HEART RATE AND HEART RATE VARIABILITY: STILL USEFUL FOR TRAINING MONITORING?

6th International Congress Mountain Sport & Health

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EA 3920 Prognostic markers and regulatory factors of heart and vascular diseases; Exercise Performance, Health, Innovation platform

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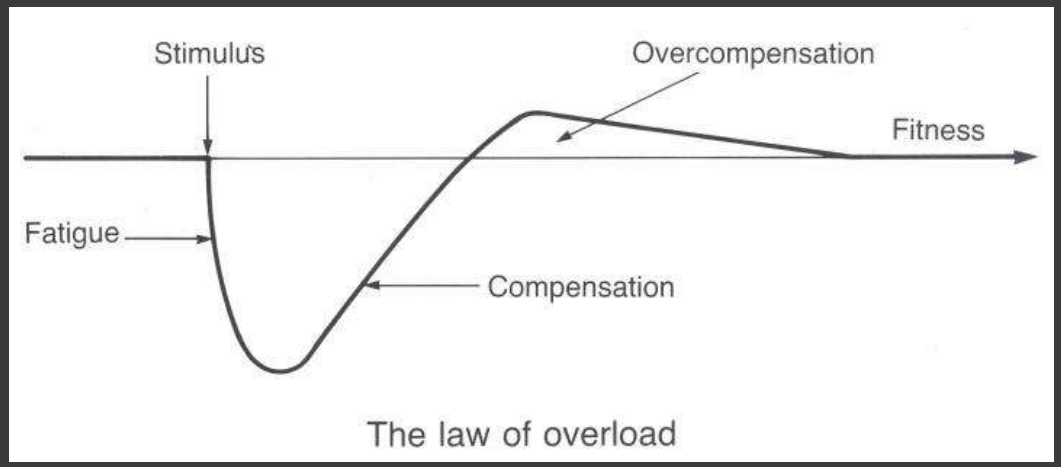
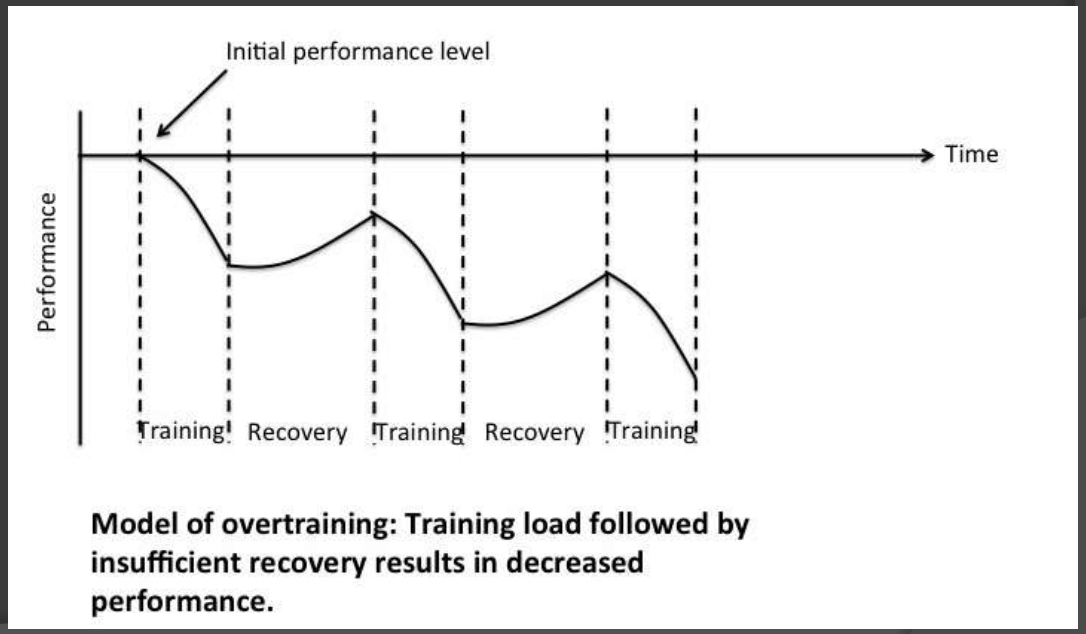
Generality



The law of overload



Model of overtraining: Training load followed by insufficient recovery results in decreased performance.

Training / fatigue

- Underlying mechanisms not well known and difficulty to correctly appreciate workload.
- Normal response or real fatigue?
- Complex phenomenon dependant on biological and psychological factors

Shephard
Sports Med 2001; 31:167-194

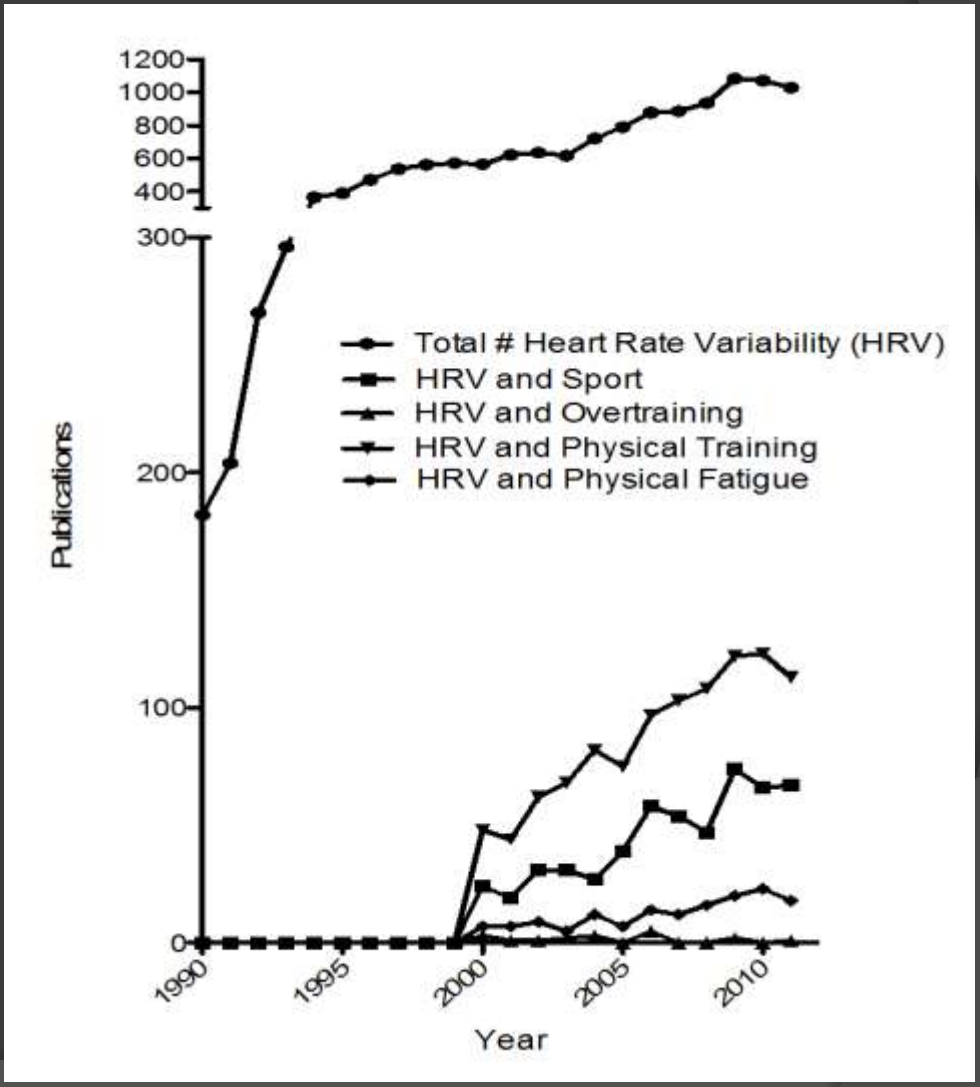
Training / fatigue

- Monitoring tools? Early detection? Prevention ?
  - **cost?**
  - **Invasive?**
  - **Technical considerations?**
  - **Reliability?**
  - **Repeatability?**
  - **Sensibility?**

HR and HRV?

Heart rate / Heart rate variability

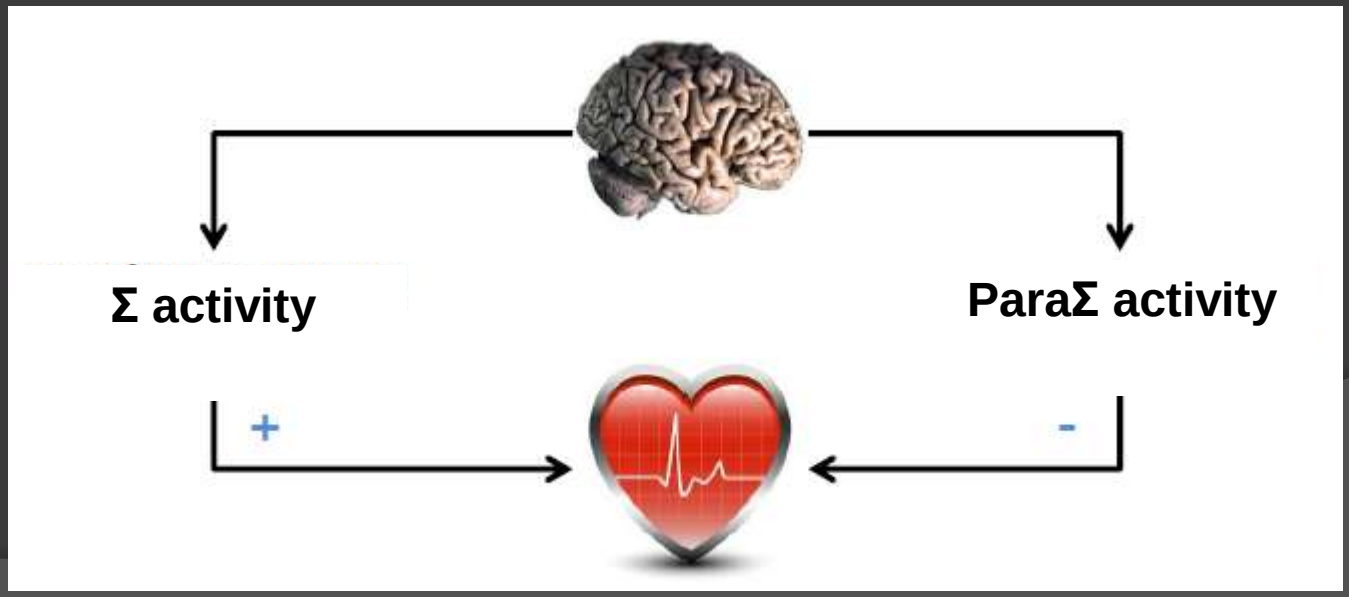
Makivić et al.
JEPonline 2013; 16(3):103-131



Heart rate / Heart rate variability

- **Sinus node regulation**
- **HR = HRi * SNS * PNS**

Rosenblueth and Simeone
Am J Physiol 1934;110:42-55



HRV & ANS activity evaluation

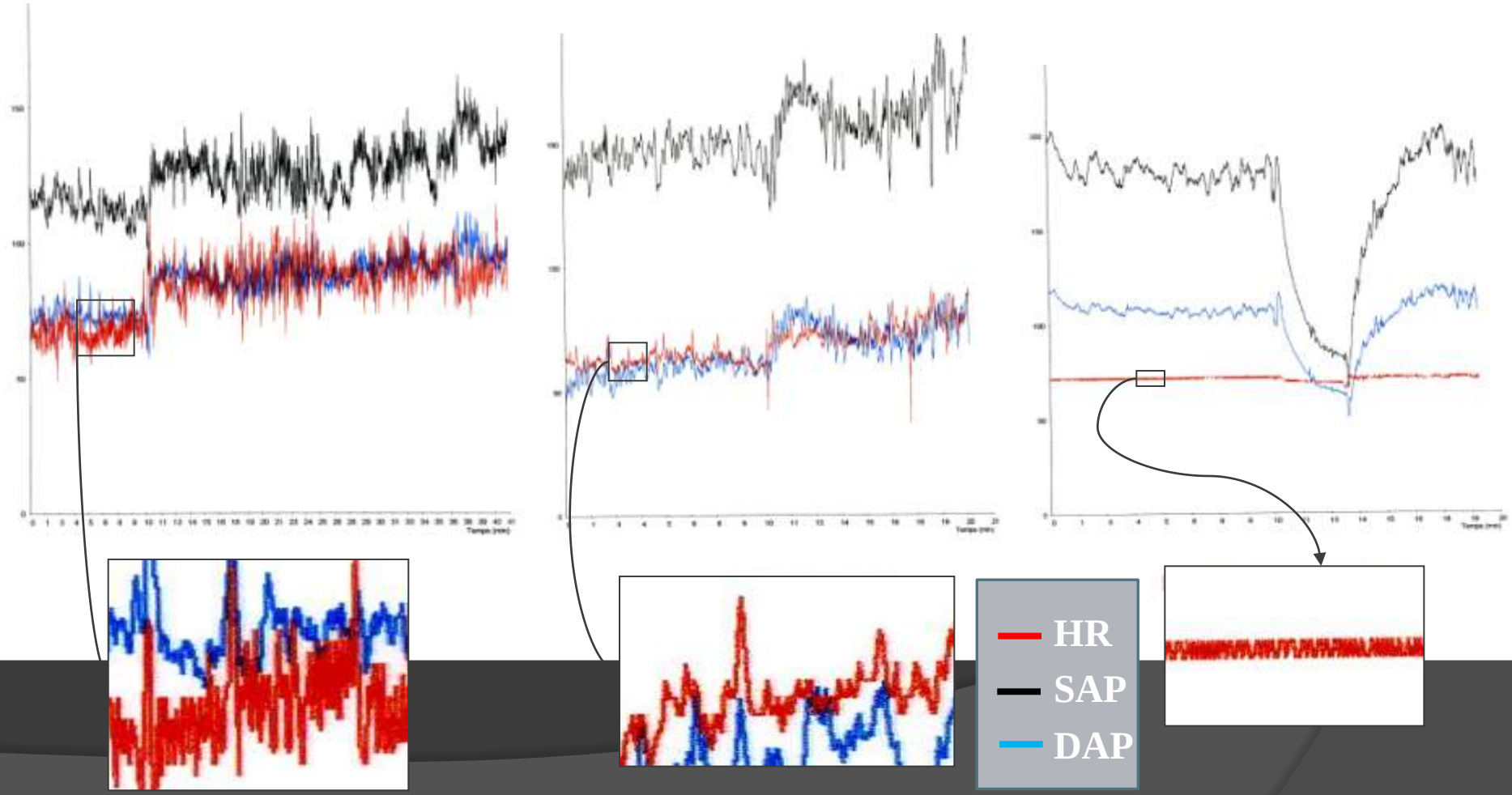
- HRV is non-invasive measure
  - of ANS activity: no
  - of the regulation by ANS of the heart: yes but…
  - Of the sinus node response to the ANS activity: yes

Why HRV?

25 years, healthy

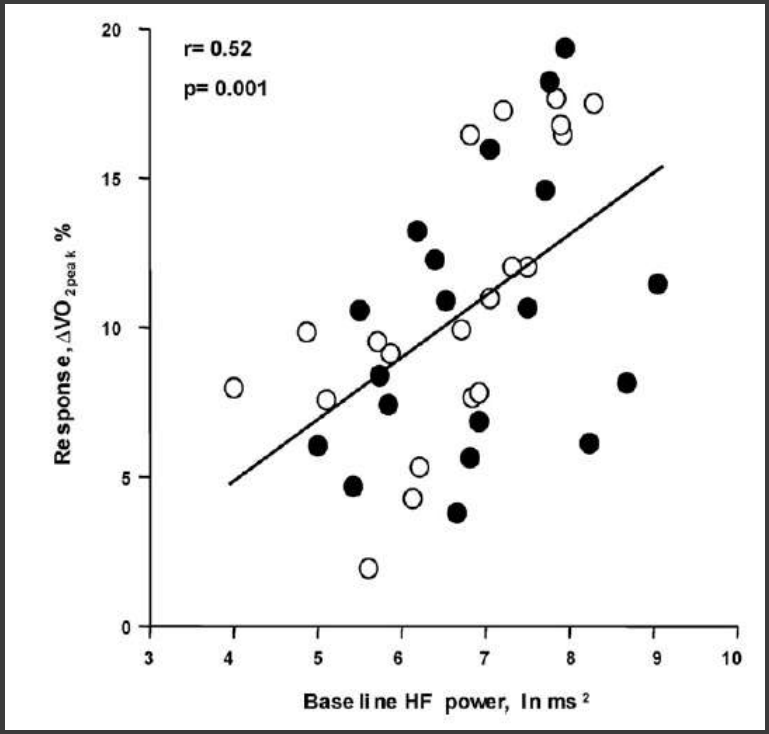
60 years, healthy

Patient with neuropathy



Why evaluate ANS activity ?

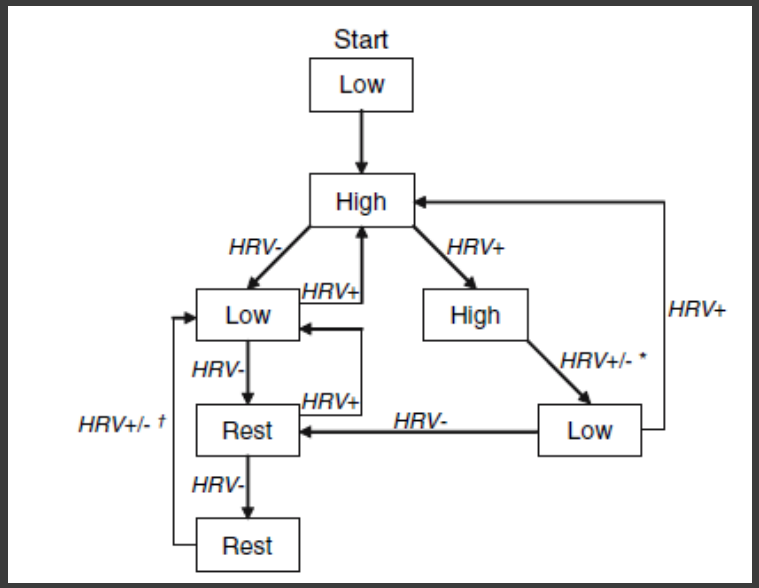
- Individual responses to aerobic exercise



Hautala et al.
Am J Physiol Heart Circ Physiol 2003;285: H1747–H1752
Neuroscience and Behavioural Reviews 2009; 33:107-115

Why evaluate ANS activity ?

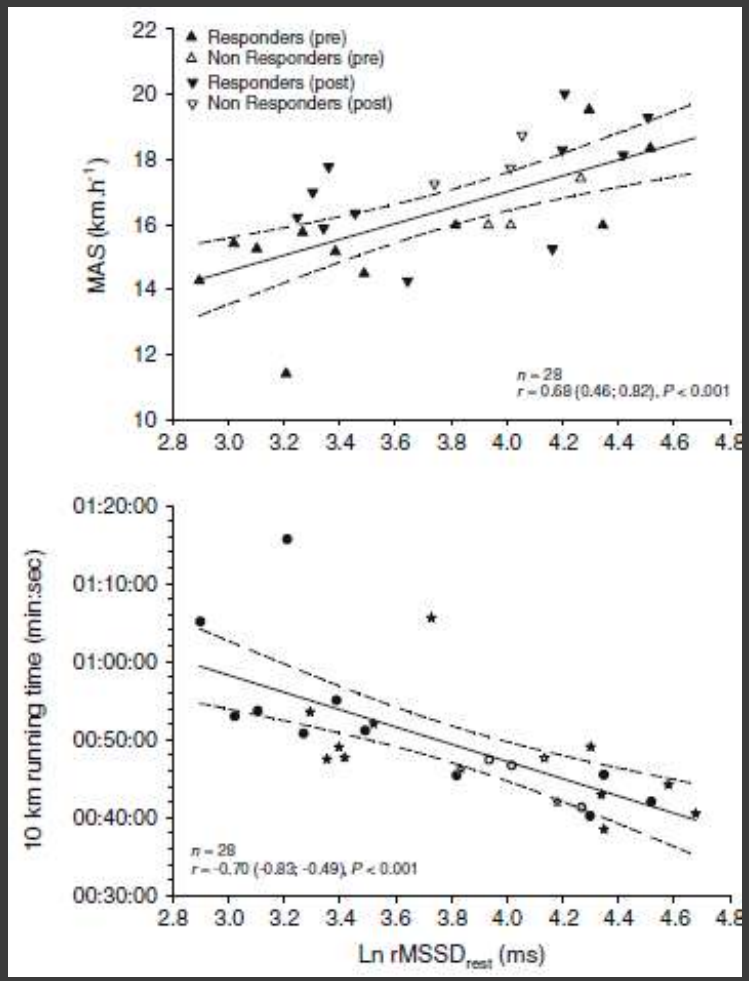
- Tailored training

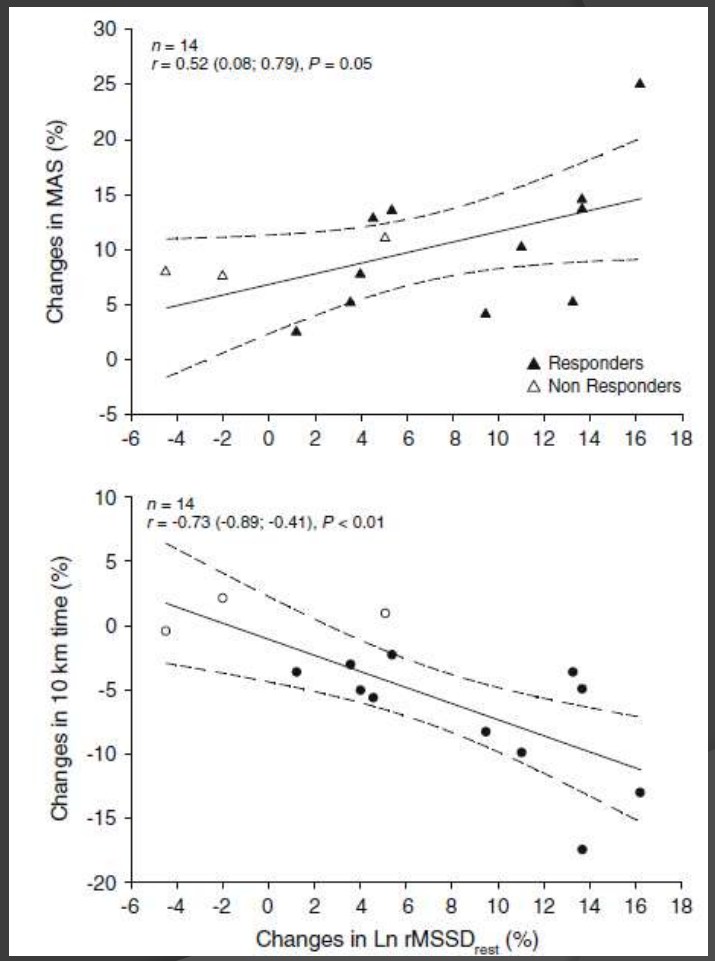


Kiviniemi et al.
Eur J Appl Physiol 2007; 101:743-751
Med Sci Sport Exer 2010; 42(7):1355-1363

- High intensity session if increase or no change in morning HRV.

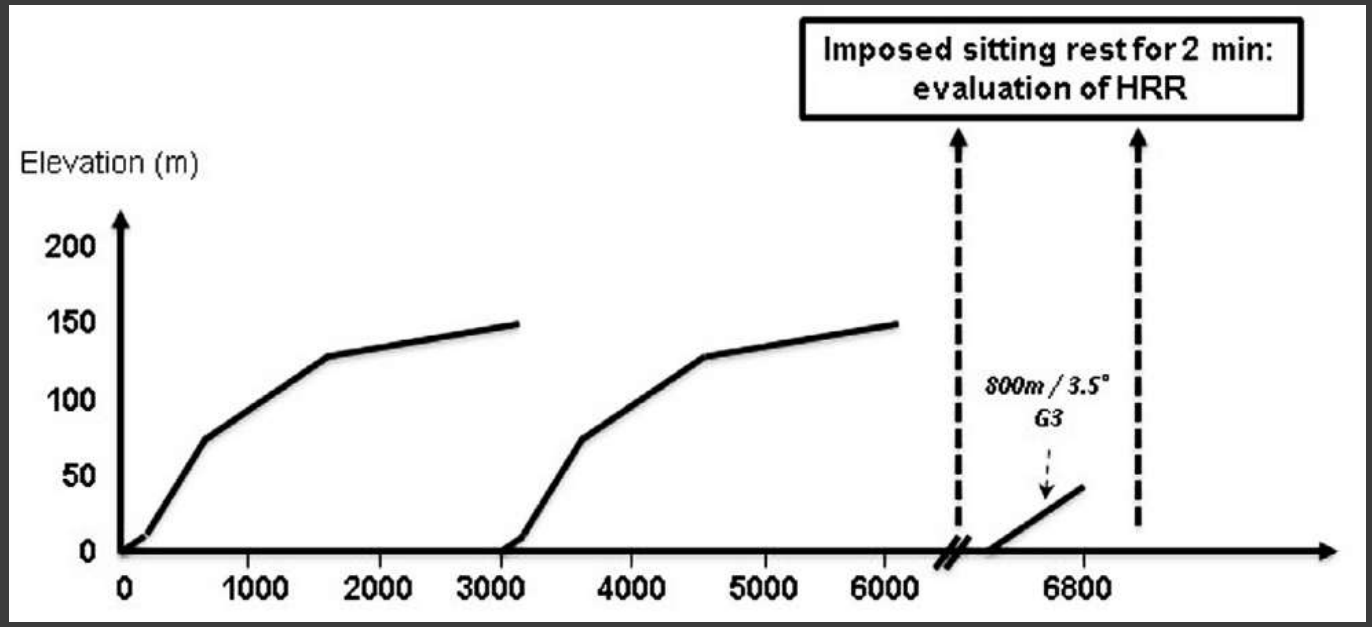
Link with performance ?





Buchheit et al.
Eur J Appl Physiol 2010 ; 108 : 1153-1167

Link with performance ?



Mourot et coll.
Int J Sports Physiol Perf 2015 ; 10 : 11-16

Link with performance?

Table 3 Correlation Coefficients (90% Confidence Limits) Between the Final Performance Time, Cardiopulmonary Variables, Blood Levels of Lactate, and the Postexercise Heart-Rate-Recovery Indexes Calculated During the 6-km and 800-m Time Trials, N = 10

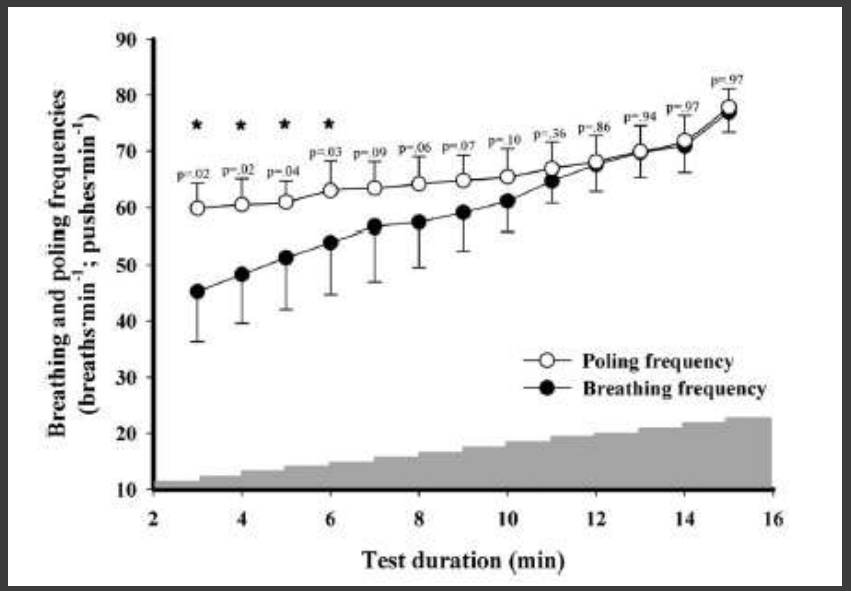
		Final time	VO_{2max}	Mean % VO_{2max}	Mean % HR_{peak}	Final BLa
6-km time trial	HRR60s	.39 (−.21; .78)	−.21 (−.68; .39)	−.21 (−.68; .39)	.03 (−.53; .57)	−.38 (−.22; .77)
	nHRR60s	.37 (−.23; .77)	−.23 (−.69; .37)	−.20 (−.68; .40)	−.04 (−.58; .52)	−.38 (−.22; .77)
	T30	.27 (−.33; .72)	−.13 (−.64; .45)	−.44 (−.80; .15)	.20 (−.40; .68)	.47 (−.11; .81)
Submaximal exercise	HRR60s	.09 (−.49; .61)	−.31 (−.74; .29)	.07 (−.50; .60)	−.15 (−.65; .44)	−.44 (−.80; .15)
	nHRR60s	.07 (−.50; .60)	−.31 (−.74; .29)	.08 (−.49; .61)	−.17 (−.66; .42)	−.44 (−.80; .15)
	T30	−.36 (−.24; .76)	**−.58 (−.86; −.04)**	.08 (−.49; .61)	.25 (−.35; .70)	.30 (−.30; .73)
800-m time trial	HRR60s	−.21 (−.68; .39)	.16 (−.43; .65)	.17 (−.42; .66)	−.27 (−.72; .33)	−.43 (−.79; .16)
	nHRR60s	.07 (−.50; .60)	.15 (−.44; .65)	.17 (−.42; .66)	−.28 (−.72; .32)	−.45 (−.80–.14)
	T30	**.59 (.06; .86)**	**−.68 (−.90; −.20)**	−.50 (−.82; .07)	.16 (−.43; .65)	−.19 (−.67; .4)

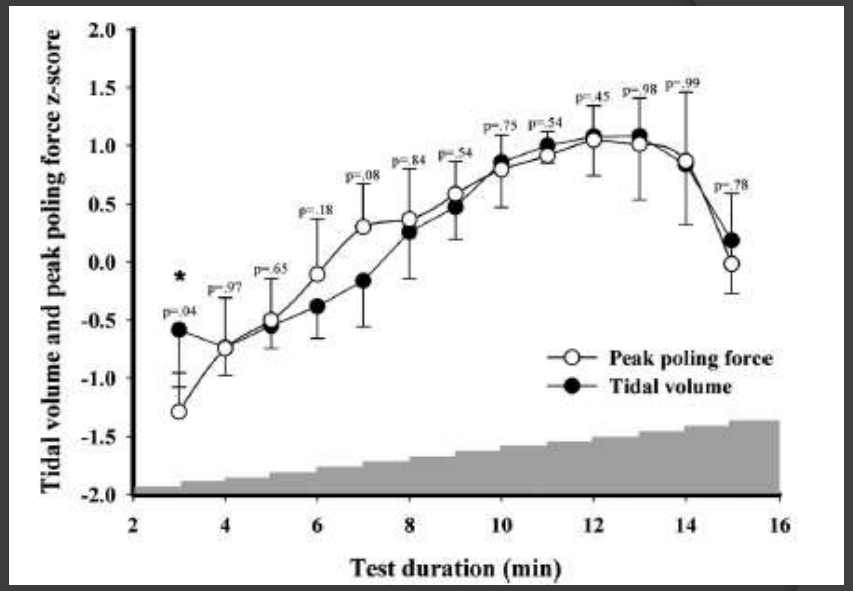
Abbreviations: VO_{2max}, maximal oxygen consumption; HR, heart rate; BLa, blood lactate during the time trial; HRR60s, difference between HR at the end of exercise and 60 s later; nHRR60s, HRR60s data expressed as a percentage of the final HR; T30, time constant for the short-term (10–40 s) postexercise recovery of HR.

Note: Bold indicates a clear relationship.

Mourot et al.
Int J Sports Physiol Perf 2015 ; 10 : 11-16

Upper body influences





Strength Cond Res 2012; 26(2): 381–387

Anaerobic Threshold Assessment Through the Ventilatory Method During Roller-Ski Skating Testing: Right or Wrong?

Nicolas Fabre,[1] Lorenzo Bortolan,[1,2] Barbara Pellegrini,[1,2] Livio Zerbini,[1,2] Laurent Mourot,[3,4] and Federico Schena[1,2]

Upper body influences

- HRV for determination of ventilatory thresholds: running/cycling

  Cottin et al.
  Int J Sports Med. 2006;27(12):959–967
  Int J Sports Med. 2007;28(4):287–294

- Swimming / XCskiing / Ski mountaineering
  - Need to take into account the activity of the arms

Di Michele et al. *Strength Cond Res*. 2012;26(11):3059–3066
Mourot et al. *Int J Sports Physiol Perf 2014, 9, 695-701*
Cassirame et al. *Eur J Sport Sci.2015 Oct;15(7):615-22*

Training induced fatigue

- **Classification**
  - **Sympathic (Basedow)**
  - **Parasympathic (Addisson)**

Israel
Medizin und Sport 1976; 16:1-12

Barron et al.
J Clin Endocrinol Metab 1985; 60:803-806

Monitoring & fatigue prevention

Pichot et al.
Med Sci Sports Exerc 2002; 34:1660-1666

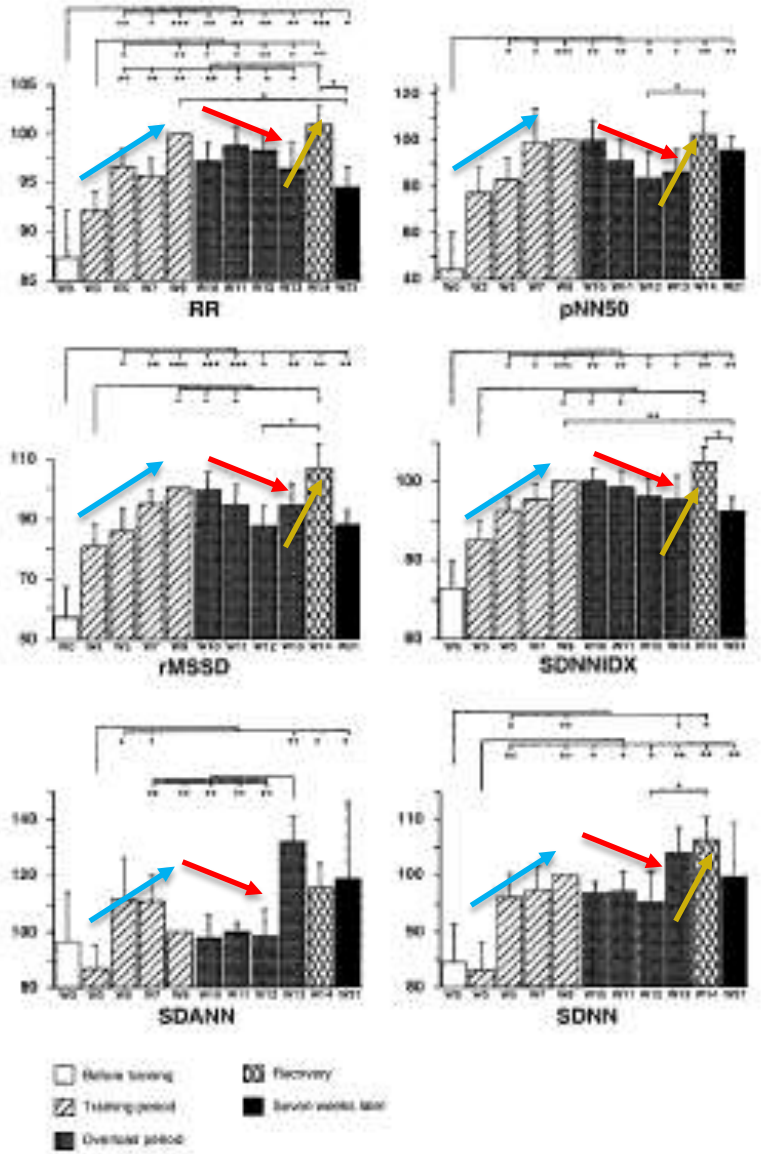
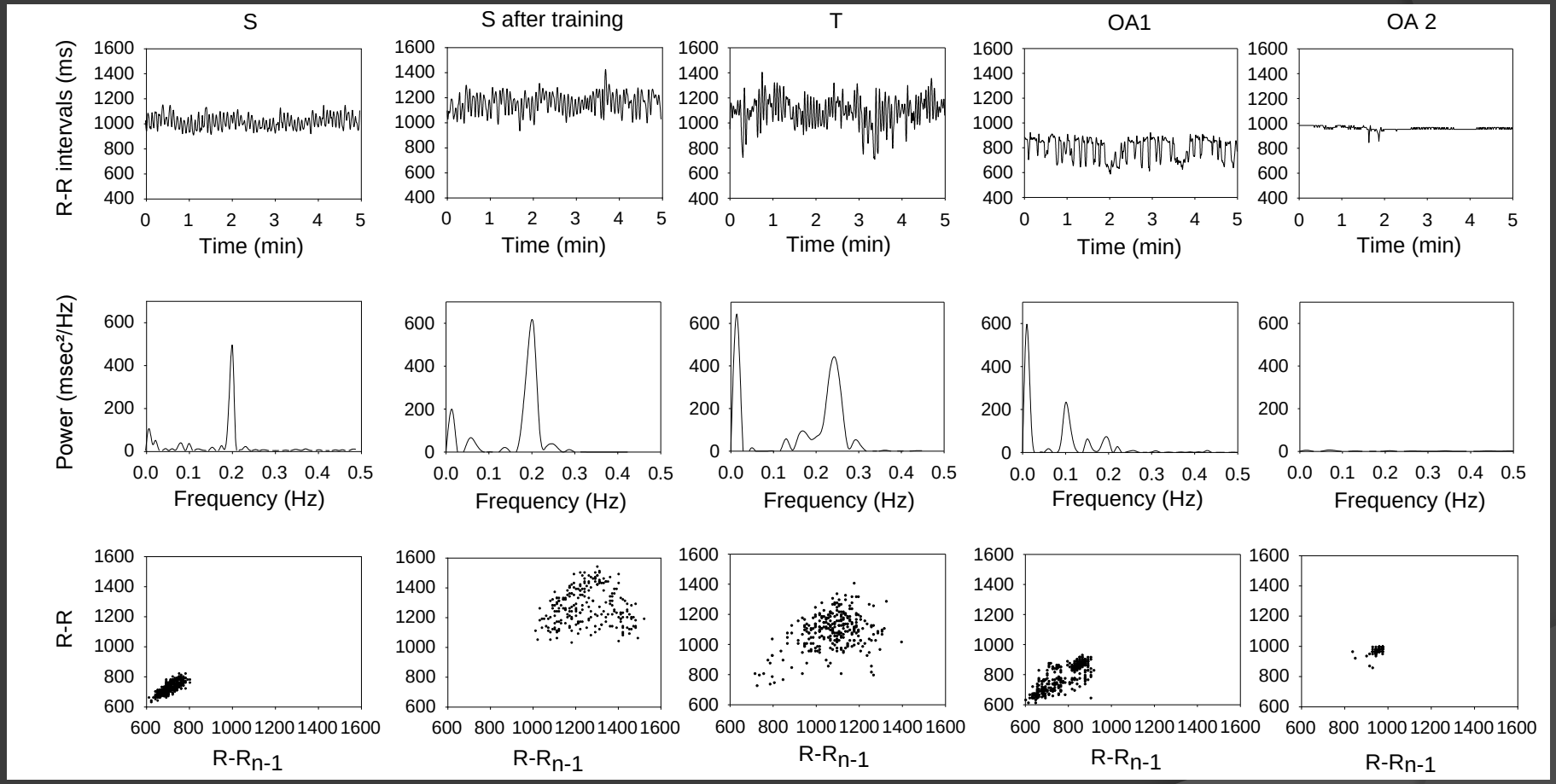


FIGURE 2—Evolution of the time domain indices of heart rate variability calculated on nocturnal periods along the protocol, including basal values measured before the beginning of the protocol (W0); the 8 wk of training period and the following recovery transition week (W3, W5, W7, and W9); the 4 wk of overload training period (W10, W11, W12, and W13); the recovery week (W14); and 6 wk after the end of the protocol (W21). All the calculations were assessed in reference to the week 9 (W9). * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

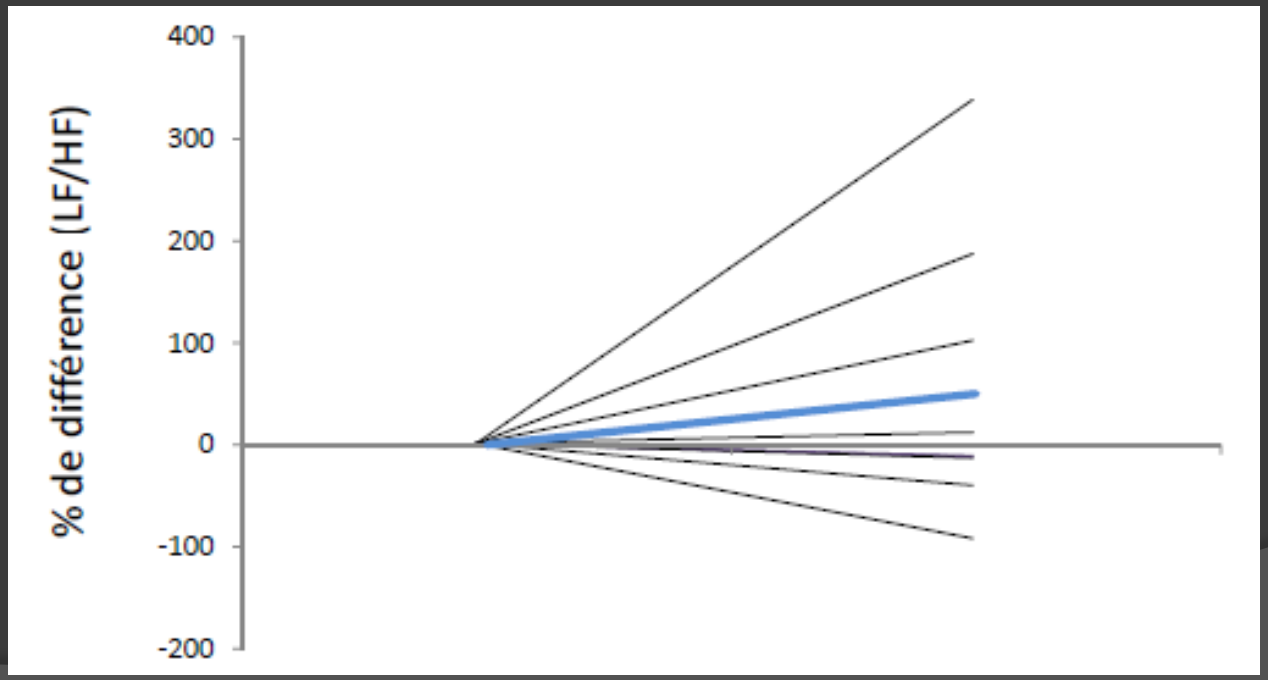
Monitoring & fatigue prevention



Mourot et al.
Clin Physiol Funct Imaging 2004; 24:10-18

Monitoring & fatigue prevention

- LF/HF
  - ~ -10% normal training
  - ~ + 50% overload

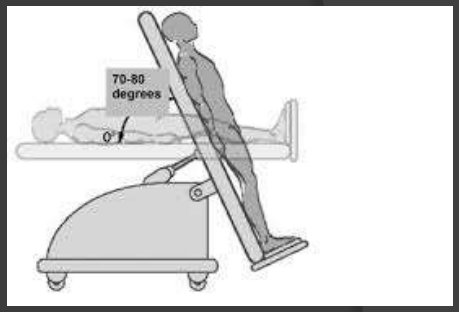


Uusitalo et al.
Int J Sports Med 1998; 19 : 532-540

Measurement

- **During night**

  Brandenberg et al. *Auton Neurosci 2005 ; 121 : 81-86*

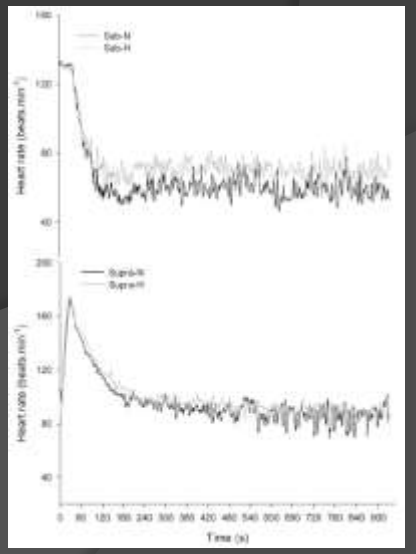


- **Tilt-test (passive or active)**

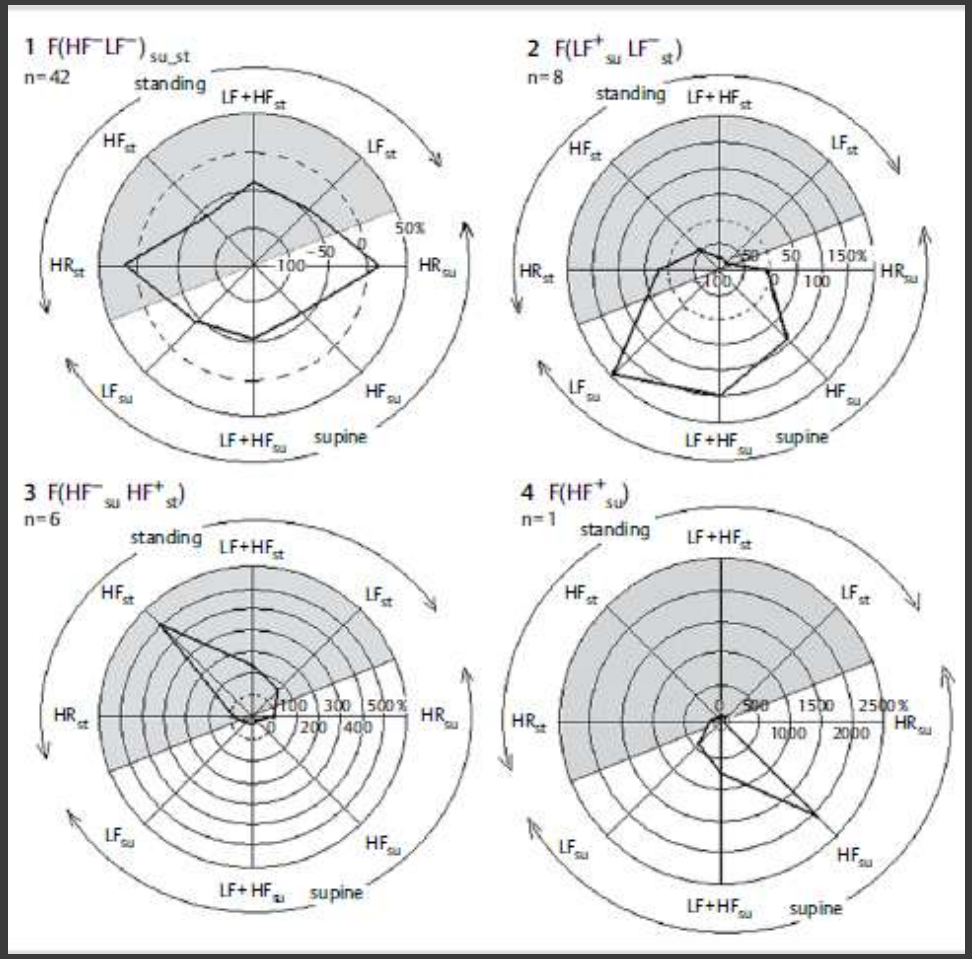
  Schmitt et al. *PLOS ONE 2013; 8(8): e71588*

- **Post exercise recovery**

  Al Haddad et al. *Int J Sports Med 2011; 32(8): 598-605*



Monitoring & fatigue prevention



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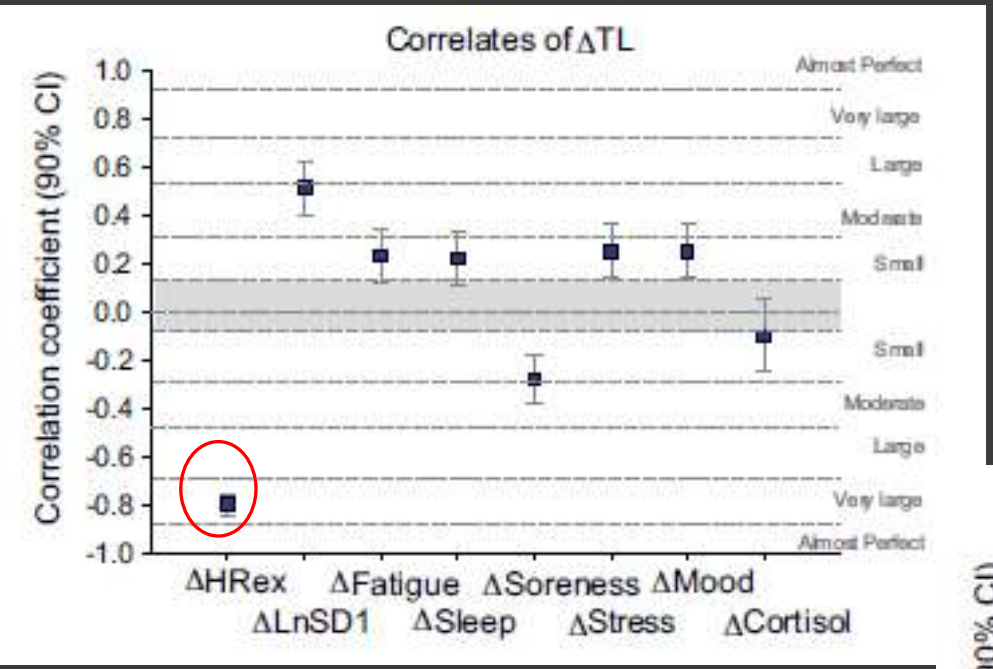

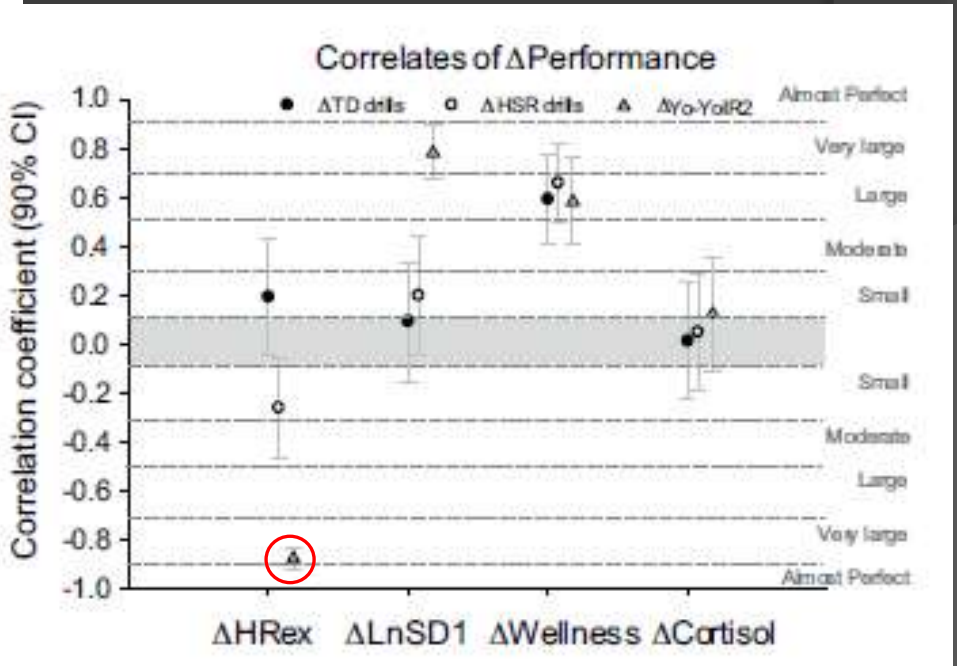

Buccheit et al.
J Sci Med Sport 2013; 16:550-555

Conclusion

- **HR and HRV are useful**
  - easy and valide measurement of the sinus node response to the ANS activity
  - Training response / performance / fatigue
- HRV depends on sympathomimetic influence
- Not really reproducible
- Required highly standardised conditions
- **Use for monitoring required carefulness and other tools such as psychological tools.**

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