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We know that heat acclimation is essential for performance in hot environments...

Consensus statement



Consensus recommendations on training and competing in the heat

S Racinais,¹ J M Alonso,^{2,3} A J Coutts,⁴ A D Flouris,⁵ O Girard,⁶ J González-Alonso,⁷ C Hauswirth,⁸ O Jay,⁹ J K W Lee,^{10,11,12} N Mitchell,¹³ G P Nassis,¹⁴ L Nybo,¹⁵ B M Pluim,¹⁶ B Roelands,¹⁷ M N Sawka,¹⁸ J Wingo,¹⁹ J D Périard¹



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...but can heat stress be used to stimulate endurance adaptations *per se*?

Does heat training improve performance in temperate environments?



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Synthesis Review

J Appl Physiol 119: 172–189, 2015.
First published May 14, 2015; doi:10.1152/jappphysiol.01055.2014.

Modulating exercise-induced hormesis: Does less equal more?

Jonathan M. Peake,^{1,2} James F. Markworth,³ Kazunori Nosaka,⁴ Truls Raastad,⁵ Glenn D. Wadley,⁶ and Vernon G. Coffey^{7,8}

“Hormesis encompasses the notion that **low levels of stress stimulate molecular pathways that improve the capacity of cells and organisms to withstand stress.**”



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Heat stress promotes physiological stress

Thermoregulatory¹

Cardiovascular²

Metabolic³

Endocrine⁴



¹Starkie RL. et al. *Brain Behav Immun* 19: 404-412, 2005
²González-Alonso J. et al. *Am J Physiol – Heart Circ Physiol* 278: H321-H330, 2000
³Fink WJ. et al. *Eur J Appl Physiol* 34: 183-190, 1975
⁴Febbraio MA. et al. *J Appl Physiol* 76: 589-597, 1994

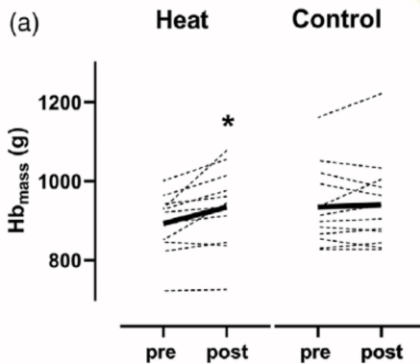


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Five weeks of heat training increased haemoglobin mass and temperate performance in elite cyclists



Rønnestad BR. et al. *Exp Physiol* 106(1): 316-327, 2020

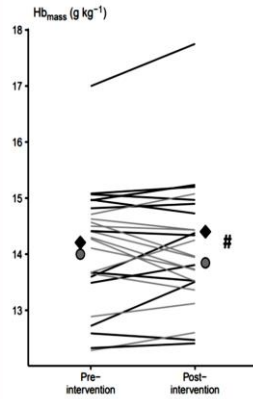


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Similar results have been observed using other methods



Rønnestad BR. et al. *Scan J Med Sci Sports* 32(7): 1089-1098, 2022

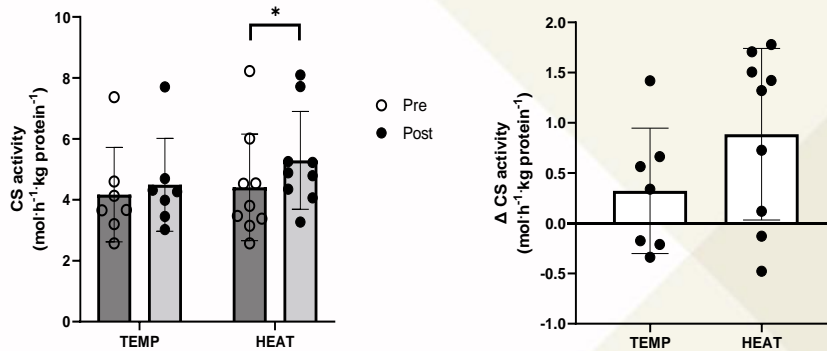


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We observed evidence of superior adaptation in muscle with heat training in amateur cyclists...



Maurer E. et al. *Physiological Reports* 9(9): 1-14, 2021

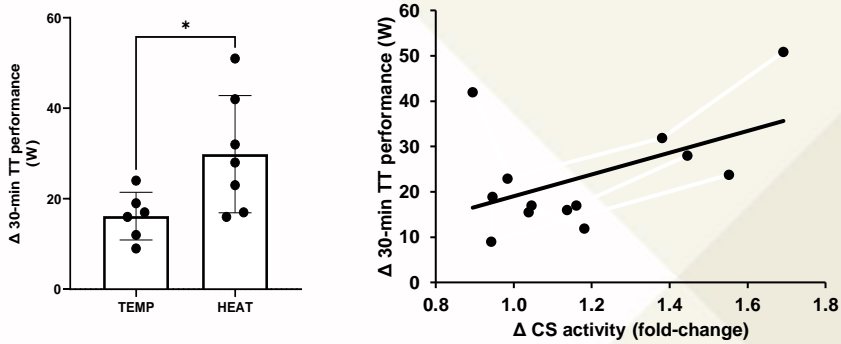


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...and this was associated with a greater increase in time-trial performance in temperate conditions...



Maunder E. et al. *Physiological Reports* 9(9): 1-14, 2021

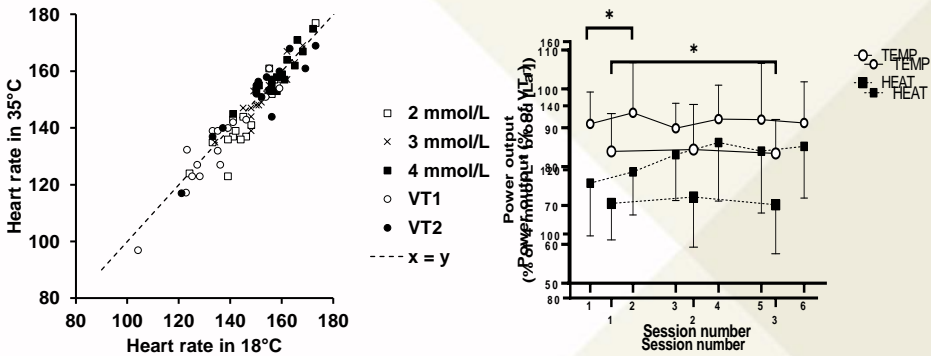


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...despite matching training interventions for cardiovascular load, and so lower relative power output during training in HEAT



Maunder E. et al. *Int J Sports Physiol Perform* 16(8): 1204-1207, 2021

Maunder E. et al. *Physiological Reports* 9(9), 1-14, 2021

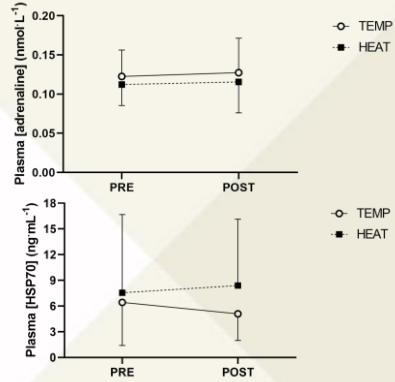
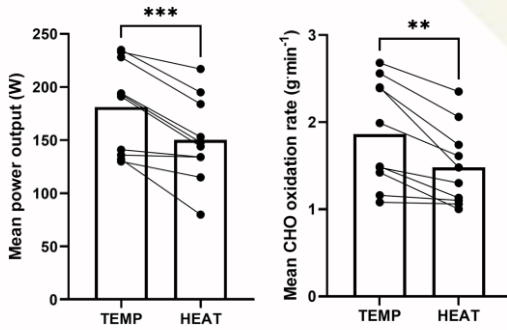


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Some stresses are probably similar or even lower in hot environments, when HR is matched



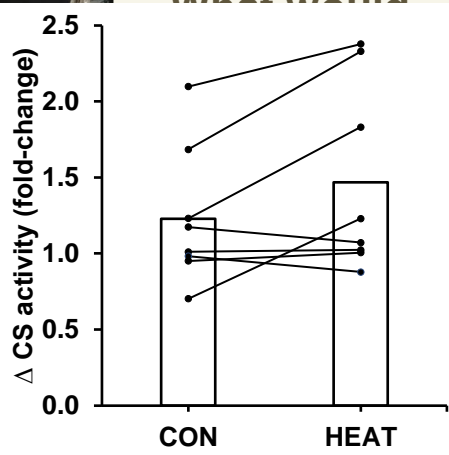
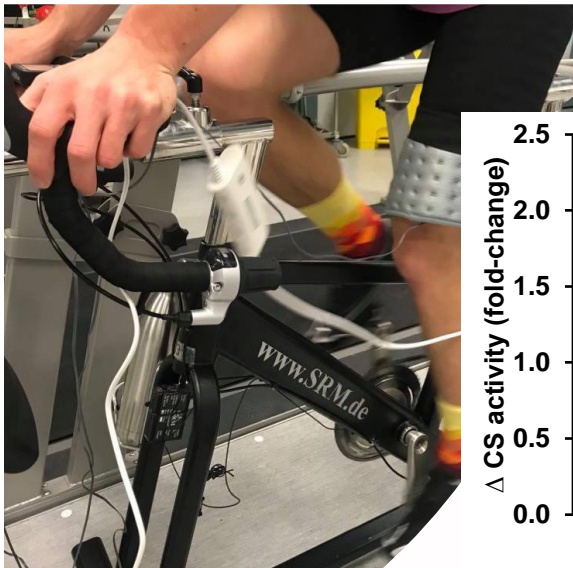
Charoensap T. et al. in preparation



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Practical applications

1. **Exposure to heat stress** during endurance training may **stimulate training adaptation** relevant to **temperate performance**
2. **Controlling and monitoring stress** when training under heat stress is essential
3. I like to use **heart rate variability** and **daily wellbeing scales**, and **regulate moderate-intensity training session using HR thresholds** (not power!)
4. Allow **time** for heat acclimation (**don't let your ego get in the way!**)
5. Athletes will need to pay greater attention to their **hydration status**

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Ed Maunder, PhD
ed.maunder@aut.ac.nz

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