Heart Rate Variability to optimise training loads and recovery

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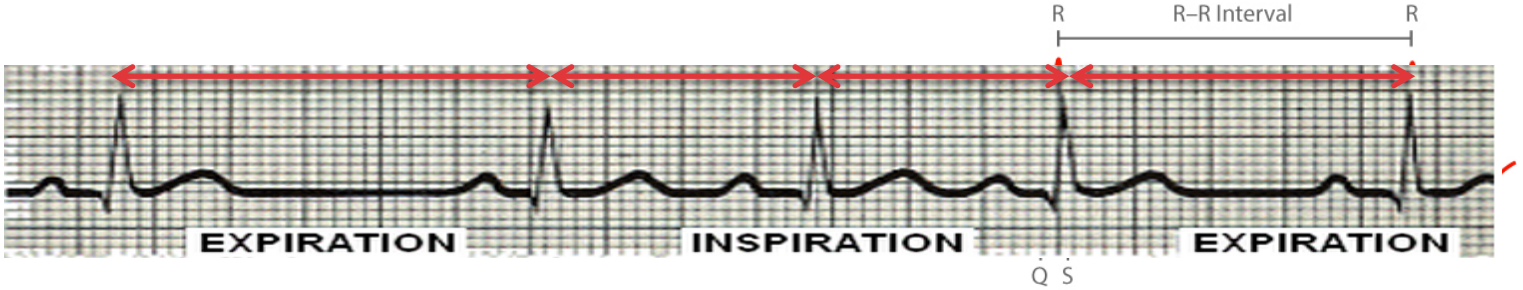
What is HRV analysis?

- Heart Rate Variability is a medical measurement

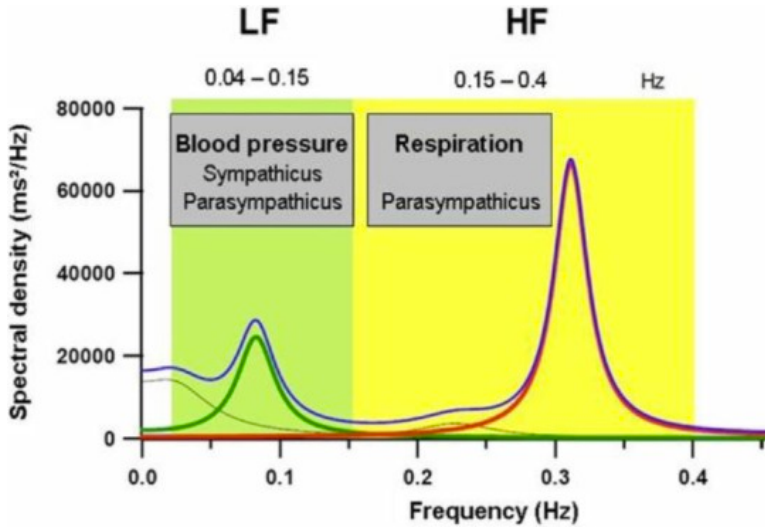


- Accurate sensors measure beat-to-beat variations
- $Log_{(e)}$ transformed RMSSD is most common HRV measure
- Daily readings commonly compared to longitudinal baseline
  - Significant deviations are colour coded
- Higher HRV generally considered better

Three kinds of HRV

Heart Rate Variability comes from 3 activities in the body:

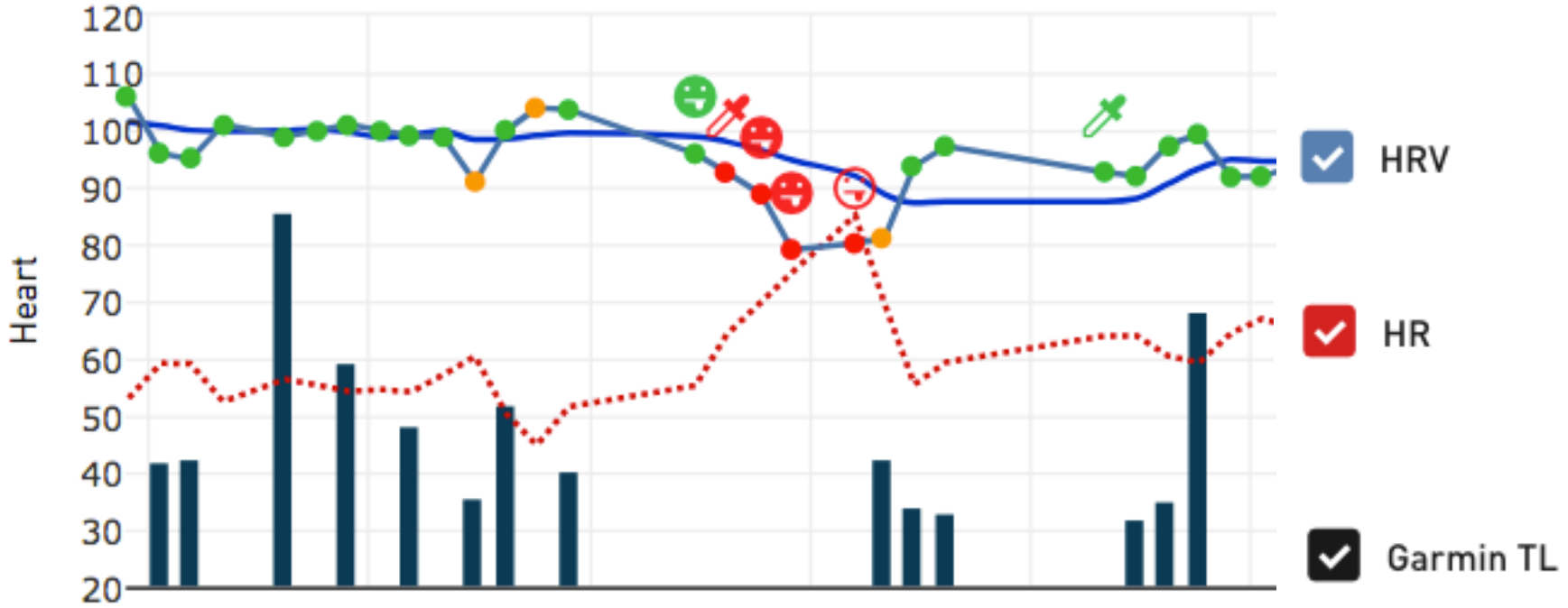
1. Breathing
   - Respiratory Sinus Arrhythmia
   - Parasympathetic (High Frequency)



2. Blood pressure regulation
   - Sympathetic + parasympathetic (LF)

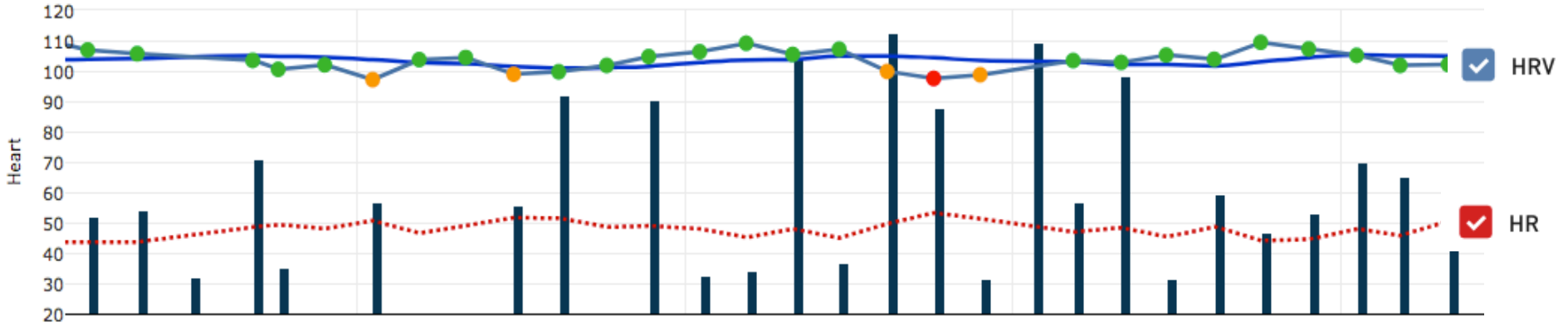
3. Changes in environment eg thermoregulation
   - Sympathetic (VLF)

What can HRV tell us - detecting sickness

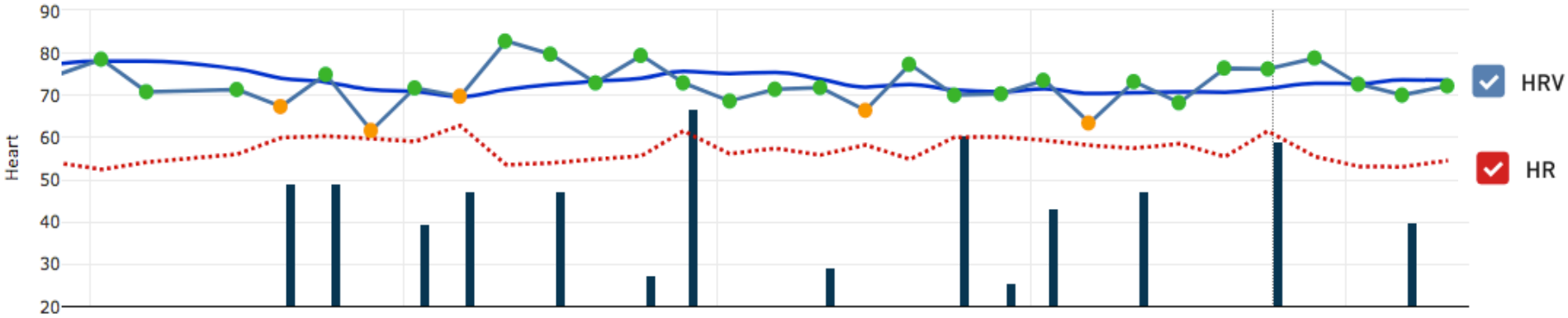


What can HRV tell us - resilience

Elite endurance athlete

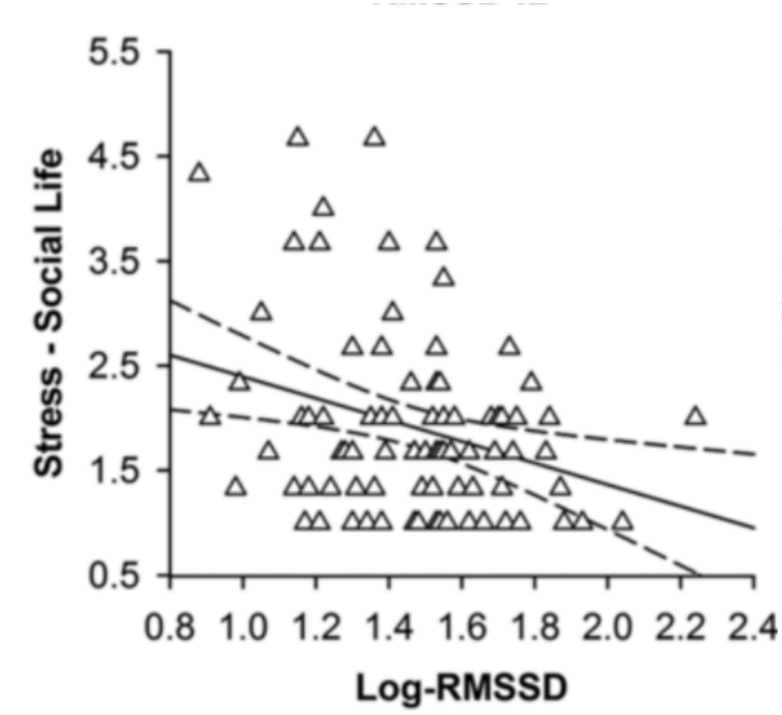


Recreational endurance athlete

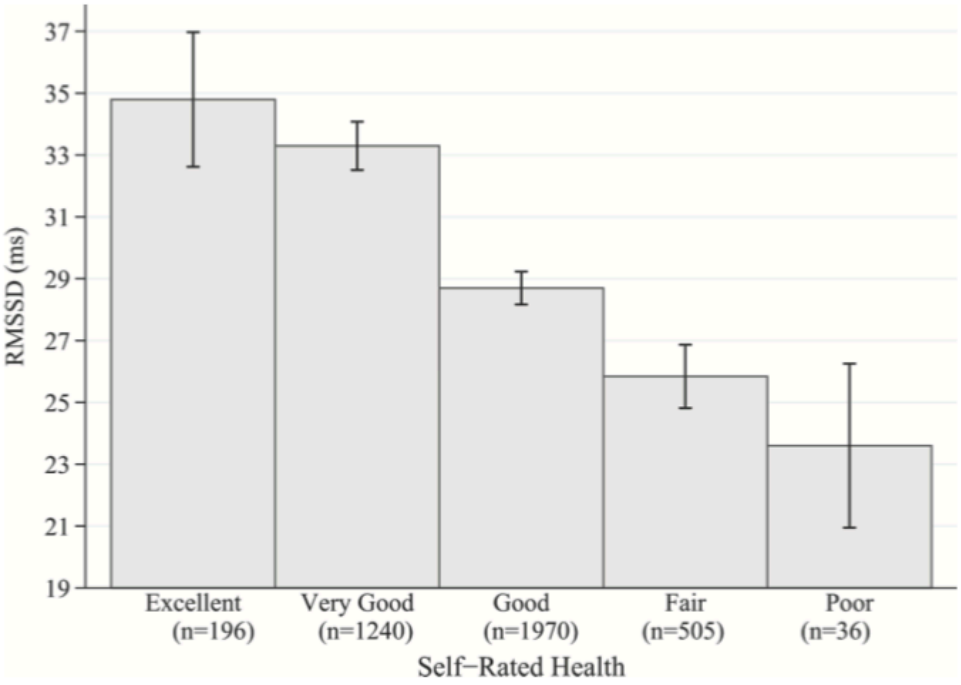


What can HRV tell us - resilience

People with high HRV experience lower psycho-social stress and enjoy better overall health

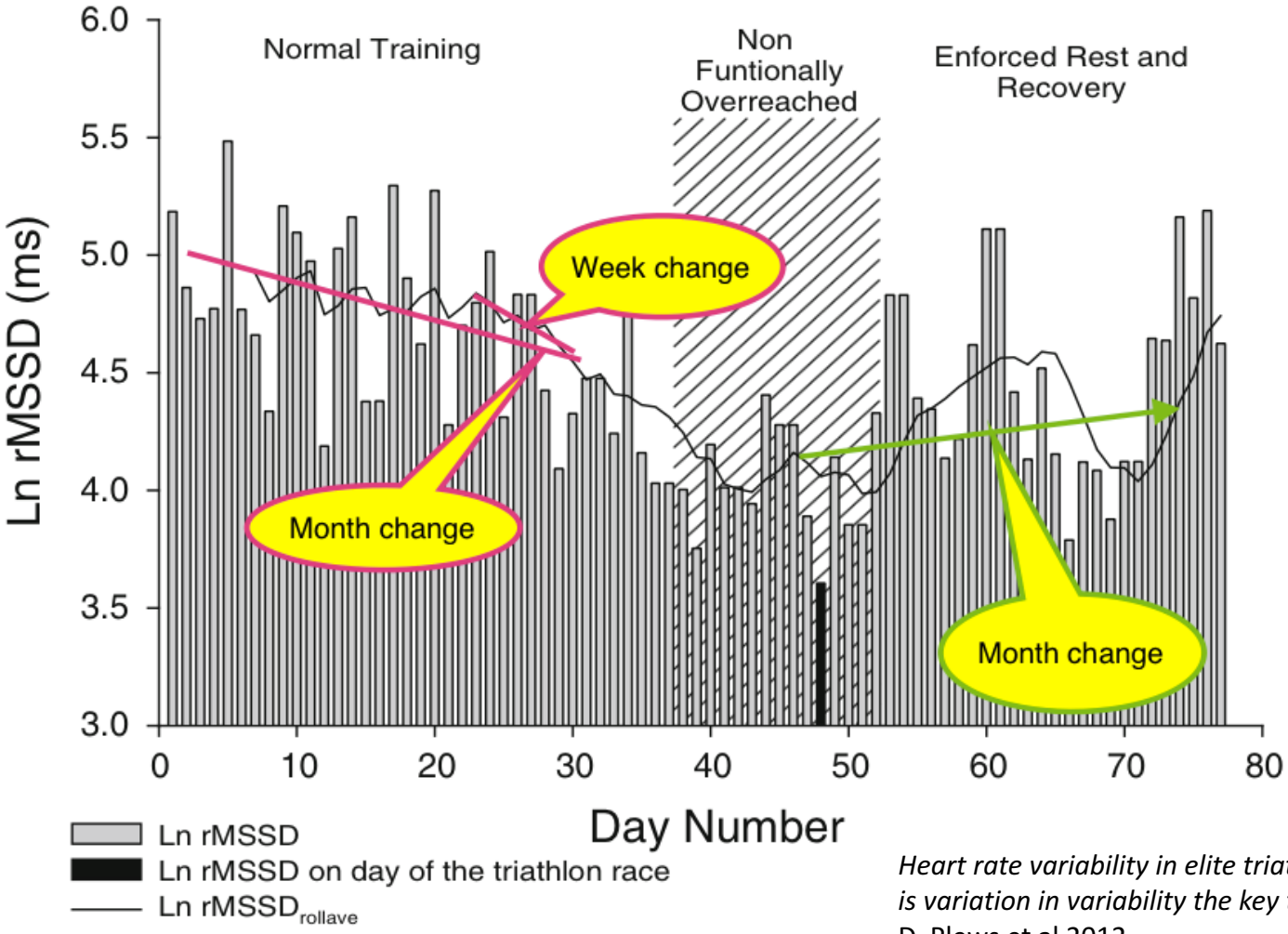


Heart rate variability is associated with psychosocial stress in distinct social domains
A. Lischke 2018



Self-rated health HRV
Jarczok 2015

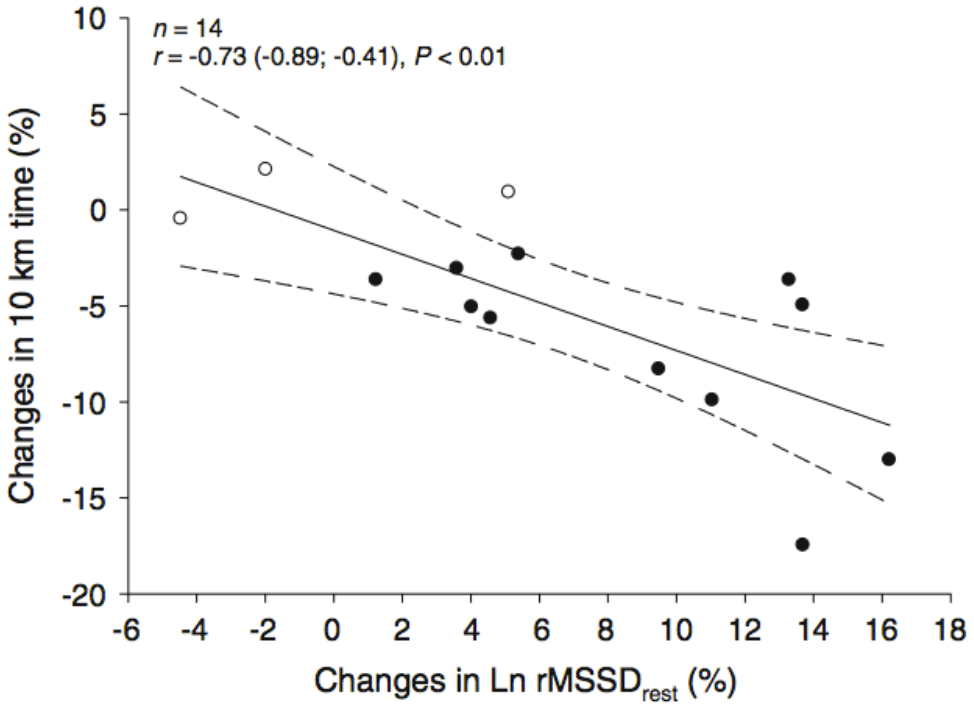
What can HRV tell us - detecting Non Functional OverReaching



Heart rate variability in elite triathletes, is variation in variability the key to effective training?
D. Plews et al 2012

What can HRV tell us – adaptation & performance improvement

10 km club runners

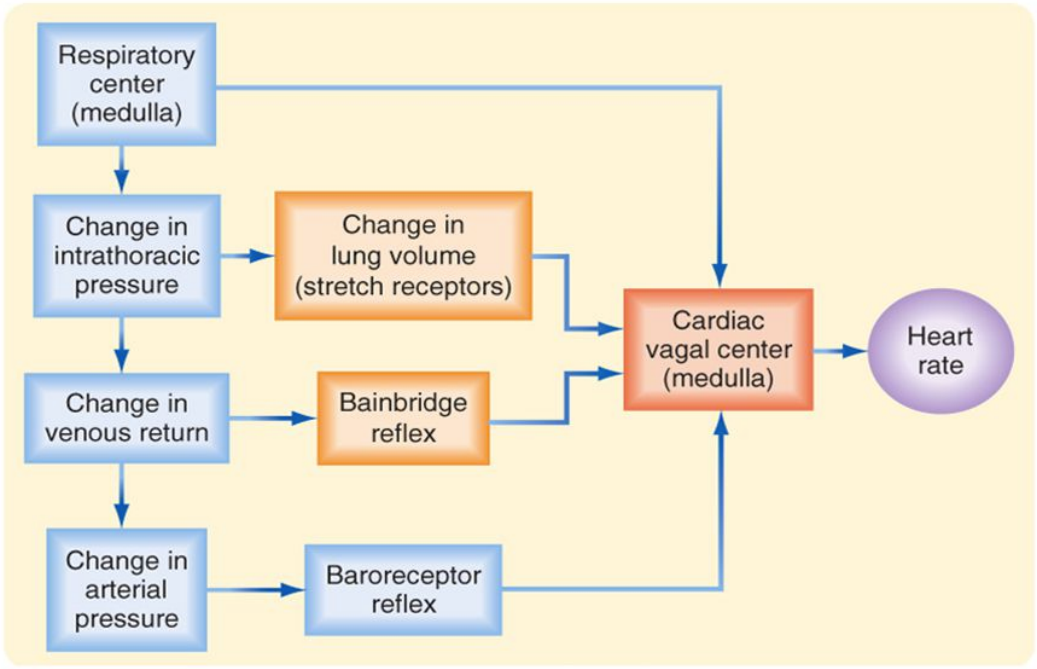


- ✓ Improvements in performance correlated with changes in HRV
- ✓ Runners with lowest starting HRV improved most

Monitoring endurance running performance using cardiac parasympathetic function
M. Buchheit et al 2009

Why is HRV controversial – physiological origin?

Respiratory Sinus Arrhythmia



- RSA (HF HRV) generated by complex set of cardiovascular and respiratory reflexes

Why is HRV controversial?

2. Large variation in successive measures
   - 12% CV in ultra short LnRMSSD (Al-Haddad, spontaneous breathing)
3. Lack of clear guidance on protocol
   - Time of day, body position, duration, frequency, breathing, environment
4. Relationship between acute TL and daily HRV changes
   - No perfect inverse correlation
   - HRV change ~ Resilience – accumulated Total Load (Kiely 2017)

Why is HRV controversial?

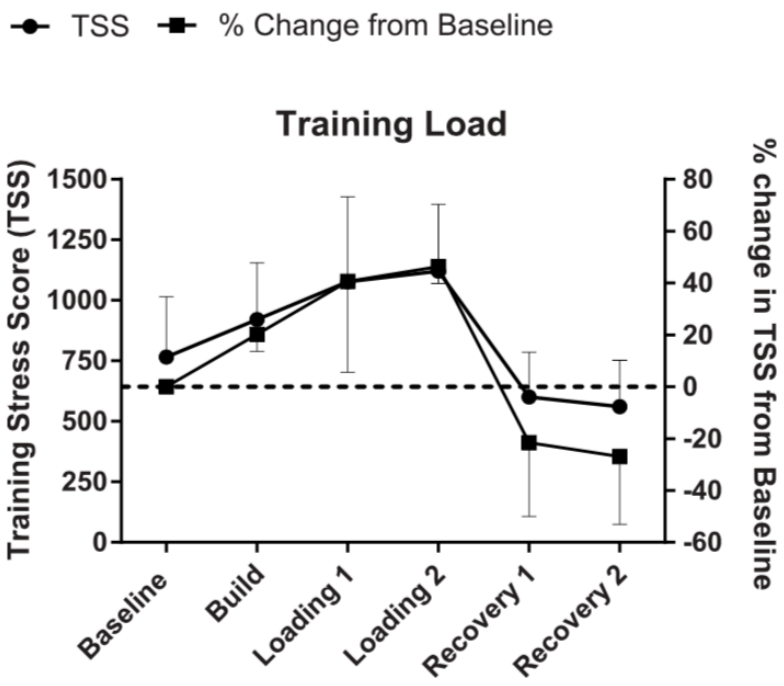
5. Sensor choice & signal quality
   - ECG best, validated HRM OK, pulse only with great care

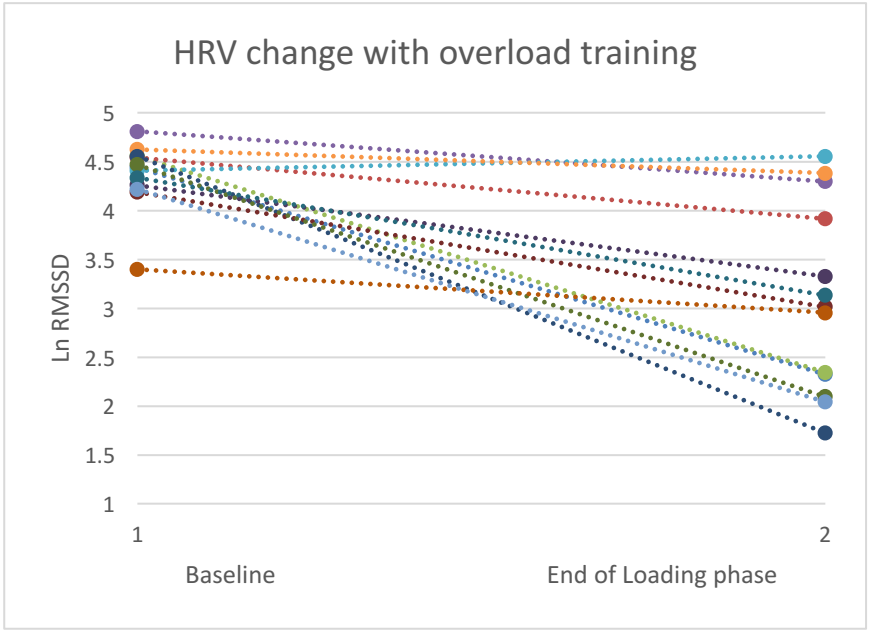


   - Even one undetected artifact can distort a measure

6. Ambiguity interpreting positive & negative changes
   - Acute stress => HRV ↓
   - Chronic stress => HRV ↑

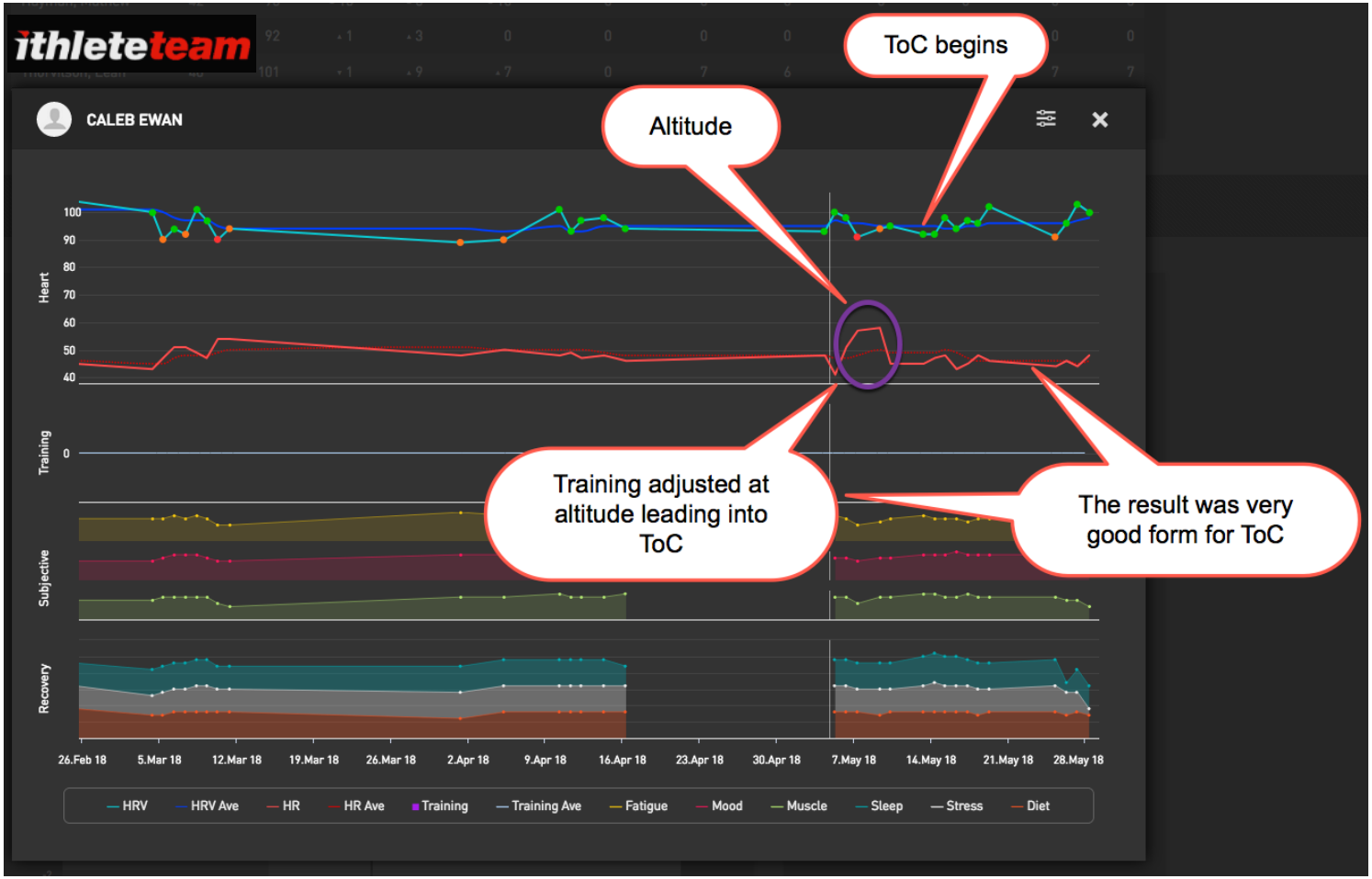
Heterogeneity of HRV responses to overload





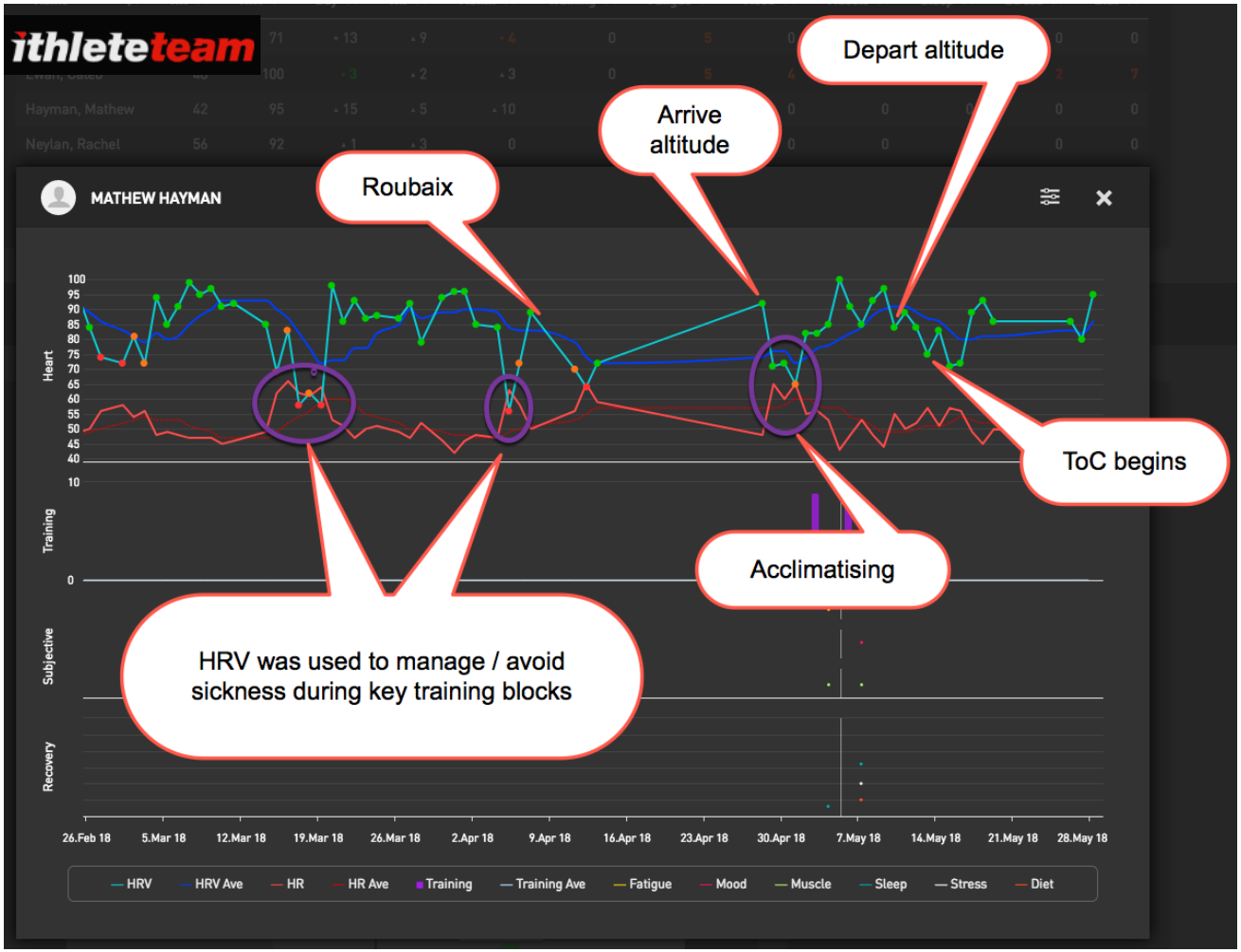
The effects of intensified training on resting metabolic rate (RMR), body composition and performance in trained cyclists. Woods et al 2017

Case studies: Caleb Ewan altitude acclimatisation



Source: Powerhouse Cycling

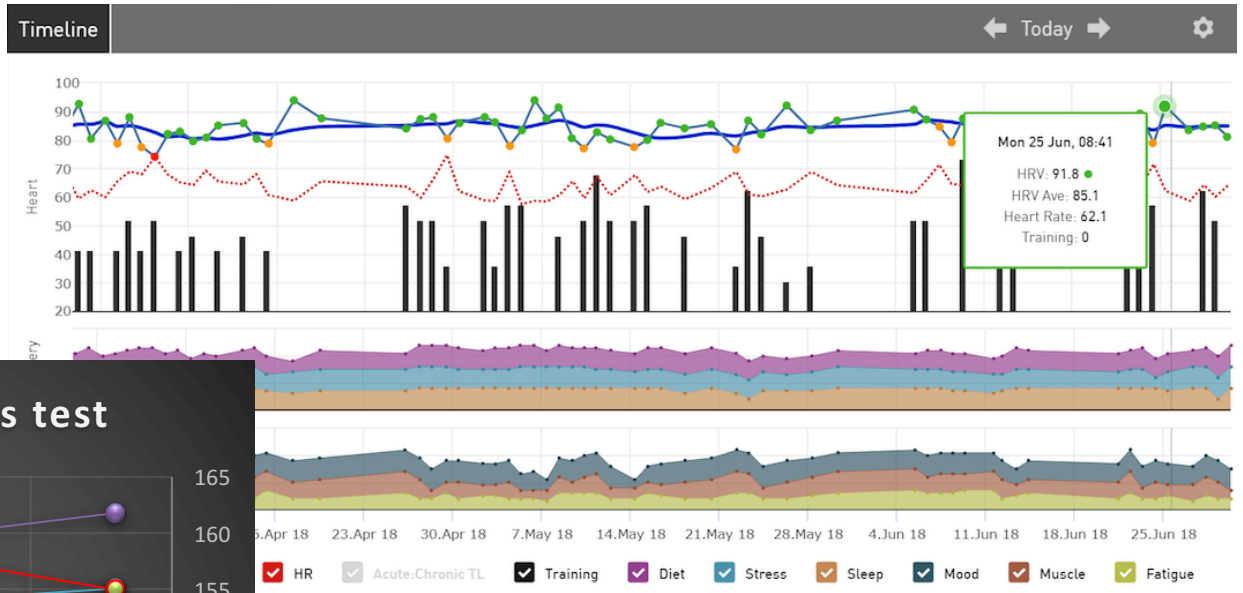
Case studies: Mat Hayman Roubaix & ToC prep

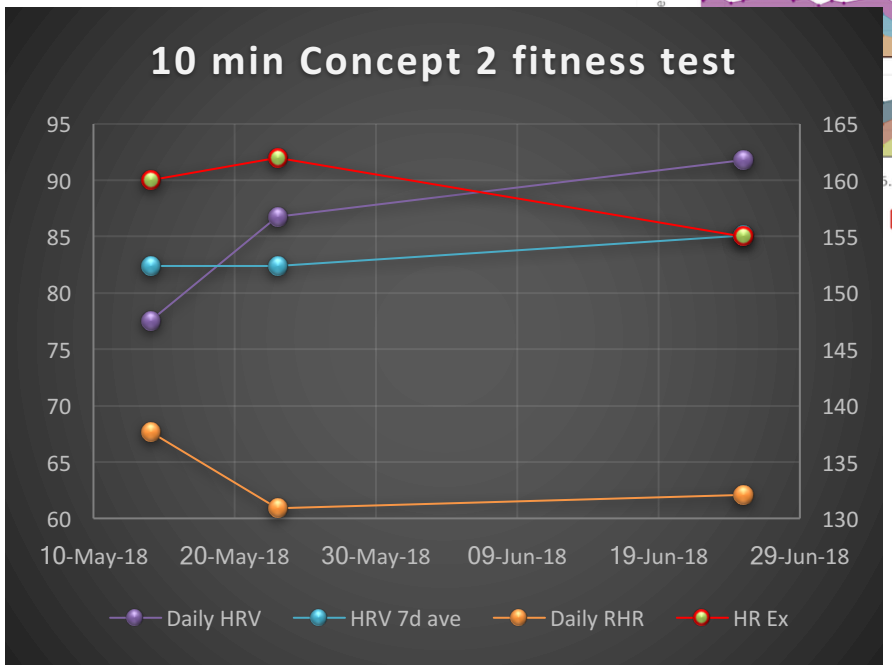


Source: Powerhouse Cycling

Case studies: Elite Downhill Racer adaptation

Daily HRV / RHR measures





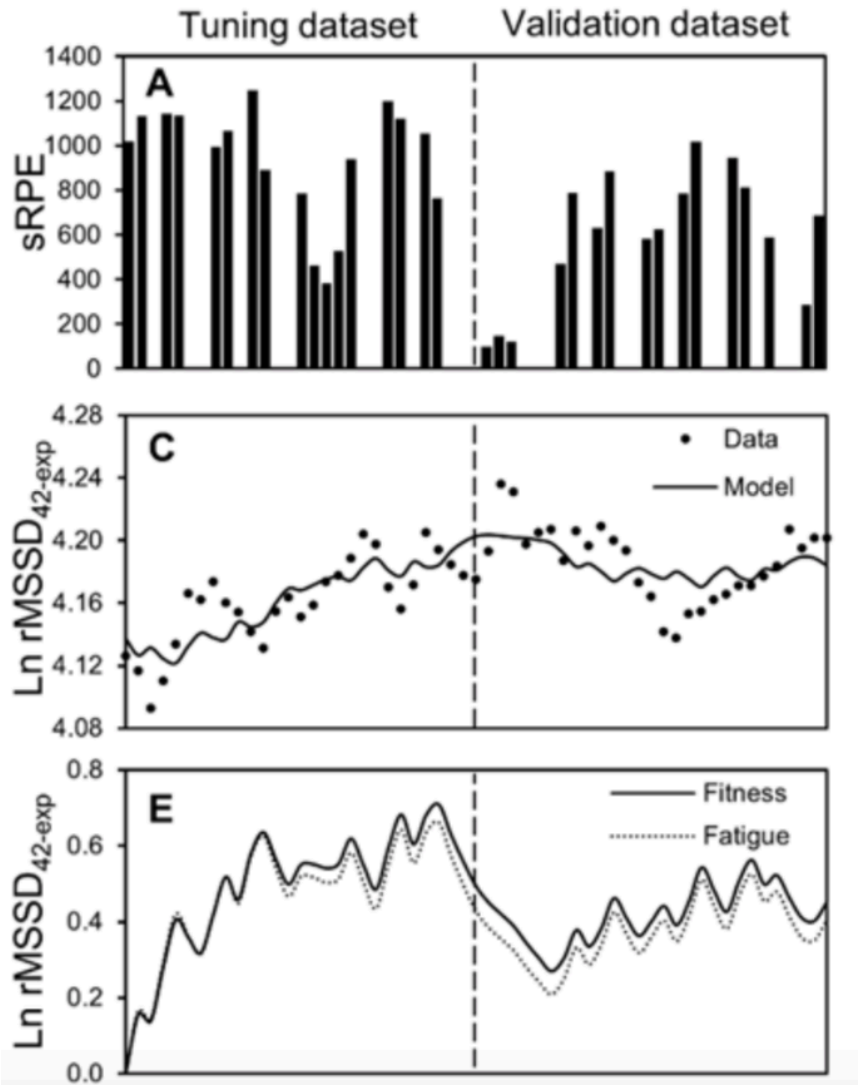
Concept 2 readiness tests

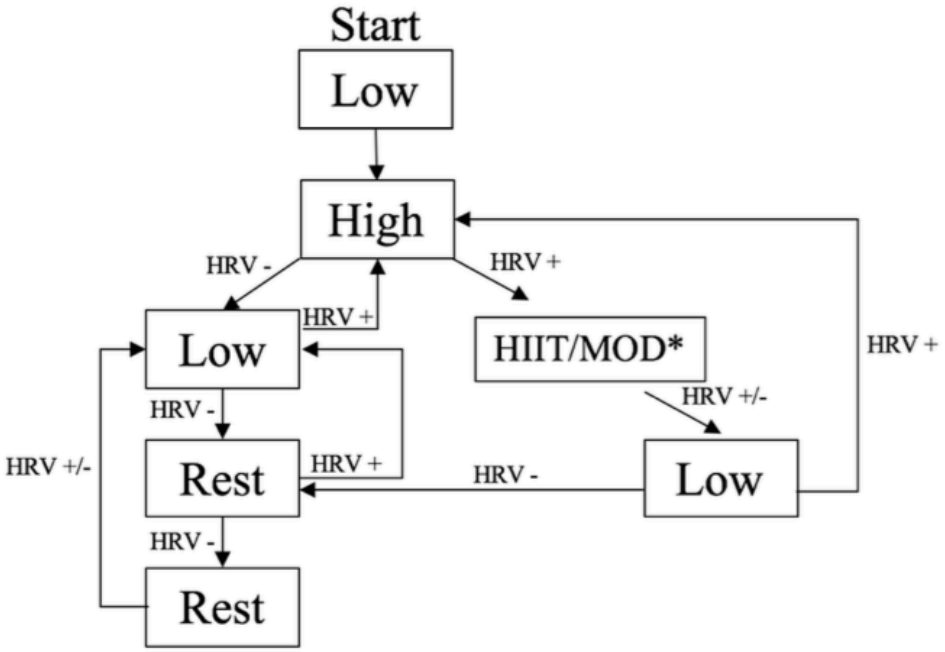
- 10 min
- 2500m
- 210 W

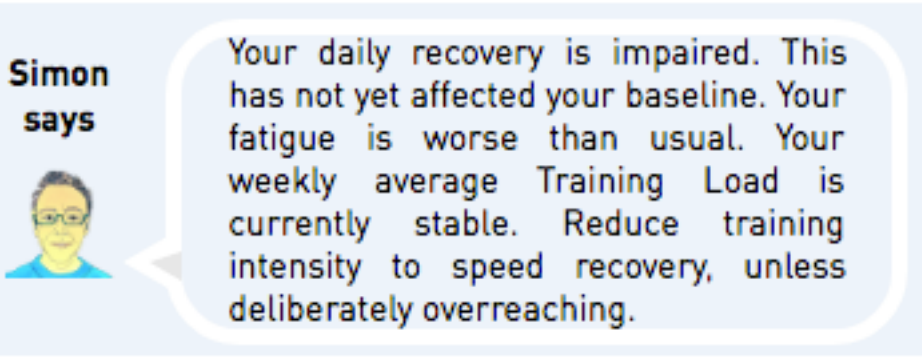
Data supplied by:

PGINT ATHLETIC DEVELOPMENT

The future – using HRV and machine learning to personalise training







Best practice recommendations

- ✓ Readings taken at same time every day (waking best)
- ✓ Use validated sensors & software
- ✓ Same body position used (standing for elite / sitting for others)
- ✓ Paced breathing (7-10 Br/min for athletes)
- ✓ At least 4-5 measures per week
- ✓ Record subjectives & comments for context
- ✓ Check trends in baseline as well as daily readings / colour code
- ✓ Don’t take measure on race day

Come and visit the *ithlete* stand to discuss HRV further – thank you!

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