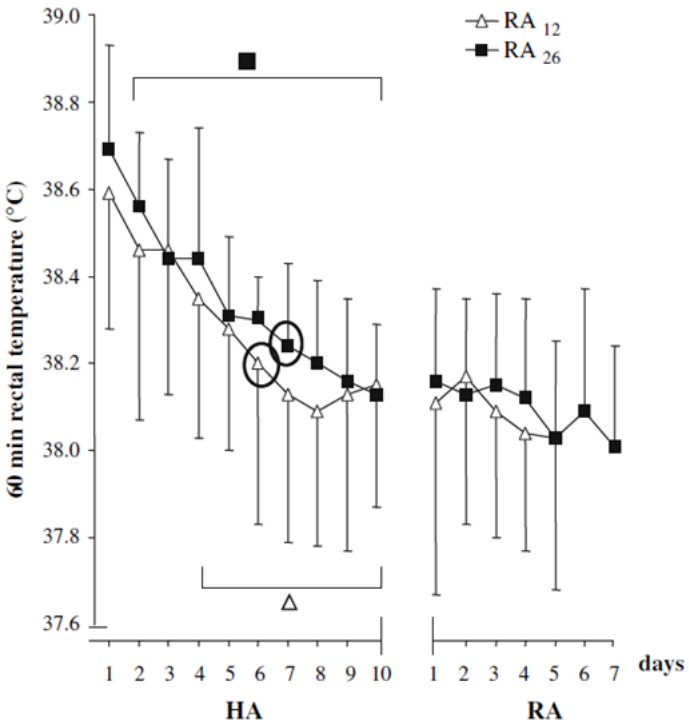
10 days HA

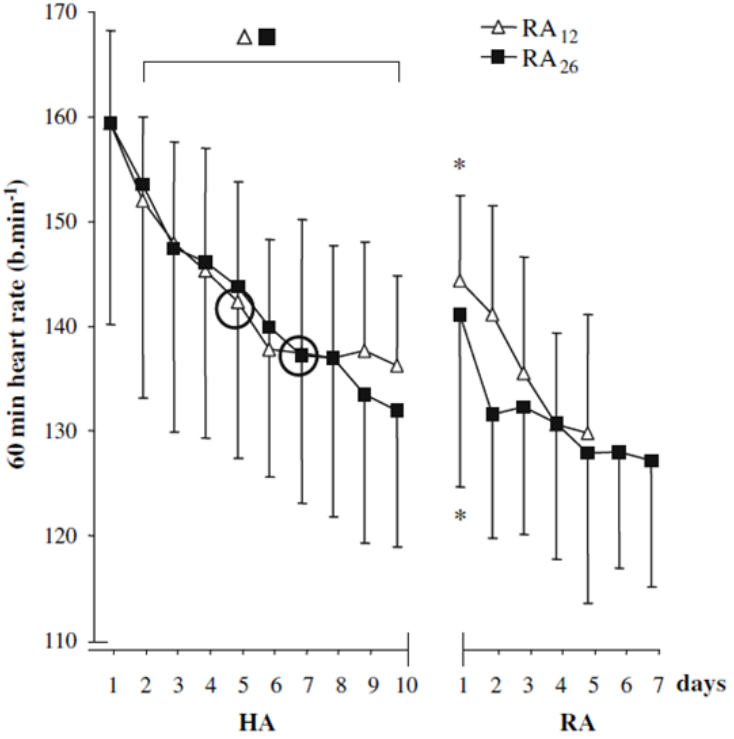
Hereafter:

8 males reacclimatized after 12 days

8 males reacclimatized after 26 days

De- and Re-acclimation



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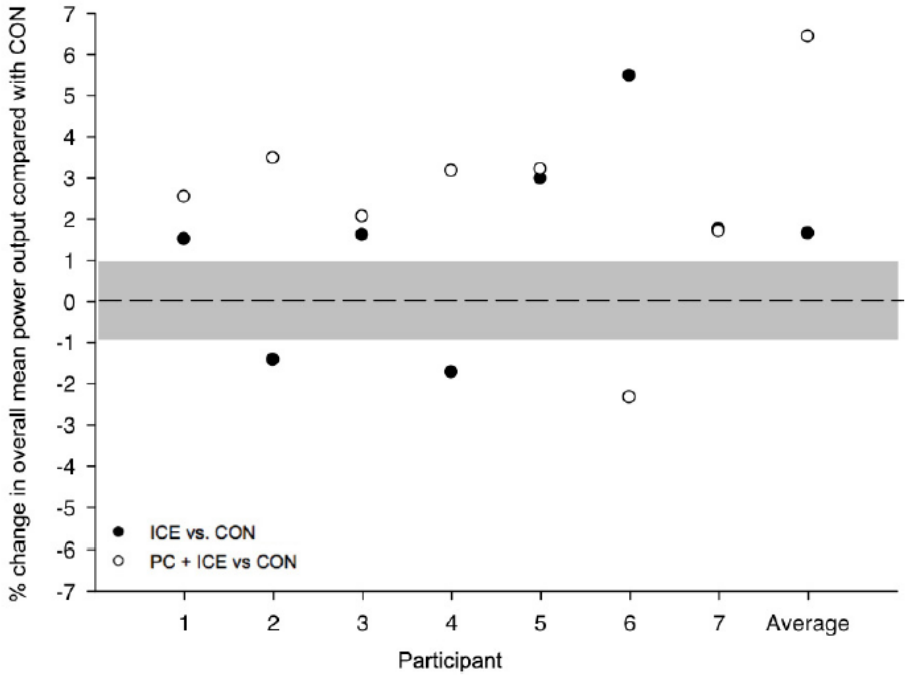
Heat acclimation - conclusions

- Acclimati(zati)on leads to impressive adaptations
- Cool rest periods are necessary to have optimal effect
- Once adaptation to heat has been attained, the time that individuals may spend in cooler conditions before returning to a hot environment could be as long as one month, without the need for extensive re-adaptation to heat

Cooling during cycling

Inside: cold fluids

Outside: protection against sun

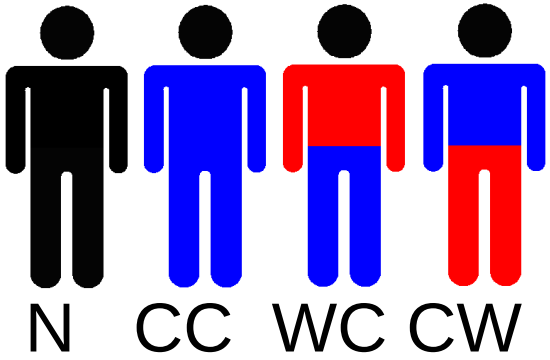


Schultze et al. IJSPP 2015

Bogerd et al. Geneeskunde en Sport, 2005

Pre-cooling

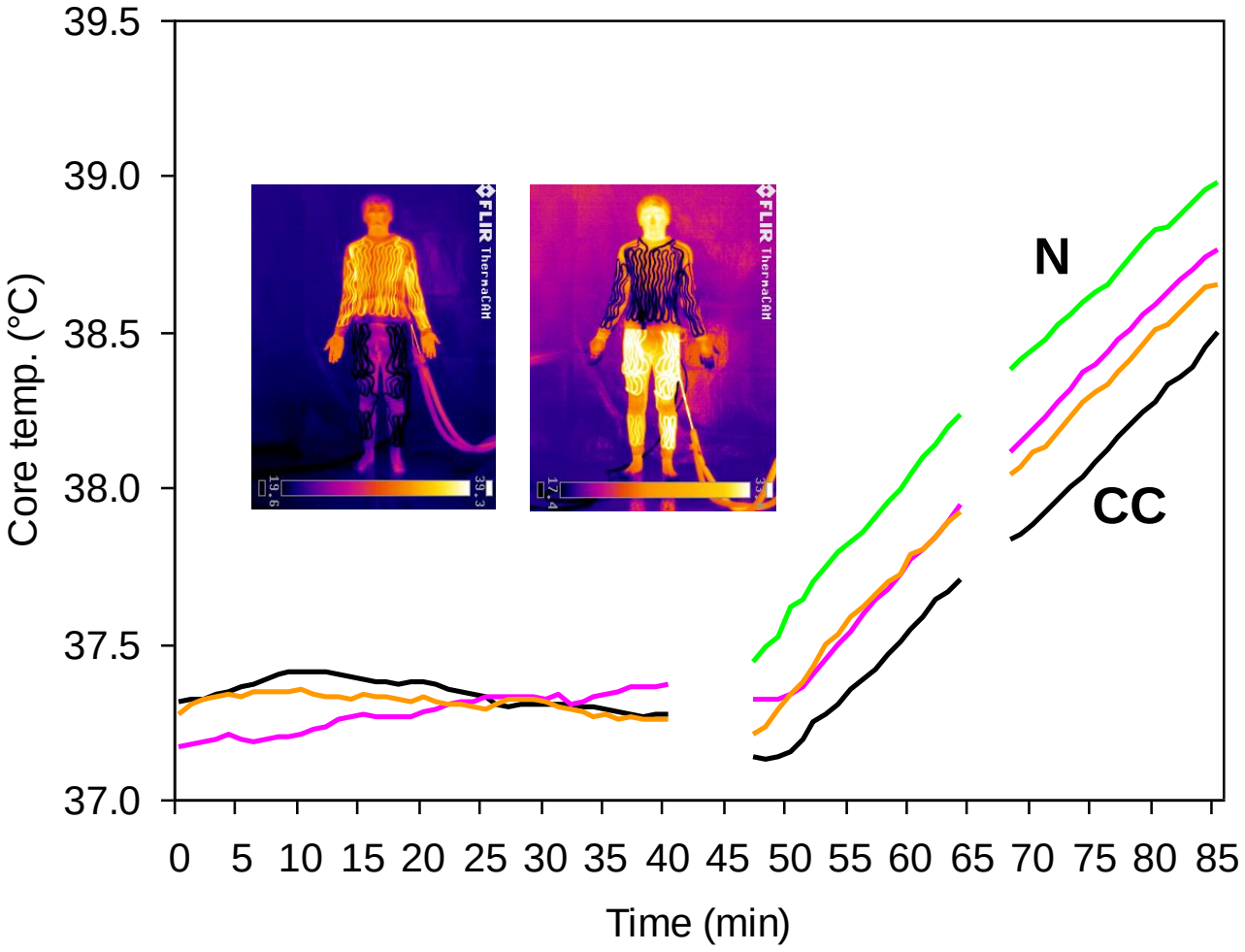
- **Eight male subjects**
- **Four cooling conditions (40 min):**



- **Followed by 40 min exercise at 60% VO_2max**

Daanen et al., IJSM 2006

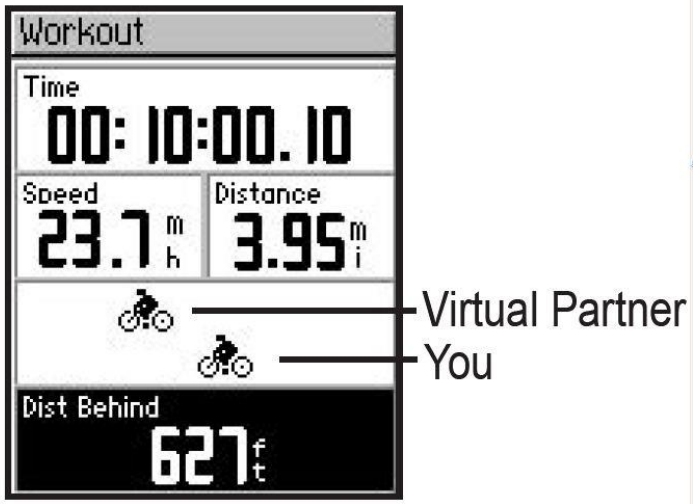
Pre-cooling – core temperature



Pacing strategies

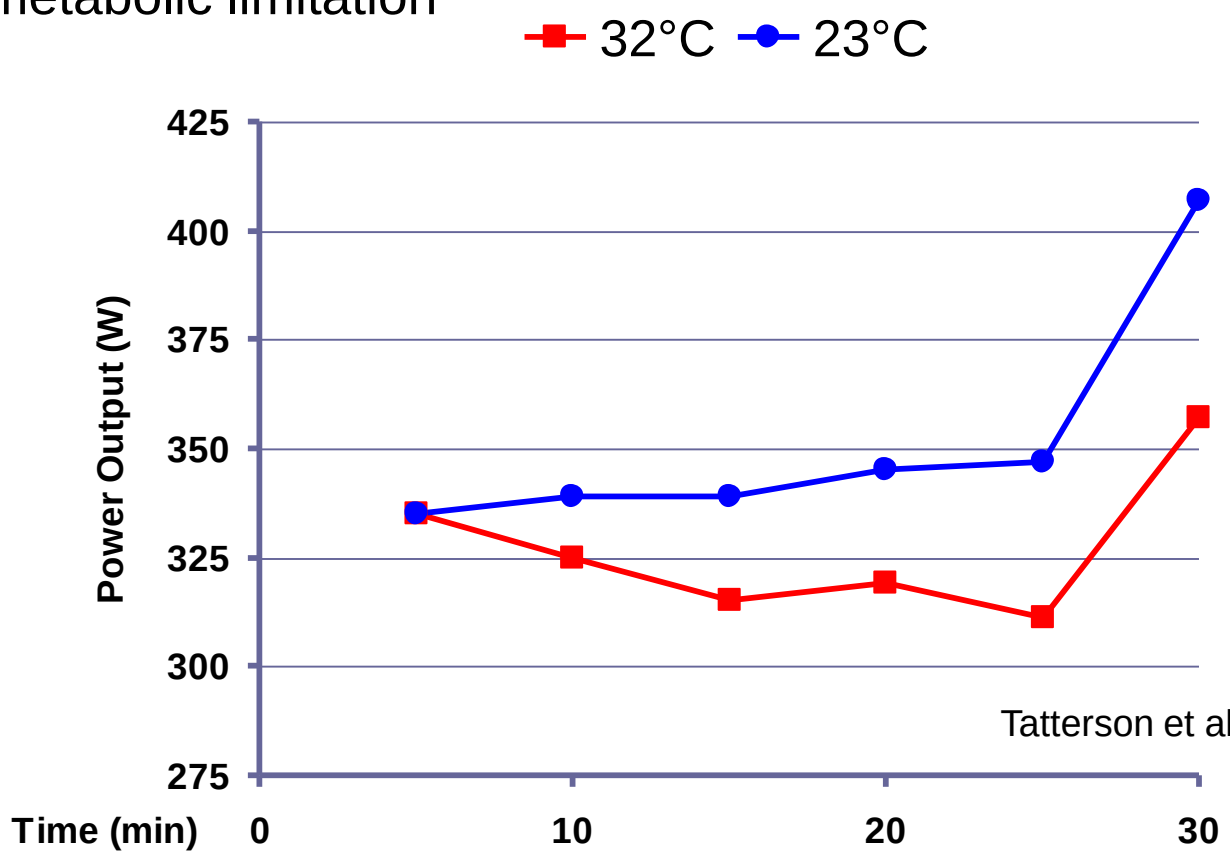
Does it help to adjust the pacing strategy when it is hot?

Tools to pace become more and more popular



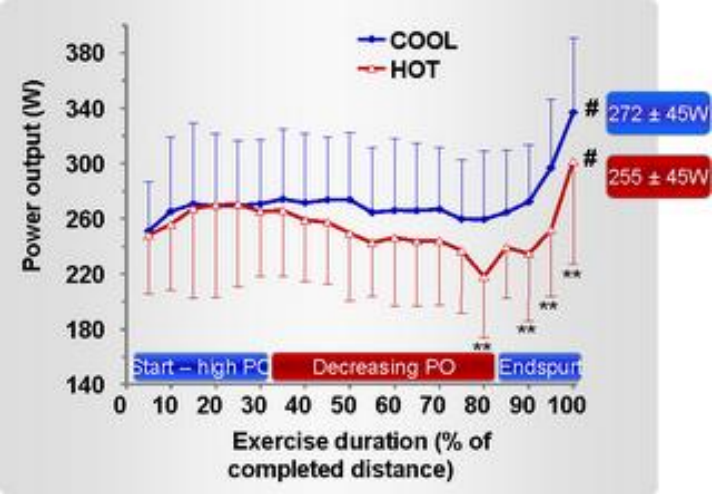
Power output during cycling

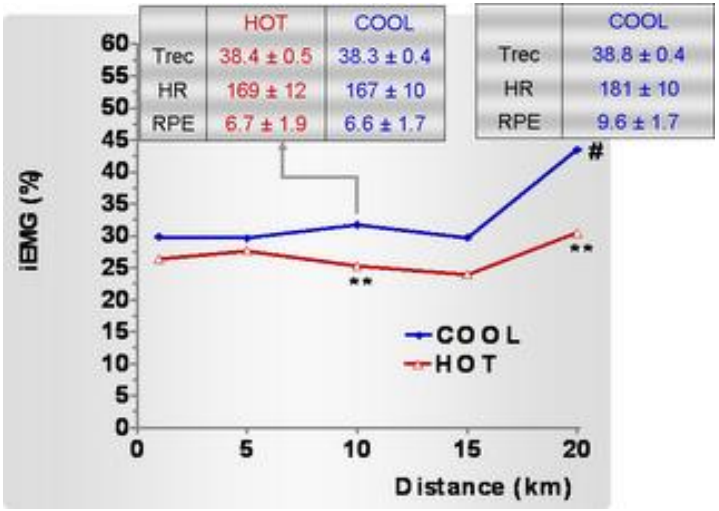
11 top cyclists – End lactate was lower in the heat => no metabolic limitation



Tatterson et al., JSMS, 2000

Power output during cycling





10 male subjects performed 20 km cycling self-paced time trails in 35°C and 15°C

Core temperature NS

Muscle activation lower in the heat => anticipation

Tucker et al., EJAP, 2004
(www.sportsscientists.com)

Conclusions

Heat strain leads to reduction in performance

This reduction can be counteracted by acclimat(izat)ion, precooling or reducing heat strain during performance

During exercise in the heat, athletes anticipate the heat strain and reduce muscle activation

More info

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