

BEAT THE HEAT

- 1. How do heat and humidity influence performance?*
- 2. How can athletes prepare for competitions in the heat?*



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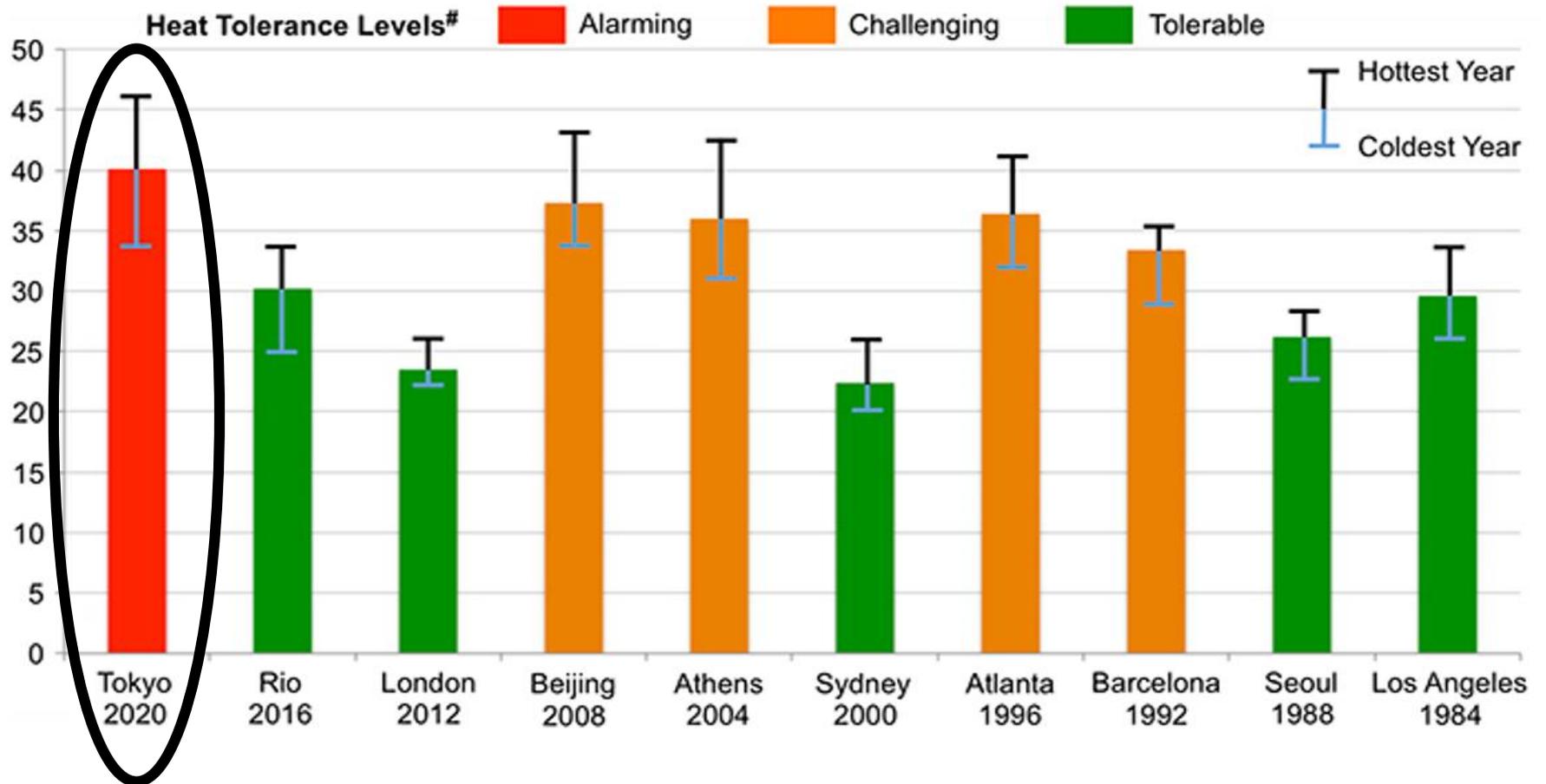
🏠 > News

'Unprecedented' Japan heatwave kills 65 in one week and leaves 23,000 in hospital

31st July 2019

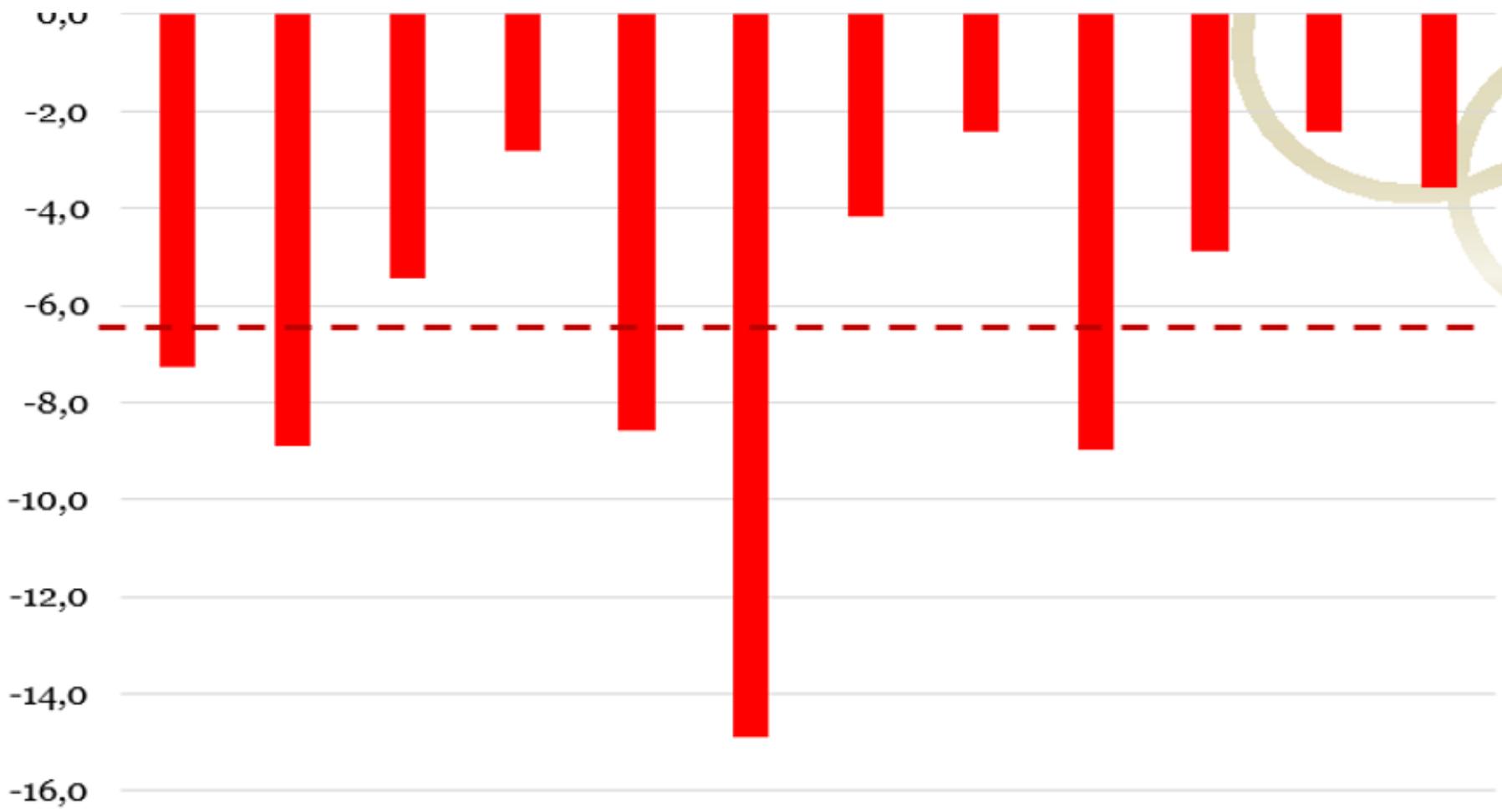
- 1 year before rowing finals
- 34°C og 77% humidity
- Heat index: 50°C





Szubski C: *Sweltering Heat at the 2020 Olympics in Tokyo*. Sportify Cities Report. 2016

Percent reduction in threshold speed/power



Performance decrement (speed/power at threshold) in «Tokyo climate» in Norwegian Olympic athletes

Why is performance impaired in the heat?

- The body prioritizes skin blood flow for cooling → reduced blood flow to working muscles → reduced oxygen delivery → increased heart rate and blood lactate
- Increased sweating = increased risk of dehydration and cramps
- Increased body temperature impairs enzyme function – cellular processes are slowed down – reduced muscle function
- Negative effect on cognitive processes – reduced co-ordination and impaired decision making

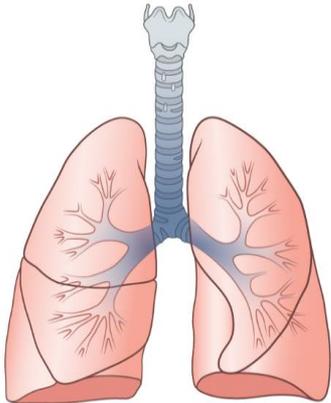


CHANGES IN BRAIN/NERVOUS SYSTEM:

- ↑ Central fatigue
- ↓ Nerve transmitters (Dopamine)
- ↓ Co-ordination(?)

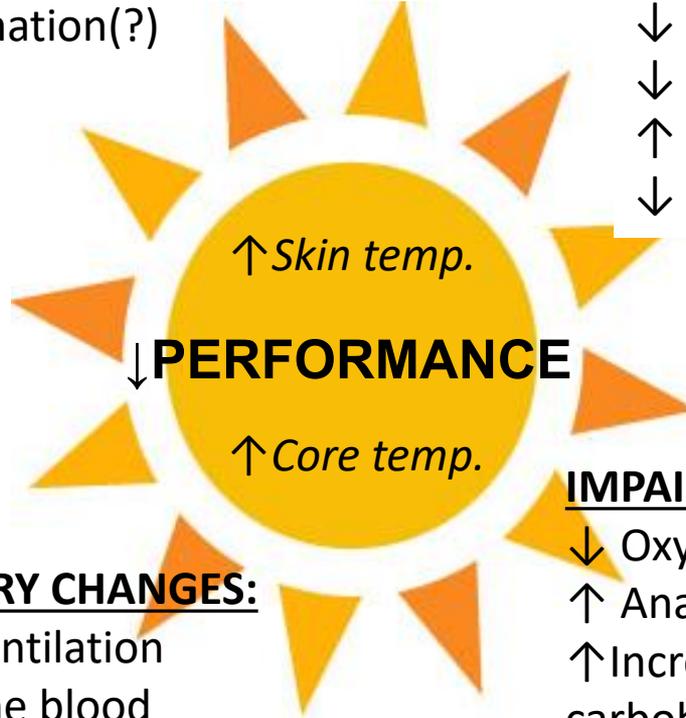
MENTAL CHALLENGES:

- ↑ Discomfort
- ↓ Technical/tactical ability
- ↓ Motivation



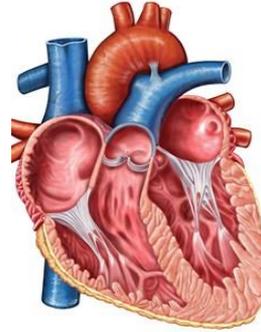
VENTILATORY CHANGES:

- ↑ Hyper-ventilation
- ↓ CO₂ in the blood
- ↓ Brain blood flow



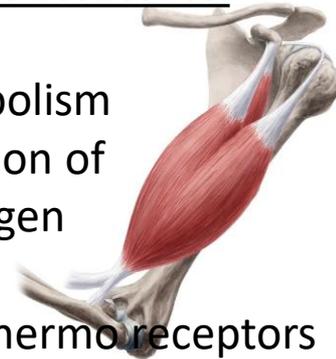
INCREASED CARDIOVASCULAR STRESS:

- ↑ Skin blood flow
- ↓ Plasma volume
- ↓ Stroke volume
- ↑ Heart rate
- ↓ Arterial pressure



IMPAIRED MUSCLE FUNCTION:

- ↓ Oxygen delivery
- ↑ Anaerobic metabolism
- ↑ Increased utilization of carbohydrate/glycogen
- ↑ Lactate and H⁺
- ↑ Feedback from thermo receptors



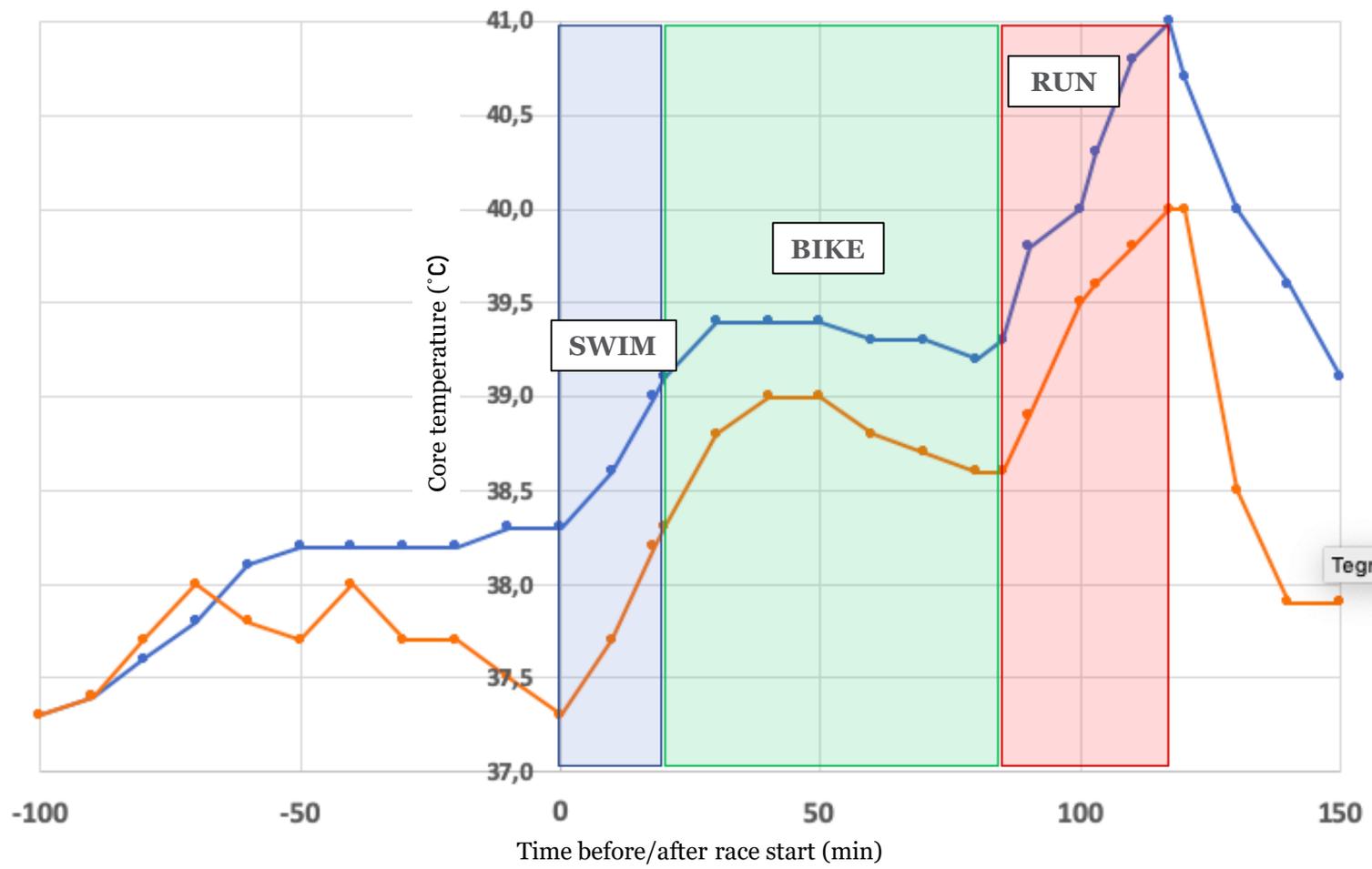
Core temperature changes in triathlon during Olympic test event in Tokyo



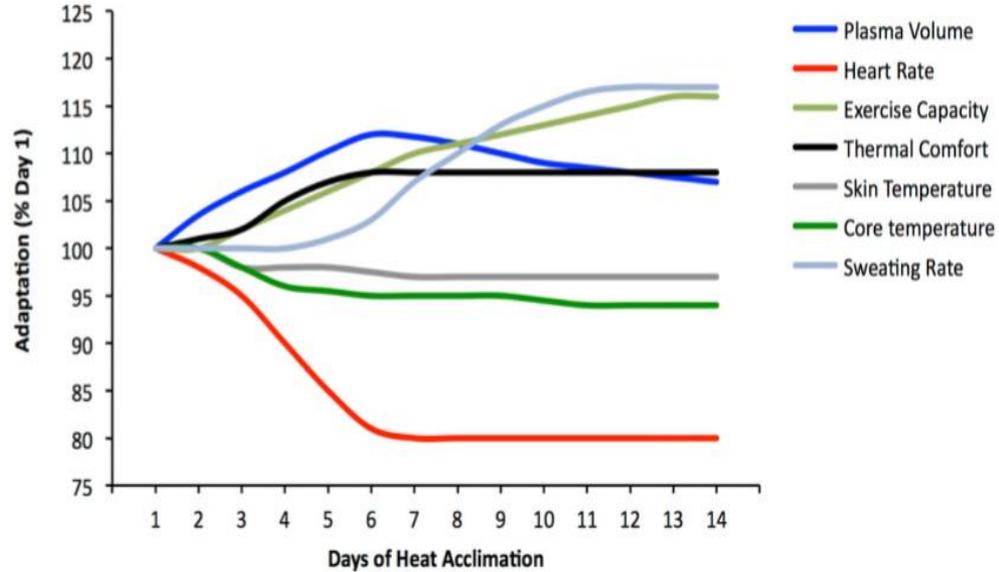
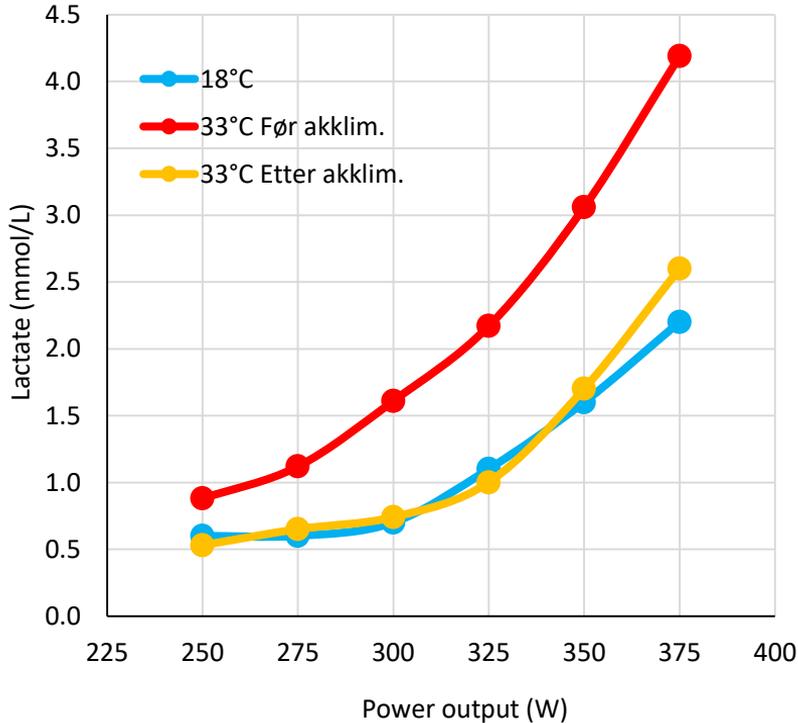
Olympiatoppen



- Core temperature at finish = 40-41°C
 - 40+min with core temp at or above 40°C
- «Acquired Thermal Tolerance»
- Significant risk of heat illness if not acclimatized!



Heat acclimation is the most effective strategy for optimising performance in the heat



10-14 days of heat acclimation can reverse much of the performance decrement in the heat



Post-exercise Hot Water Immersion Elicits Heat Acclimation Adaptations That Are Retained for at Least Two Weeks

Michael J. Zurawlew^{1*}, Jessica A. Mee² and Neil P. Walsh¹

¹College of Human Sciences, Bangor University, Bangor, United Kingdom

²School of Sport and Exercise Science, University of Worcester, Worcester, United Kingdom

Heat acclimation by post-exercise hot water immersion (HWI) on thermal strain and improves exercise performance during heat stress; adaptations by this method remains unknown. Typically, adaptation acclimation (<7 heat exposures) decay rapidly and are lost within 2 weeks should therefore be completed within 2 weeks of relocating to the high pre-competition/deployment training. To establish whether adapta

Train Cool - Bathe Hot - Perform Better in the Heat!

Hot bath after exercise for six days reduced both resting and exercising body temperature and improved 5k running performance by 4.9% in the heat.

17 males
Hot water (n=10)
Thermoneutral (n=7)

Hot bath induced heat acclimation:

- Lower core temperature
- Earlier sweating (at lower temperature)
- Lower perceived exertion

Zurawlew, Walsh, Fortes and Potter Scand J Med Sci Sports 2016



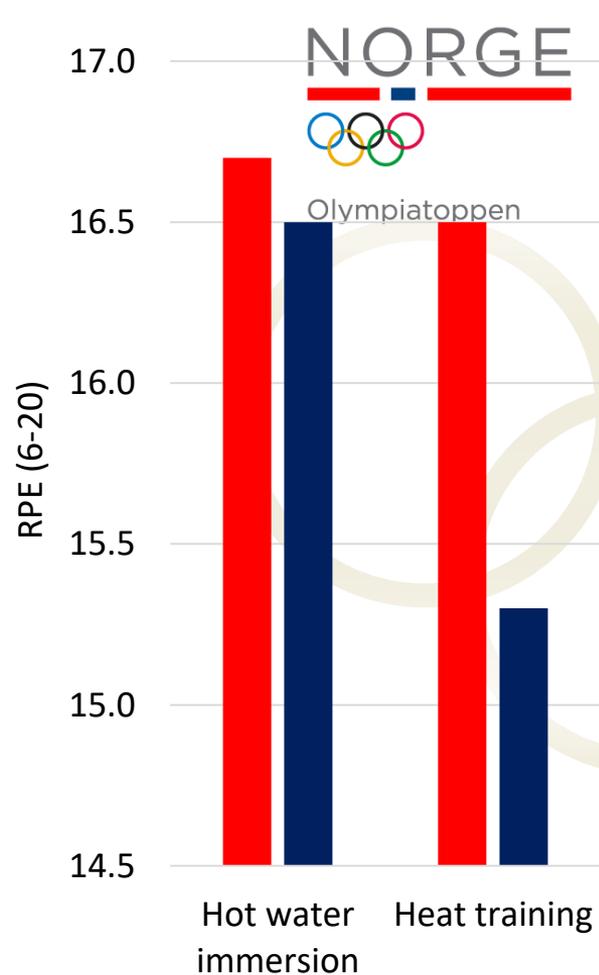
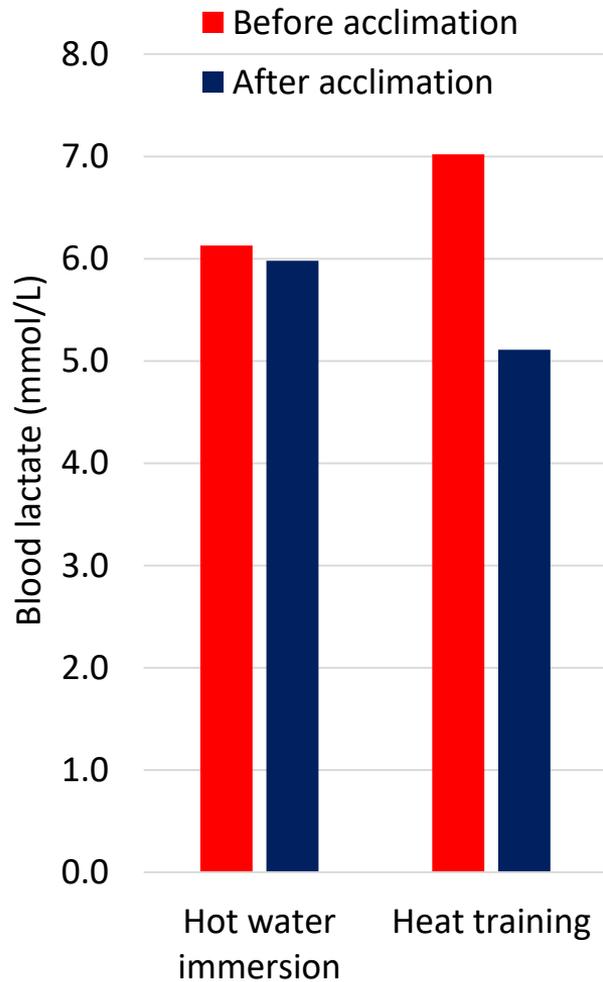
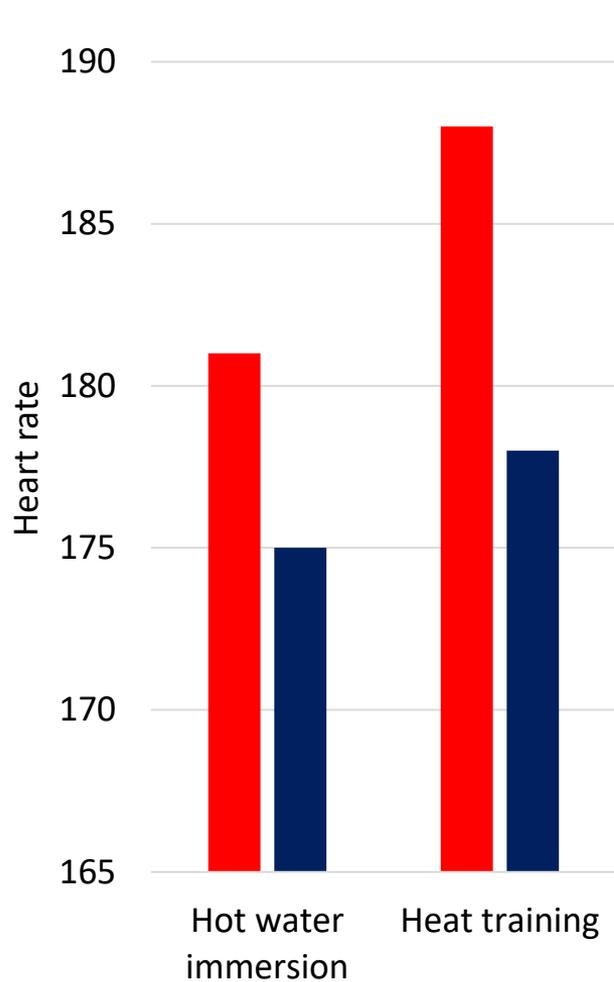
World Champs 2017 (Sarasota)



Compare the efficacy of **hot water immersion** vs. **heat training**:

Group 1 hot water immersion:
20-40min i 40°C

Group 2 heat training:
45min low-intensity cycling in 33-35°C



World Champs 2018 (Plovdiv)



Heat acclimation improves exercise performance

Santiago Lorenzo,¹ John R. Halliwill,¹ Michael N. Sawka,² and Christopher T. Minson¹

¹Department of Human Physiology, University of Oregon, Eugene, Oregon; and ²Thermal and Mountain Medicine Division, US Army Research Institute of Environmental Medicine, Natick, Massachusetts

Submitted 6 May 2010; accepted in final form 18 August 2010

Lorenzo S, Halliwill JR, Sawka MN, Minson CT. Heat acclimation improves exercise performance. *J Appl Physiol* 109: 1140–1147, 2010. First published August 19, 2010; doi:10.1152/jappphysiol.00495.2010.—This study examined the impact of heat acclimation on improving exercise performance in cool and hot environments. Twelve trained cyclists performed tests of maximal aerobic power ($\dot{V}O_{2max}$), time-trial performance, and lactate threshold, in both cool [13°C, 30% relative humidity (RH)] and hot (38°C, 30% RH) environments before and after a 10-day heat acclimation (~50% $\dot{V}O_{2max}$ in 40°C) program. The hot and cool condition $\dot{V}O_{2max}$ and lactate threshold tests were both preceded by either warm (41°C) water or thermoneutral (34°C) water immersion to induce hyperthermia (0.8–1.0°C) or sustain normothermia, respectively. Eight matched control subjects completed the same exercise tests in the same environments before and after 10 days of identical exercise in a cool (13°C) environment. Heat acclimation increased $\dot{V}O_{2max}$ by 5% in cool (66.8 ± 2.1 vs. 70.2 ± 2.3 ml·kg⁻¹·min⁻¹, $P = 0.004$) and by 8% in hot (55.1 ± 2.5 vs. 59.6 ± 2.0 ml·kg⁻¹·min⁻¹, $P = 0.007$) conditions. Heat acclimation im-

proved time-trial performance in cool conditions (14.5 vs. 13.5 min, $P = 0.007$) and in hot conditions (14.5 vs. 13.5 min, $P = 0.007$). Heat acclimation also improved lactate threshold in cool conditions (14.5 vs. 13.5 min, $P = 0.007$) and in hot conditions (14.5 vs. 13.5 min, $P = 0.007$). Heat acclimation improved exercise performance in cool conditions and therefore pro-

duced the purpose of this study was to determine the impact of heat acclimation on maximal aerobic power, time-trial performance, and lactate threshold, in a cool (13°C) environment. We hypothesized that heat acclimation would improve exercise performance capabilities in cool conditions and therefore pro-

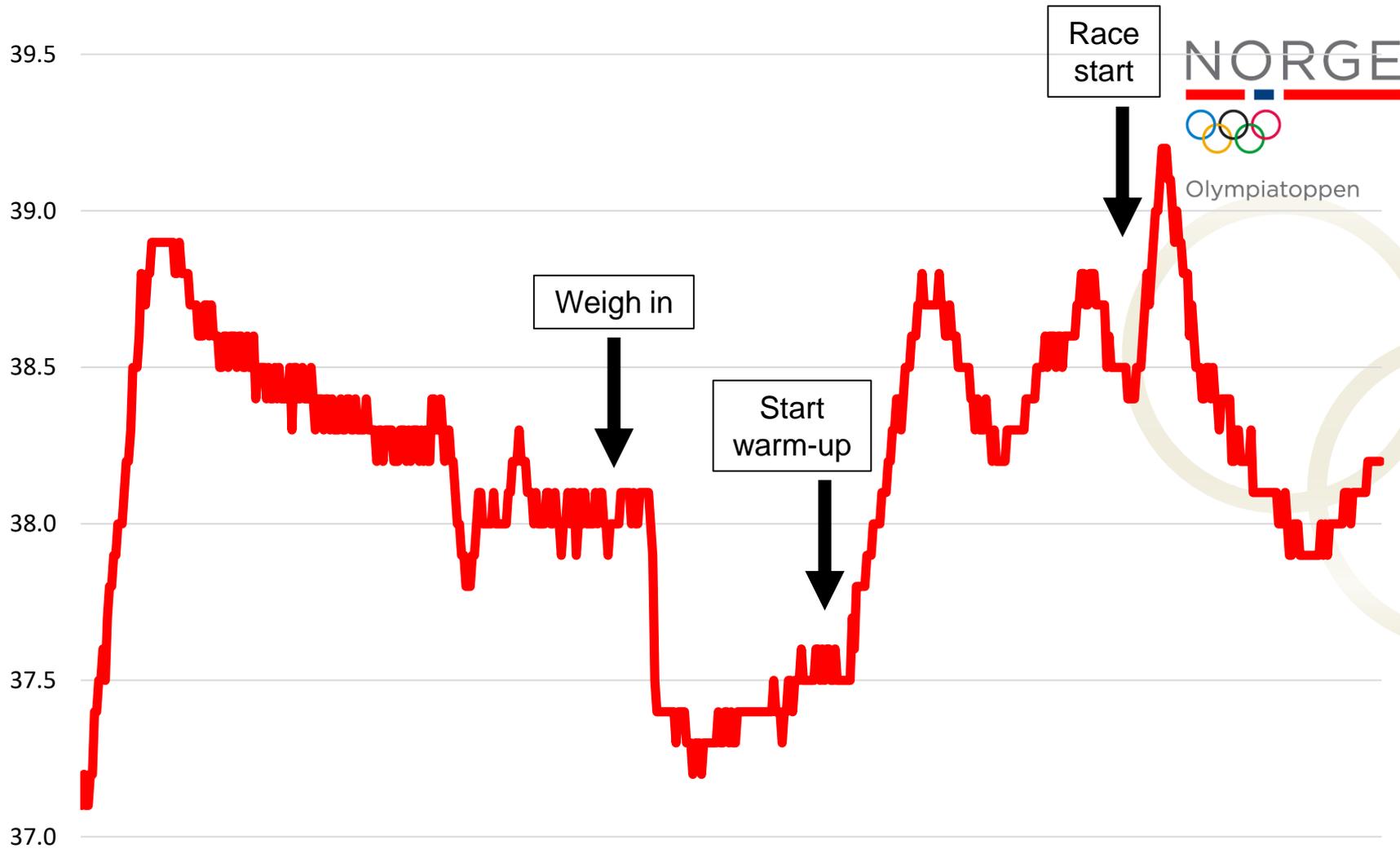
NORGE



Olympiatoppen



Core temperature (°C)



Factors that increase the risk of heat stroke :

- **Dehydration**
- **Medications that influence heat tolerance / temperature regulation:**
 - Vasopressors
 - Beta-blockers
 - Diuretics
 - Anti-depressants / anti-psychotics
 - ADHD medications
 - Stimulants
- **Infections & sunburn** – change the body's temperature «set-point»

Reduced heat tolerance in athletes with SCI



The body's most important effectors for temperature regulation are controlled by the central nervous system.

Spinal cord injury:

- Reduced capacity to regulate body temperature
- Impaired thermal perception
- Lower stroke volume— greater decrease in performance in the heat?



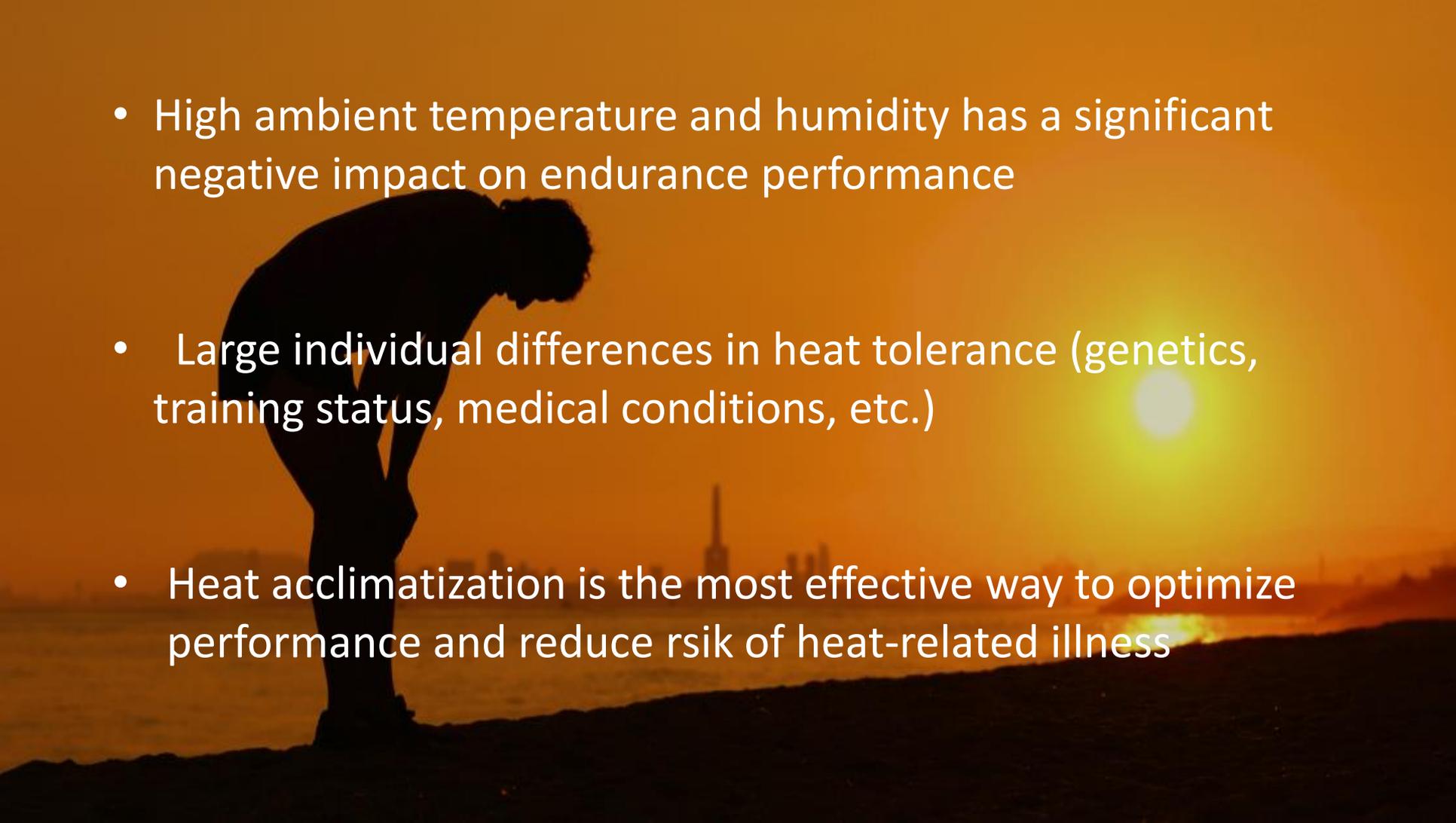
Can you combine heat acclimation and altitude training?

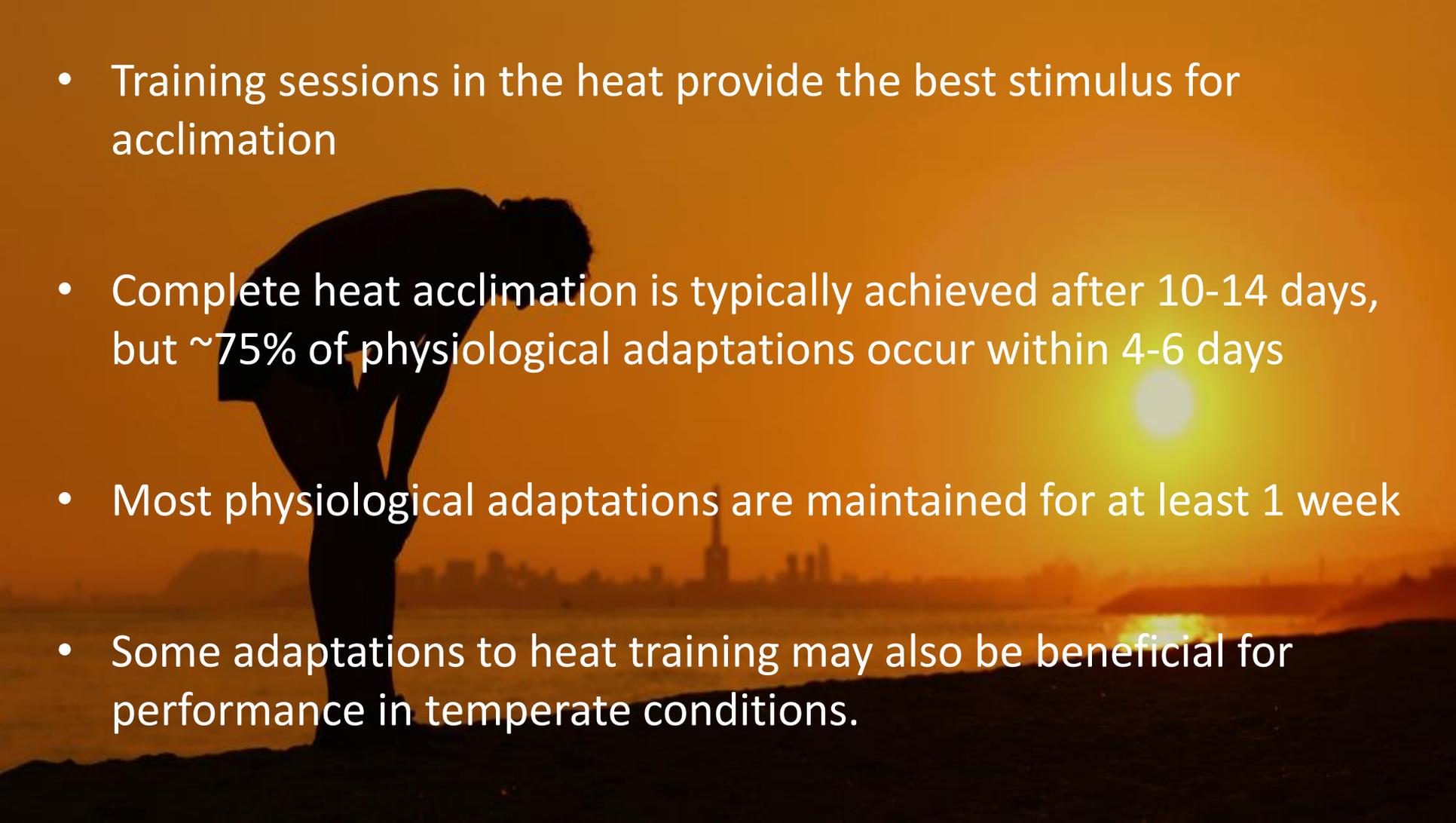


How do we prepare our athletes for the Tokyo climate?



- Heat acclimation
- Test the efficacy and feasibility of different cooling strategies
- Measure sweat rates and tailor hydration plans
- Test different warm-up strategies
- Practice mental strategies to maintain focus and preserve technical and tactical abilities

- High ambient temperature and humidity has a significant negative impact on endurance performance
 - Large individual differences in heat tolerance (genetics, training status, medical conditions, etc.)
 - Heat acclimatization is the most effective way to optimize performance and reduce risk of heat-related illness
- 
- A silhouette of a person bending over, possibly stretching or resting, against a bright orange and yellow sunset background. The sun is visible on the right side, and a city skyline is faintly visible in the distance.

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- A silhouette of a person in athletic wear is shown in a stretching pose, leaning forward with hands on knees. The background is a warm, orange-hued sunset over a body of water, with a city skyline visible in the distance. The sun is a bright, glowing orb on the right side of the frame.
- Training sessions in the heat provide the best stimulus for acclimation
 - Complete heat acclimation is typically achieved after 10-14 days, but ~75% of physiological adaptations occur within 4-6 days
 - Most physiological adaptations are maintained for at least 1 week
 - Some adaptations to heat training may also be beneficial for performance in temperate conditions.