Monitoring the training process of professional cyclists

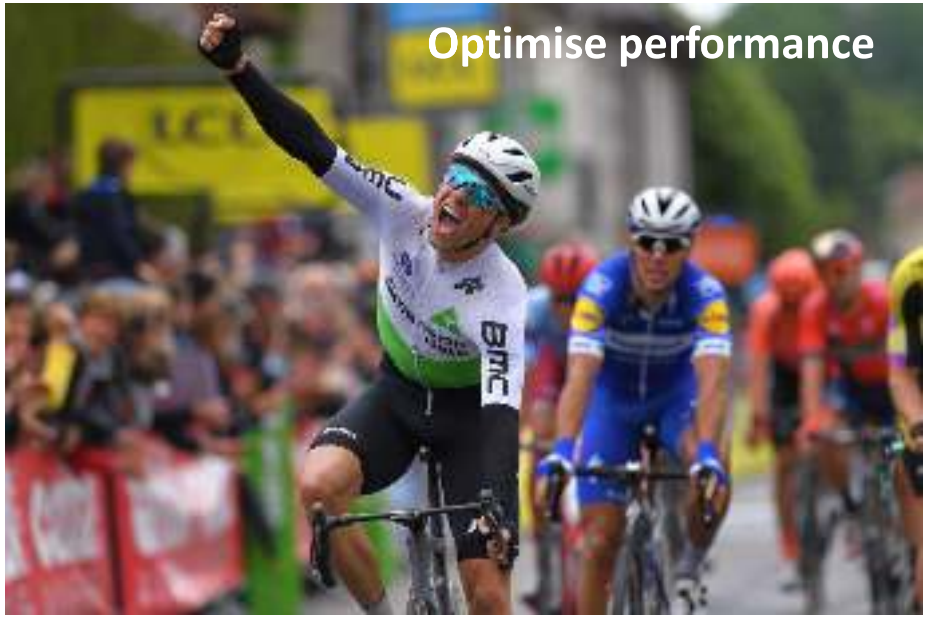
Dajo Sanders, Ph.D

Team Dimension Data for Qhubeka

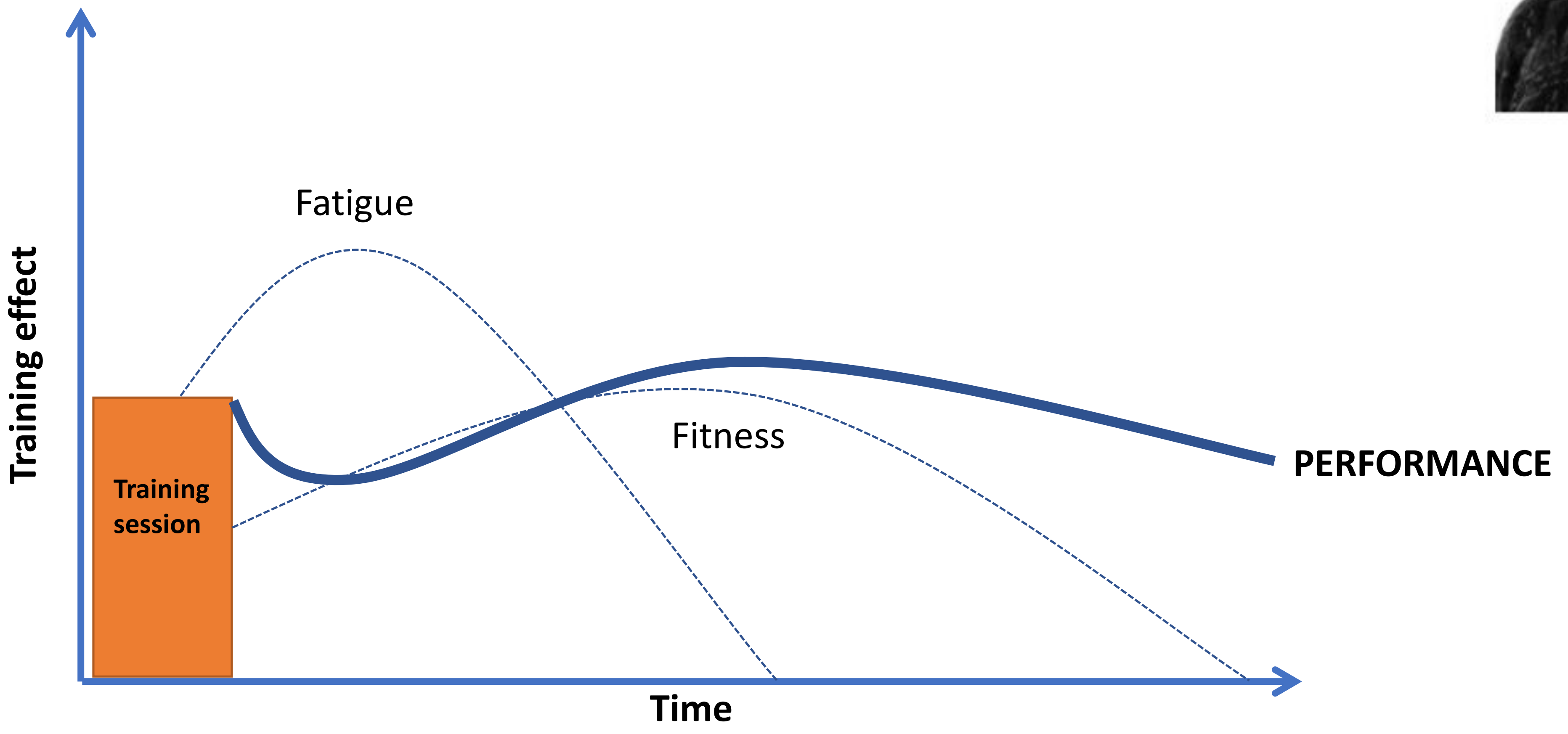
Maastricht University

Training Monitoring – Why?

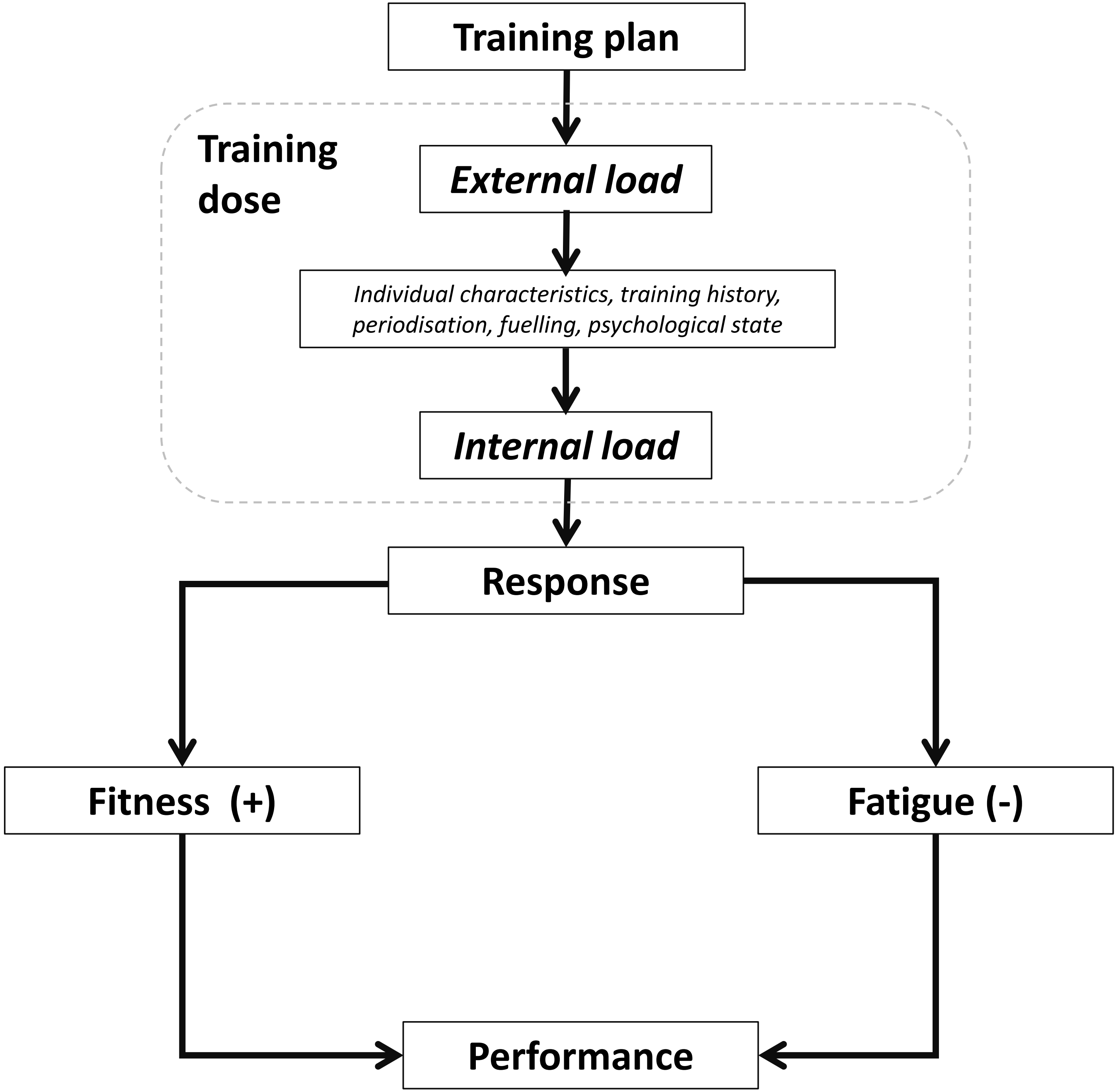
Balance between training, competition and recovery to maximise performance at specific time points during the competitive season



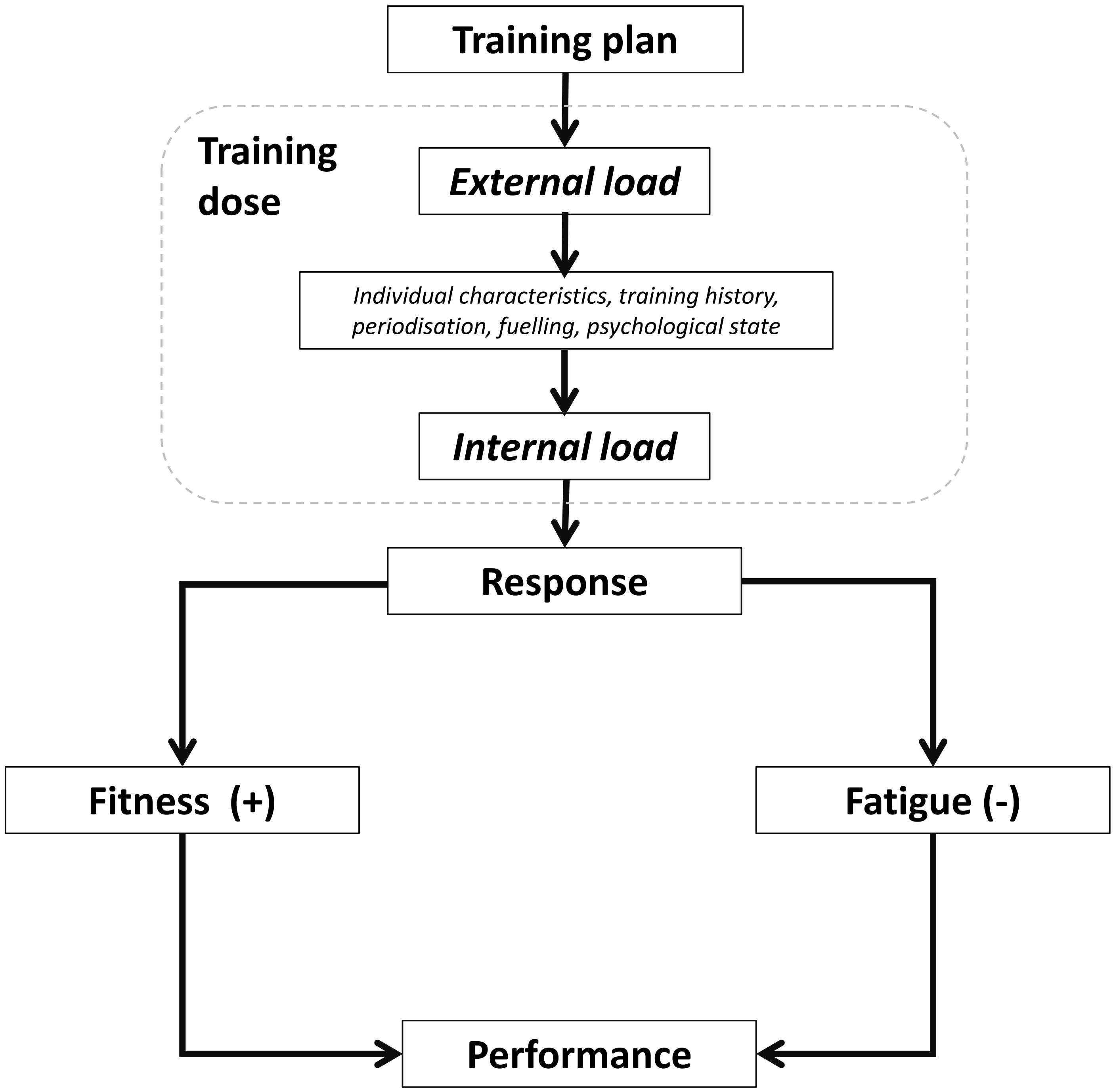
Performance = Fitness - Fatigue



Banister, 1975



Impellizzeri et al, 2005; 2019, Coutts, 2016



Impellizzeri et al, 2005; 2019, Coutts, 2016

Internal load metrics in cycling

Heart rate based

Banister’s TRIMP *(Banister & Calvert, 1975)*
Edwards’ TRIMP *(Edwards, 1993)*
Lucia’s TRIMP *(Lucia et al. 2003)*
Individualized TRIMP *(Manzi et al. 2009)*

Subjective

Session-RPE *(Foster et al. 1996)*

TABLE 2. Foster's modified Borg scale (13).

Rating	Descriptor
0	Rest
1	Very, very easy
2	Easy
3	Moderate
4	Somewhat hard
5	Hard
6	
7	Very hard
8	
9	
10	Maximal

	Zones	Intensity measure	Weighting factor	Specific to…
Banister's TRIMP	No	Mean HR	Generic blood lactate response	Gender
Edwards' TRIMP	Zone 1: 50-60% HR_{max} Zone 2: 60-70% HR_{max} Zone 3: 70-80% HR_{max} Zone 4: 80-90% HR_{max} Zone 5: 90-100% HR_{max}	HR in zones	Arbitrary (1 to 5)	Not applicable
Lucia's TRIMP	Zone 1: <VT Zone 2: >VT <RCP Zone 3: >RCP	HR in zones	Arbitrary (1 to 3)	Not applicable
iTRIMP	No	Each HR value	Individual blood lactate response	Individual
Session-RPE	No	RPE	/	/

Sanders & Akubat, unpublished

External Training Load

- **Power Output** based metrics

  Training Stress Score (TSS) *(Coggan, 2003)* TRAININGPEAKS

  → Normalized Power, FTP

  Training Load Cycling (TLC) *(Green, 2016)* today's plan

  → 3" RA, environmental adjustments, power-duration characteristics

Table 2. Duration, intensity and load of baseline training and grand tour data.

	Baseline training (n = 51)	First week GT (n = 84)	Second week GT (n = 98)	Third week GT (n = 82)
Duration (min)	187 ± 106	296 ± 26[a]	297 ± 85[a]	248 ± 91[a,b]
Distance (km)	102 ± 55	162 ± 62[a]	180 ± 43[a]	148 ± 59[a]
RPE	3.5 ± 1.9	6.0 ± 1.6[a]	7.0 ± 1.9[a]	7.4 ± 2.0[a,b]
Mean PO (W)	201 ± 30	208 ± 24	237 ± 41[a,b]	241 ± 56[a,b]
NP (W)	241 ± 45	271 ± 25[a]	291 ± 38[a,b]	281 ± 43[a,b]
% PO zone 1 (min)	86.8 ± 12.2	75.9 ± 6.5[a]	68.1 ± 13.9[a,b]	67.8 ± 21.5[a,b]
% PO zone 2 (min)	5.9 ± 5.6	9.5 ± 4.1	11.2 ± 5.0[a]	12.9 ± 11.7[a,b]
% PO zone 3 (min)	7.4 ± 7.7	14.7 ± 4.0[a]	20.7 ± 11.1[a,b]	20.2 ± 16.4[a]
Mean HR (beats·min^{-a})	124 ± 13	130 ± 9	130 ± 11	127 ± 16
Mean HR % HR_{max}	65 ± **7**	66 ± 4	67 ± 6	65 ± 8
Maximal HR (beats·min^{-a})	167 ± 20	181 ± 7[a]	177 ± 9[a]	174 ± 9
Mean training load				
sRPE (AU)	786 ± 673	1773 ± 505[a]	2147 ± 972[a,b]	1958 ± 992[a]
iTRIMP (AU)	208 ± 180	292 ± 105[a]	372 ± 138[a]	270 ± 185[a]
TSS (AU)	155 ± 104	261 ± 49[a]	300 ± 104[a,b]	223 ± 111[a,b,c]

Sanders et al. 2018

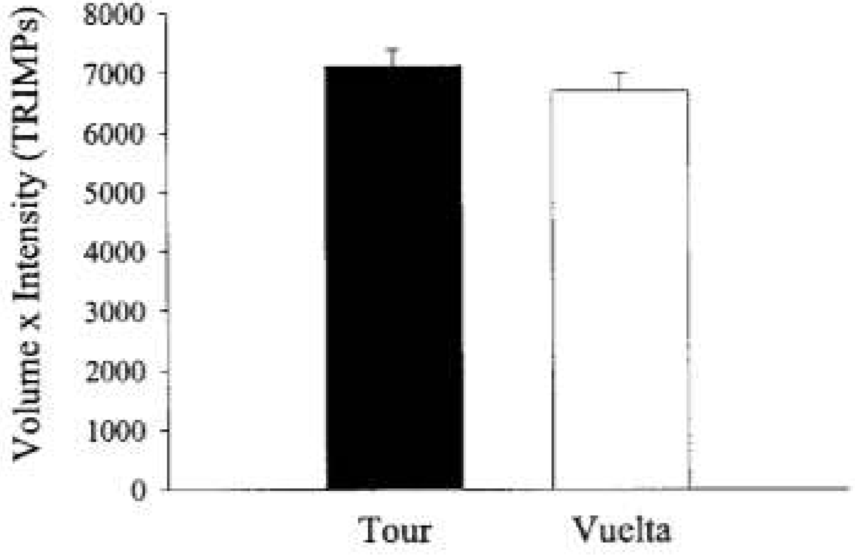
TABLE 3. Physiological responses to the different competition stages categories.

Variables	FLAT (*N* = 125)	SEMO (*N* = 99)	HIMO (*N* = 86)
HR (beats·min^{-1})	119 ± 10	130 ± 9*	135 ± 9*†
%HR_{max}	51 ± 7	58 ± 6*	61 ± 5*†
%HR_{OBLA}	57 ± 8	65 ± 7*	69 ± 6*†
%HR_{LT}	65 ± 10	74 ± 11*	79 ± 9*†
Power output (W)	192 ± 45	234 ± 43*	246 ± 44*
%W_{max}	45 ± 9	53 ± 8*	57 ± 8*†
TRIMP	156 ± 31	172 ± 31*	215 ± 38*†

Values are means ± SD. *N*, number of heart rate recordings; FLAT, flat stage; SEMO, semi-mountainous stage; HIMO, high-mountain stage; HR, heart rate; HR_{max}, maximal heart rate; HR_{OBLA}, heart rate at the onset of blood lactate accumulation; HR_{LT}, heart rate at the individual lactate threshold; W_{max}, maximal power output; TRIMP, training impulse (1).

* Significantly different from FLAT; † significantly different from SEMO.

Padilla et al. 2001

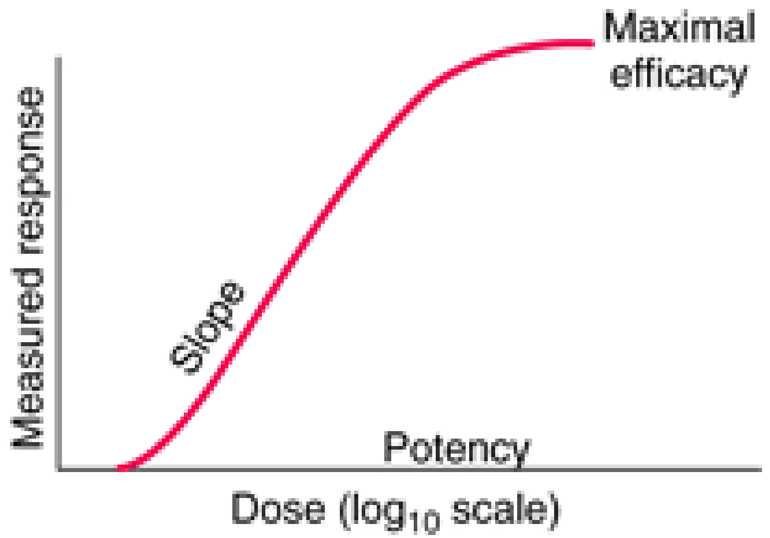


Lucia et al. 2003

The dose-response relationship

- The method used to quantify the training load must be related to the outcome of importance
    - Fitness
    - Fatigue
    - Performance

- Pro-active versus reactive



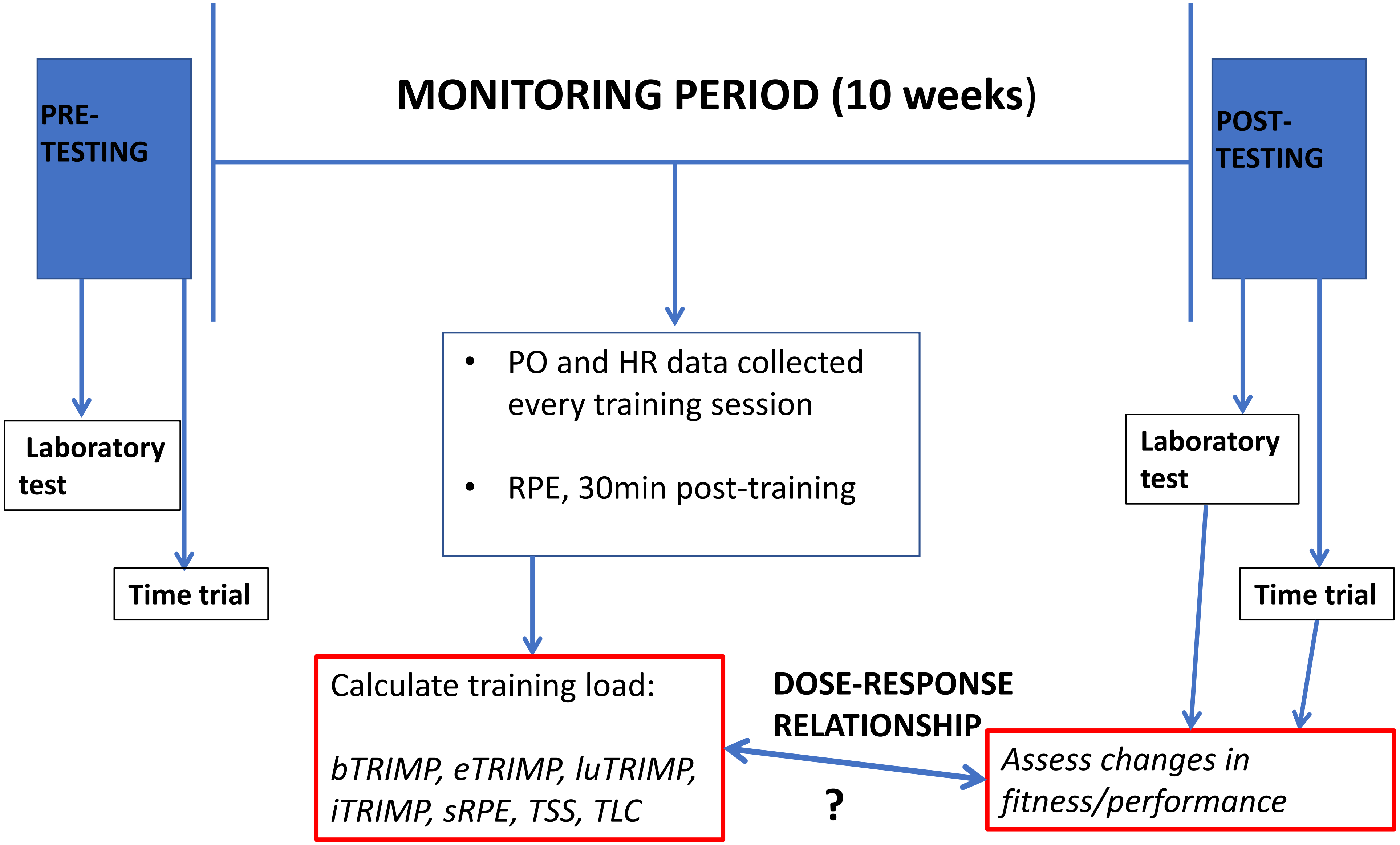
International Journal of Sports Physiology and Performance, 2017, 12, 668-675
http://dx.doi.org/10.1123/ijspp.2016-0454

Human Kinetics
ORIGINAL INVESTIGATION

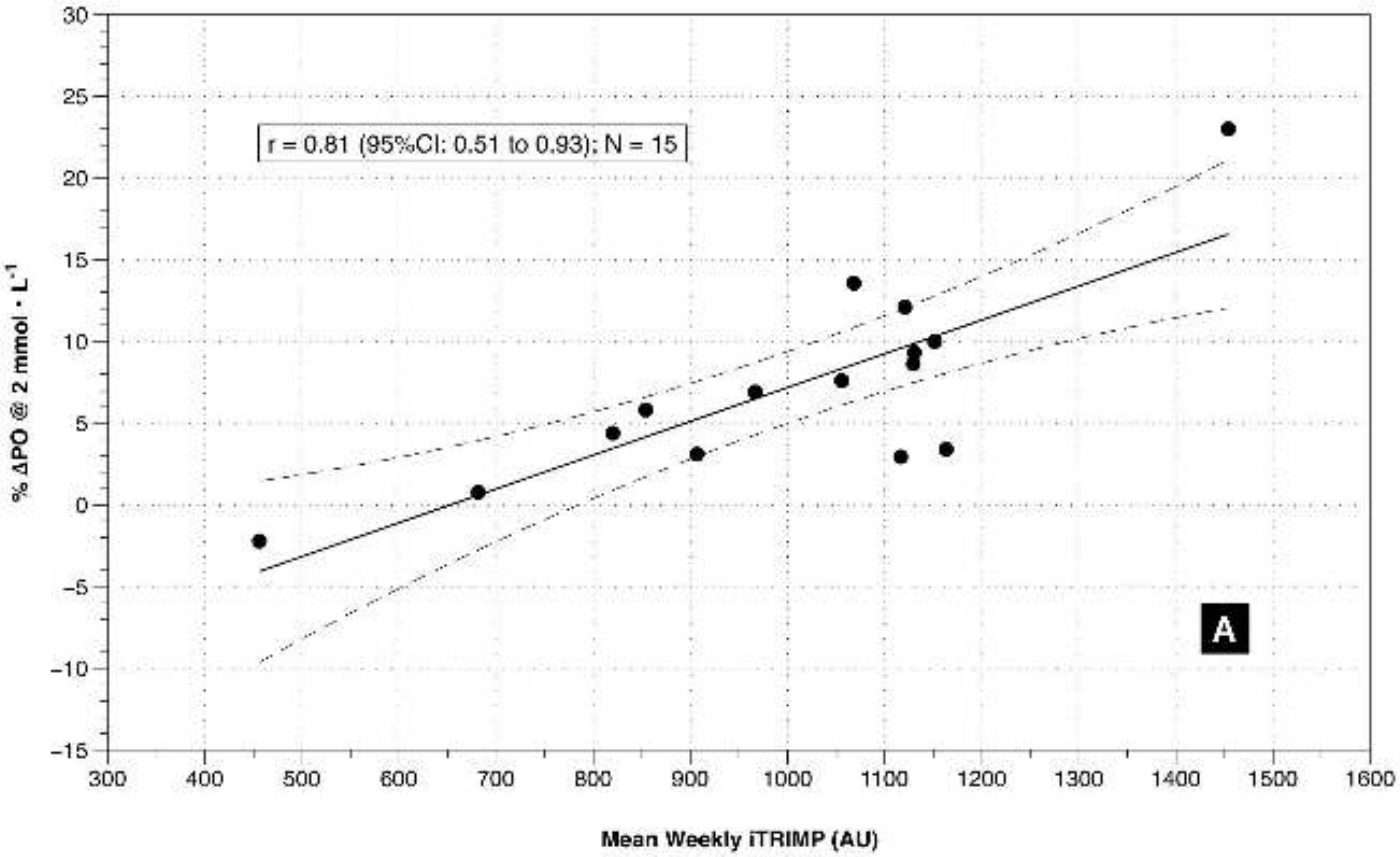
Methods of Monitoring Training Load and Their Relationships to Changes in Fitness and Performance in Competitive Road Cyclists

Dajo Sanders, Grant Abt, Matthijs K.C. Hesselink, Tony Myers, and Ibrahim Akubat

Assess the dose-response relationship between different training load measures and changes in fitness and performance in well-trained competitive cyclists



MONITORING PERIOD (10 weeks)
PRE-TESTING
POST-TESTING
Laboratory test
Time trial
PO and HR data collected every training session
RPE, 30min post-training
Laboratory test
Time trial
Calculate training load:
bTRIMP, eTRIMP, luTRIMP, iTRIMP, sRPE, TSS, TLC
DOSE-RESPONSE RELATIONSHIP
?
Assess changes in fitness/performance


r = 0.81 (95%CI: 0.51 to 0.93); N = 15
A
% ΔPO @ 2 mmol · L-1
Mean Weekly iTRIMP (AU)
30
25
20
15
10
5
0
−5
−10
−15
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600

	sRPE	iTRIMP	bTRIMP	eTRIMP	luTRIMP	TSS	TLC
% ΔPO 2mMol	0.54±0.39*	**0.81±0.17****	0.52±0.34*	0.64±0.28*	0.67±0.32**	**0.75±0.25****	**0.74±0.36****
% ΔPO 4mMOl	0.60±0.30*	**0.77±0.20****	0.67±0.27**	0.73±0.23**	0.72±0.29**	**0.79±0.22****	**0.81±0.29****
% ΔPO 8MT	0.51±0.35	**0.63±0.29***	0.40±0.38	0.48±0.36	**0.70±0.30****	0.41±0.43	0.32±0.59

Discussion

- **All** training load methods used in the study show large to very large relationships between mean weekly training load and changes in submaximal aerobic fitness in this group of competitive cyclists

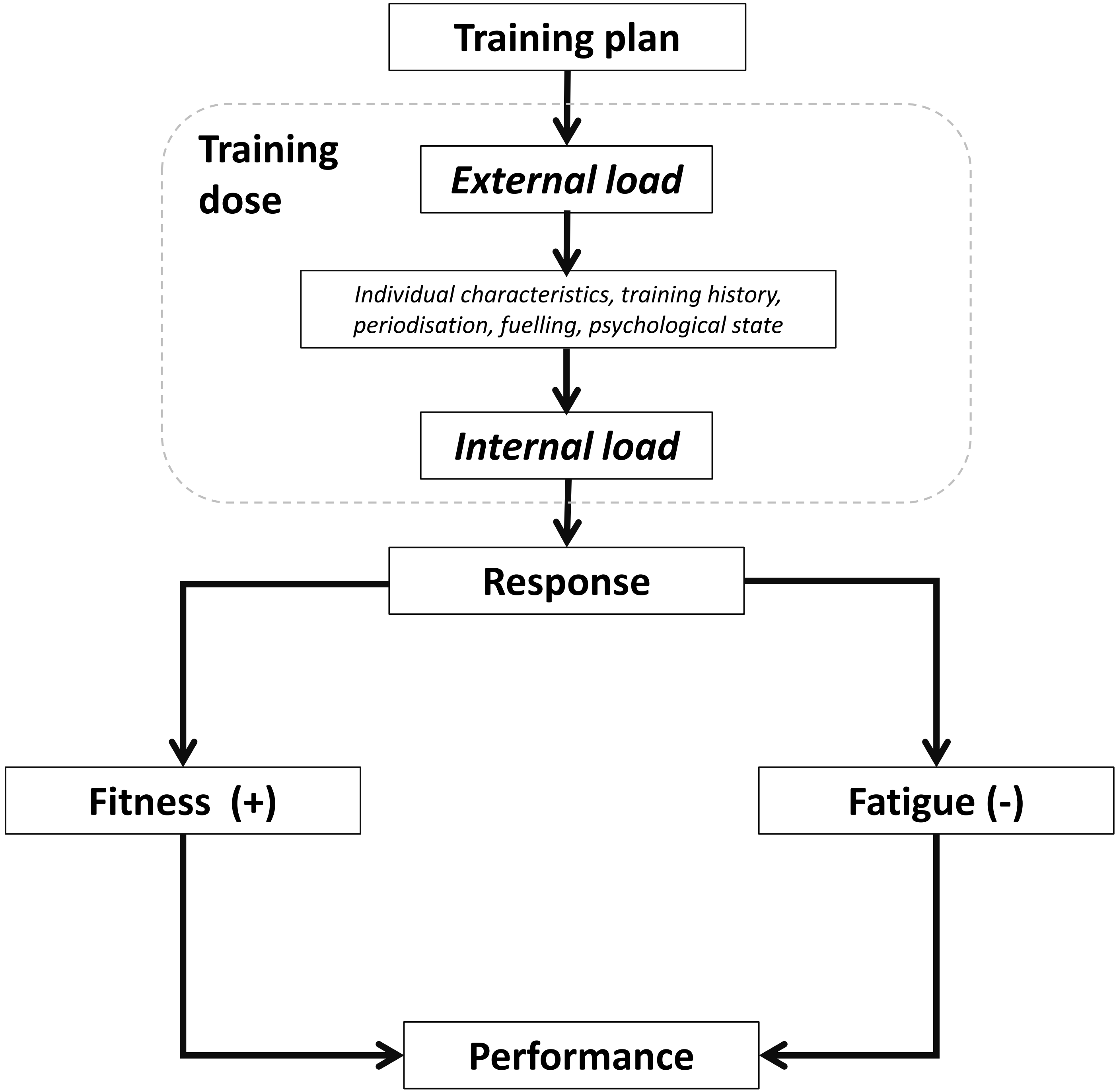
- Strongest relationships for both submaximal aerobic fitness variables were observed for **iTRIMP** , **TSS** and **TLC**

- These results support the use of a training load method that integrates individual physiological characteristics (i.e. HR – blood lactate relationship, threshold power, power-duration).

Subjective *vs* objective intensity - influence on training load?

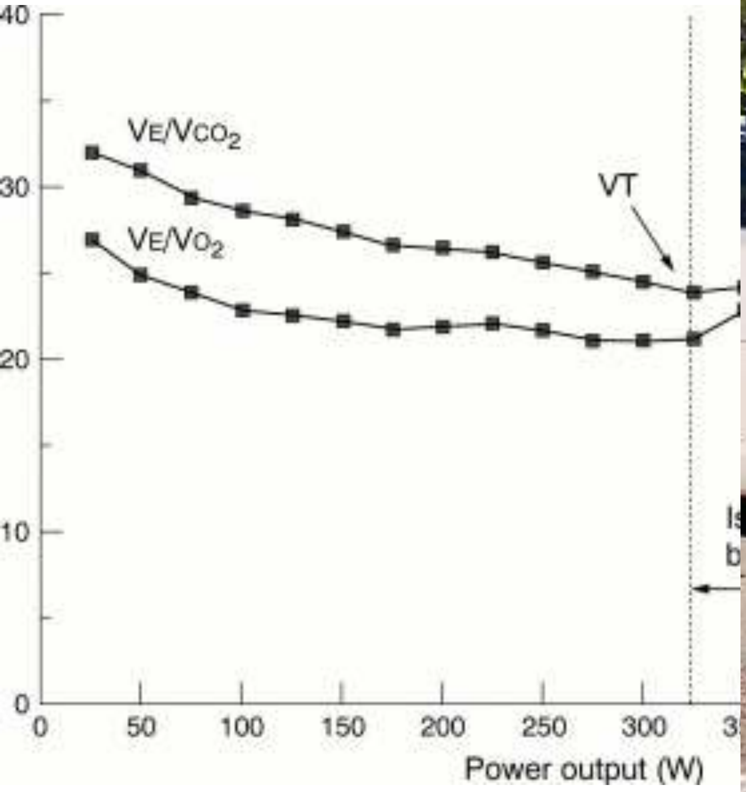
"RPE provided moderate to very largely different results compared to HR or PO. Differences in training-intensity quantification can have a possible impact on the accuracy of training-load quantification and the evaluation of training characteristics."

Sanders et al. 2018

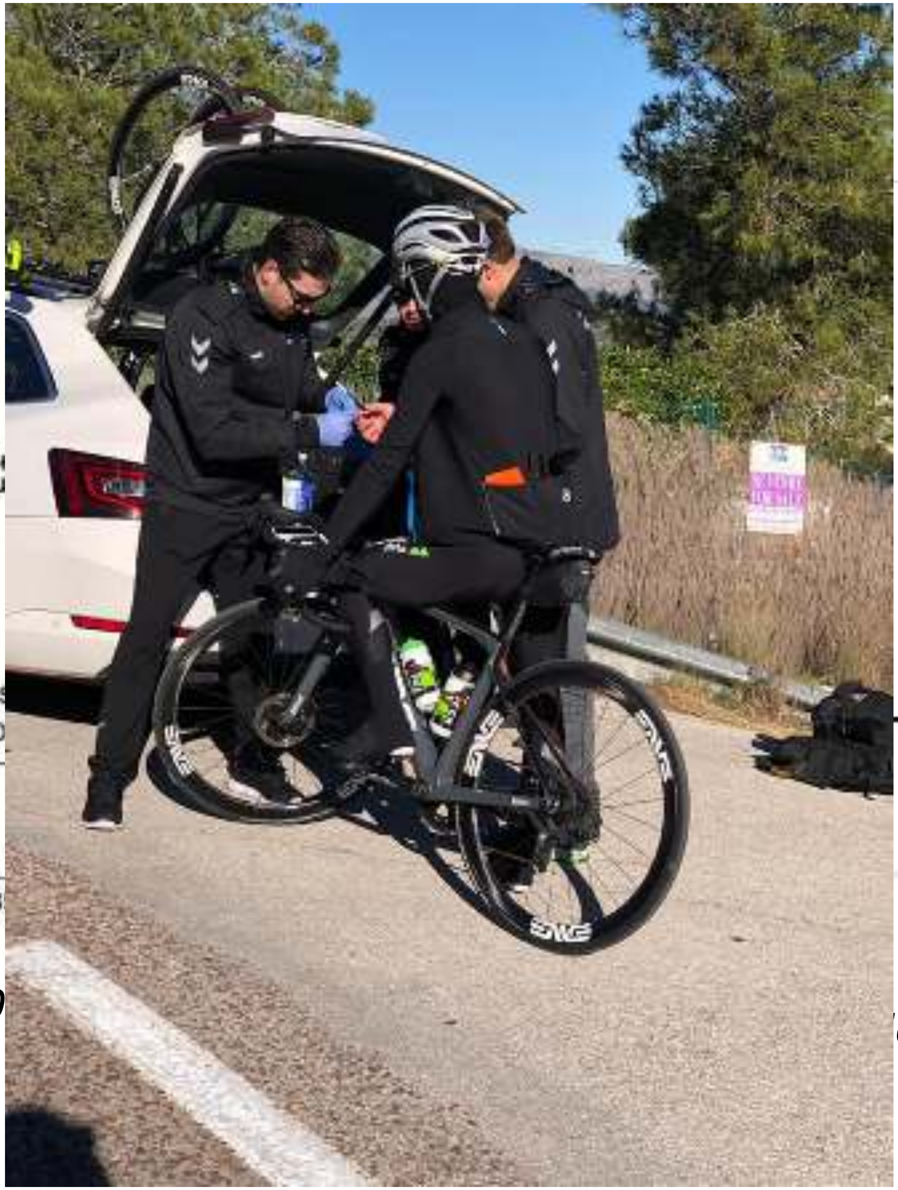


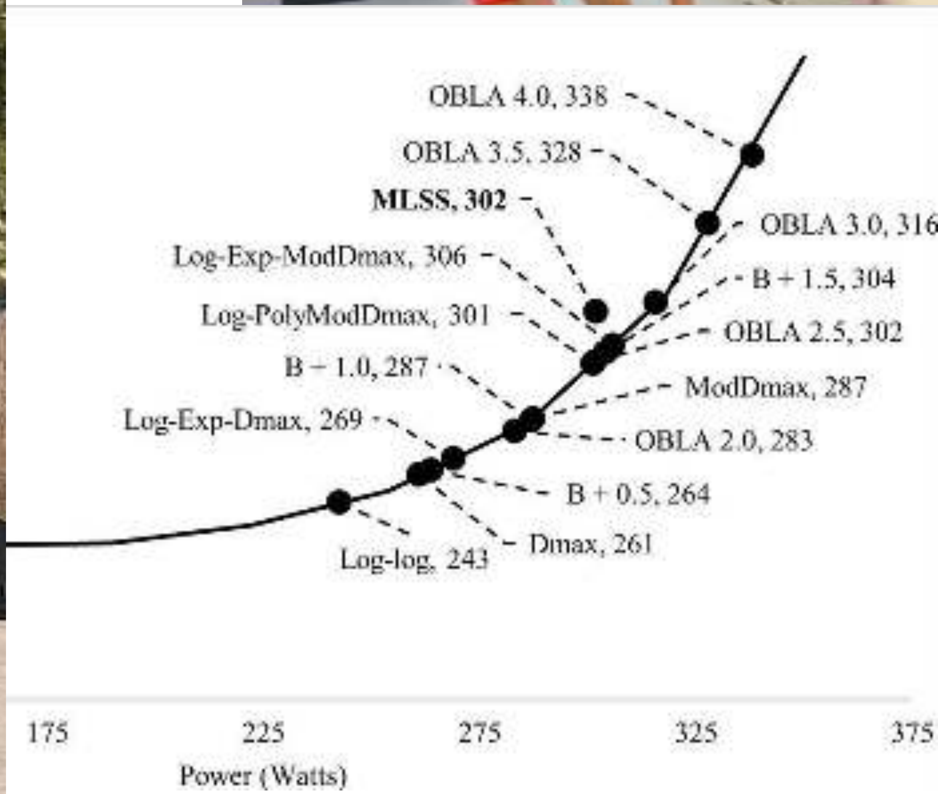
Impellizzeri et al, 2005; 2019, Coutts, 2016

Fitness – Physiological Assessments



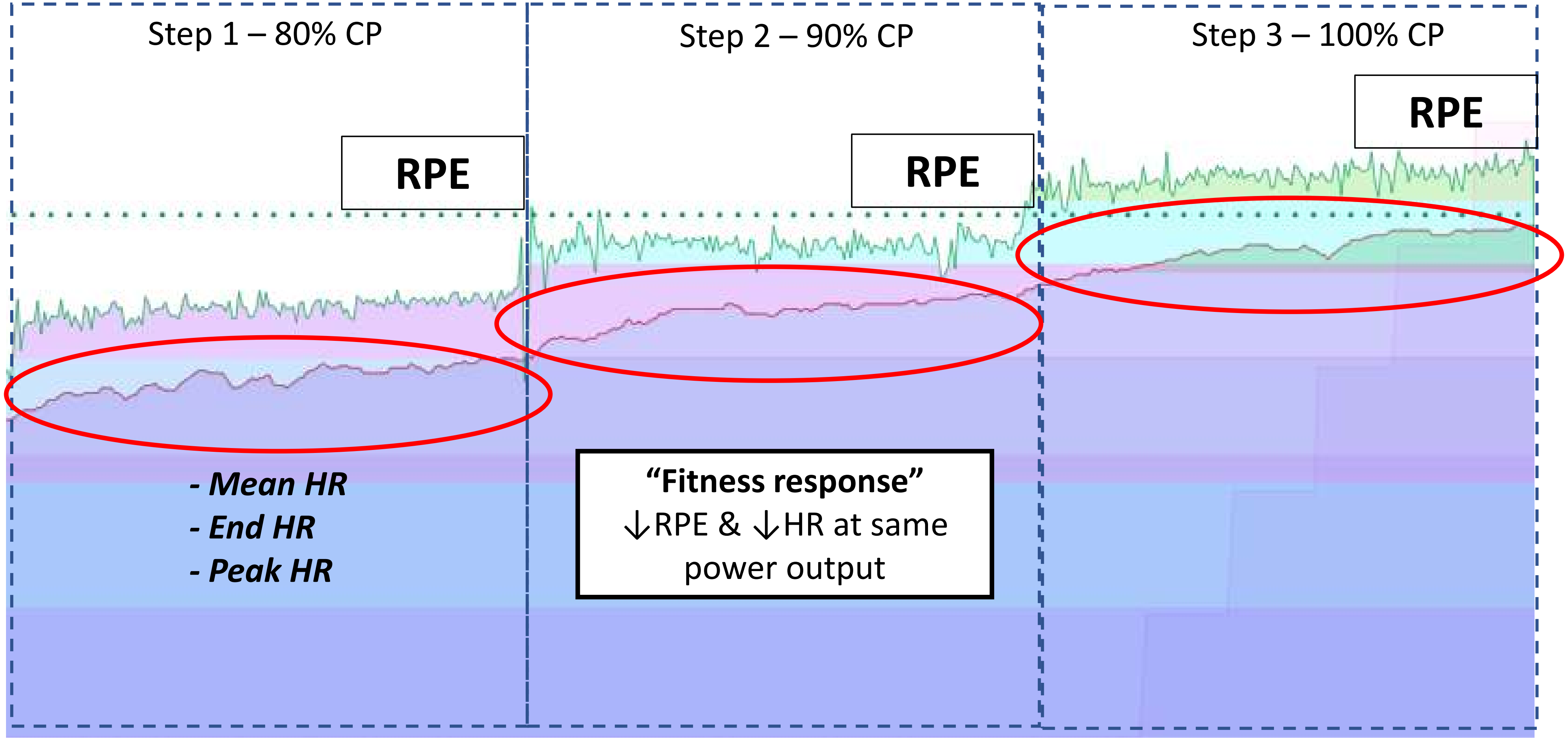
Chicharro et al. 20

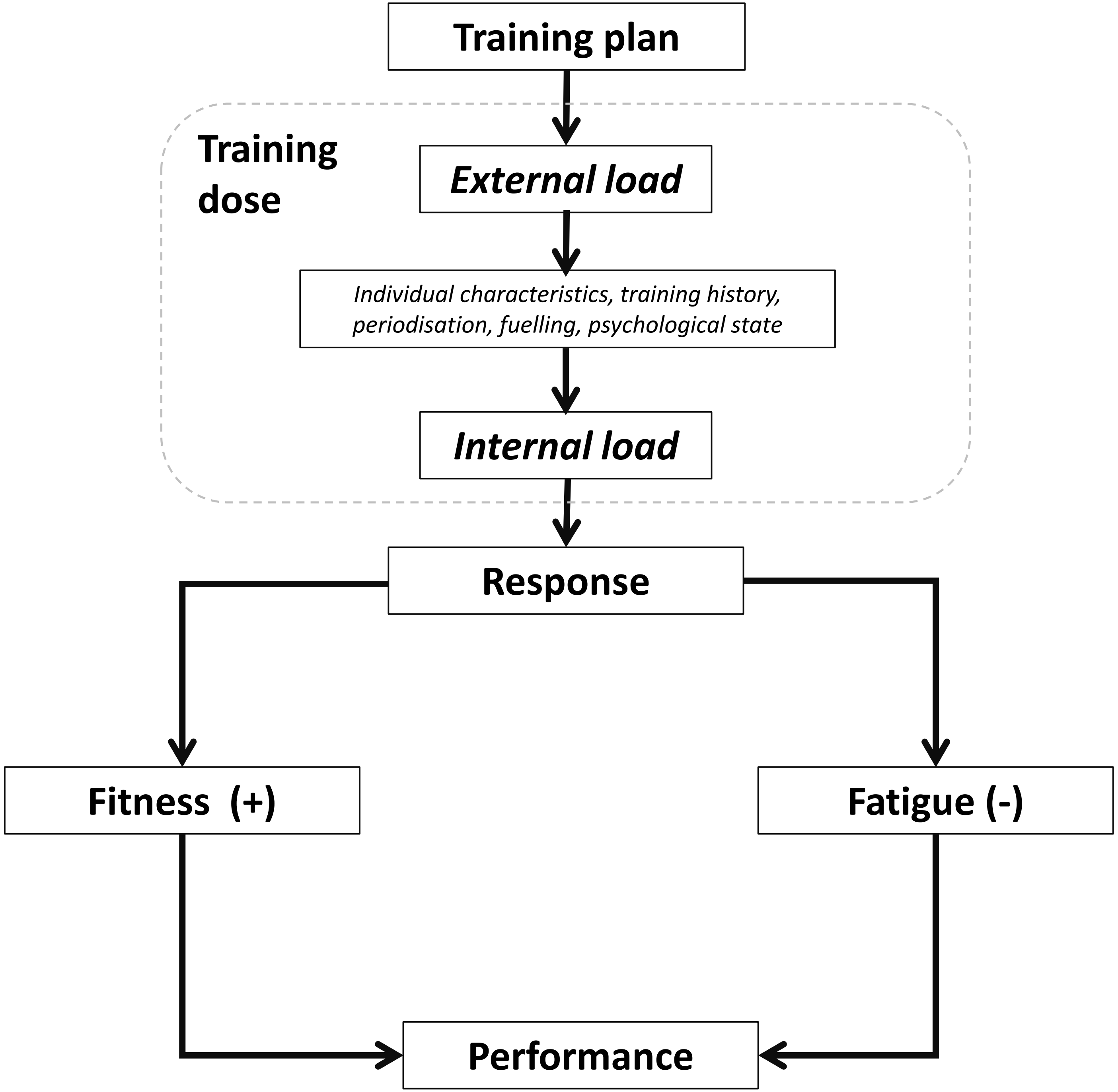




amnick et al. 2019

Fitness – Integrating subjective & objective data





Impellizzeri et al, 2005; 2019, Coutts, 2016

Fatigue – Psychometric questionnaires

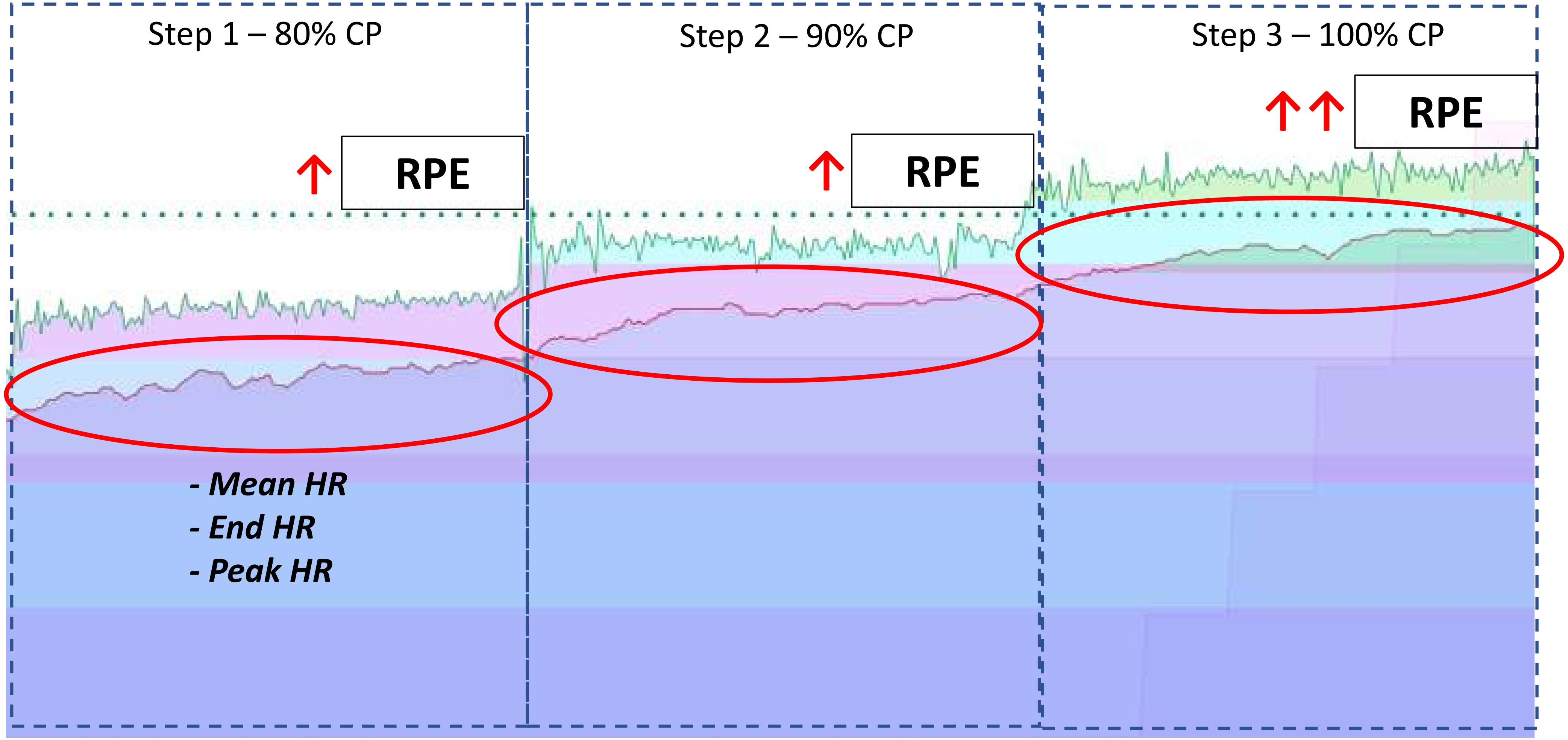
- Profile of Mood States (POMS)
  (*Morgan et al. 1987)*

- Recovery-Stress Questionnaire for Athletes (REST-Q-Sport)
  (Kellmann & Kallus, 2001)

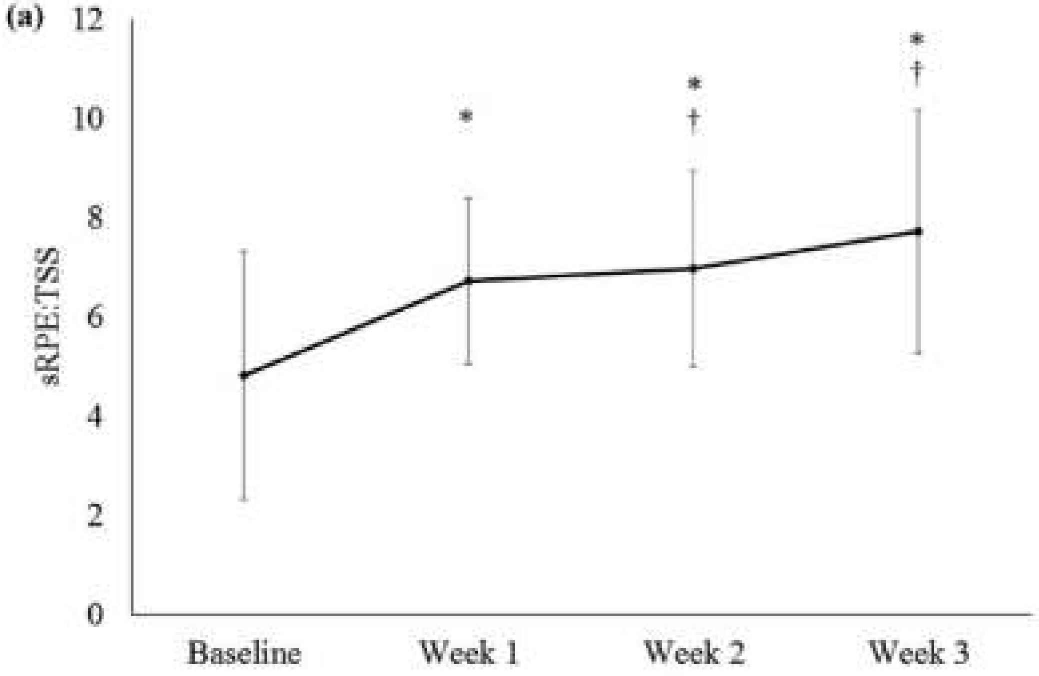
- Daily Analysis of Life Demands for Athletes (DALDA)
  (Rushall, 1990)

- Total Recovery Scale (TQR)
  (Kentta & Hassmen, 1998)

Fatigue – Integrating subjective & Objective data

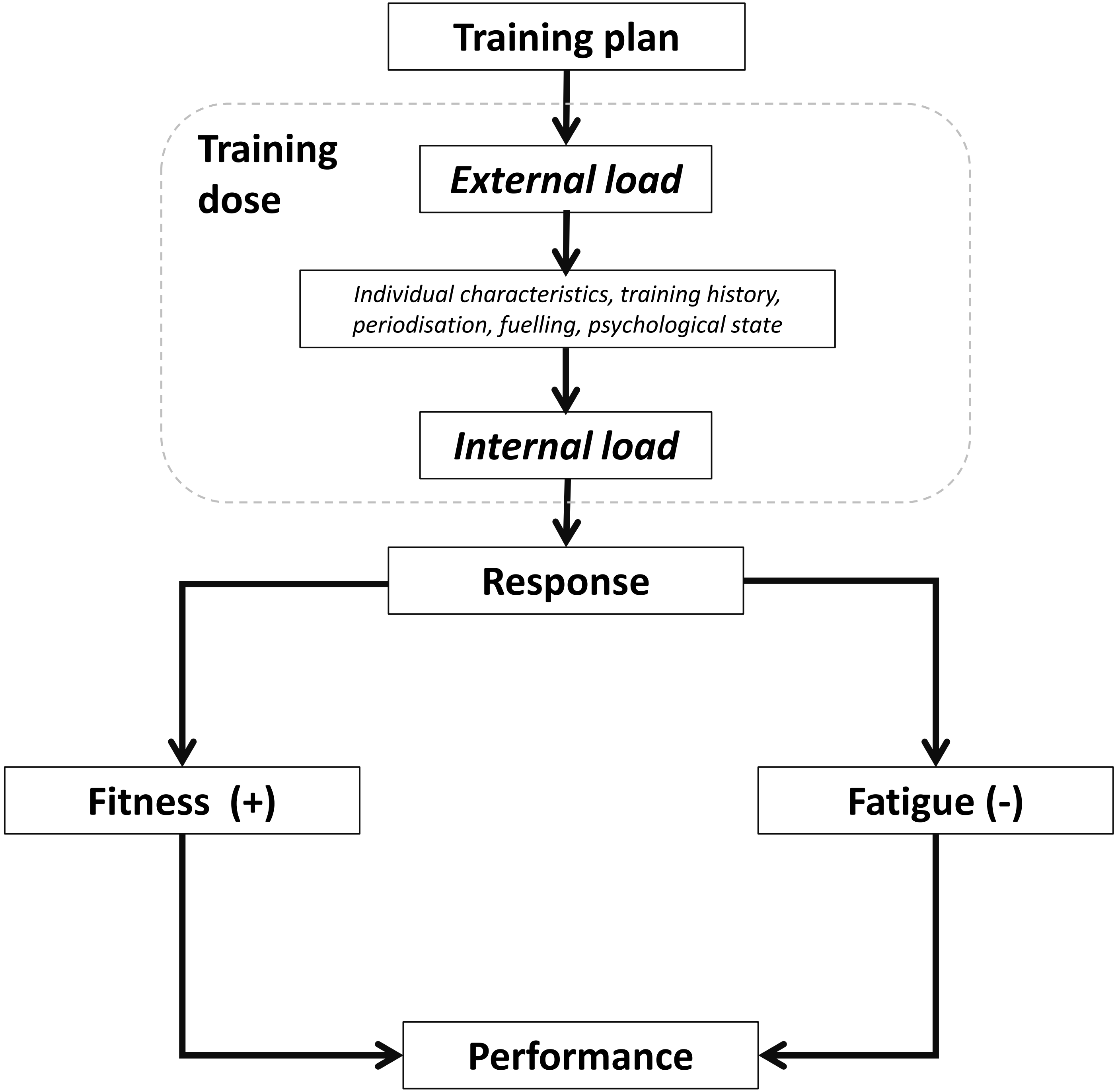


Fatigue – Integrating objective & subjective data



	Grand Tour			
	Baseline	Week 1	Week 2	Week 3
Intensity ratio				
RPE:HR	3.02 ± 1.50	4.71 ± 1.28[a]	5.51 ± 1.28[a]	5.39 ± 1.57[a]
RPE:PO	1.75 ± 0.87	2.88 ± 0.74[a]	2.97 ± 0.78[a]	3.13 ± 0.88[a]
PO:HR	1.64 ± 0.22	1.59 ± 0.21	1.73 ± 0.23[a,b]	1.72 ± 0.33[b]
Load ratio				
sRPE:iTRIMP	5.68 ± 4.80	6.44 ± 2.39	6.72 ± 1.47	7.51 ± 4.12
sRPE:TSS	4.82 ± 2.50	6.72 ± 1.68[a]	6.98 ± 1.98[a]	7.72 ± 2.45[a,b,c]
TSS:iTRIMP	1.10 ± 0.56	1.02 ± 0.34	0.99 ± 0.26	1.12 ± 0.51

Sanders et al. 2018



Impellizzeri et al, 2005; 2019, Coutts, 2016

Performance Indicators

- **Time trials**
→ Power output or "time to complete" measured as performance indicator
→ Interpretation based on rider type/specialisation (i.e. W/kg vs W)

- **Time-to-exhaustion trials**
→ More variable *(Currel & Jeukendrup, 2008)*
→ Has some ecological validity for certain aspects of cycling performance (e.g. finish climb)

Currel & Jeukendrup, 2008; Paton & Hopkins, 2001

Power-duration curves

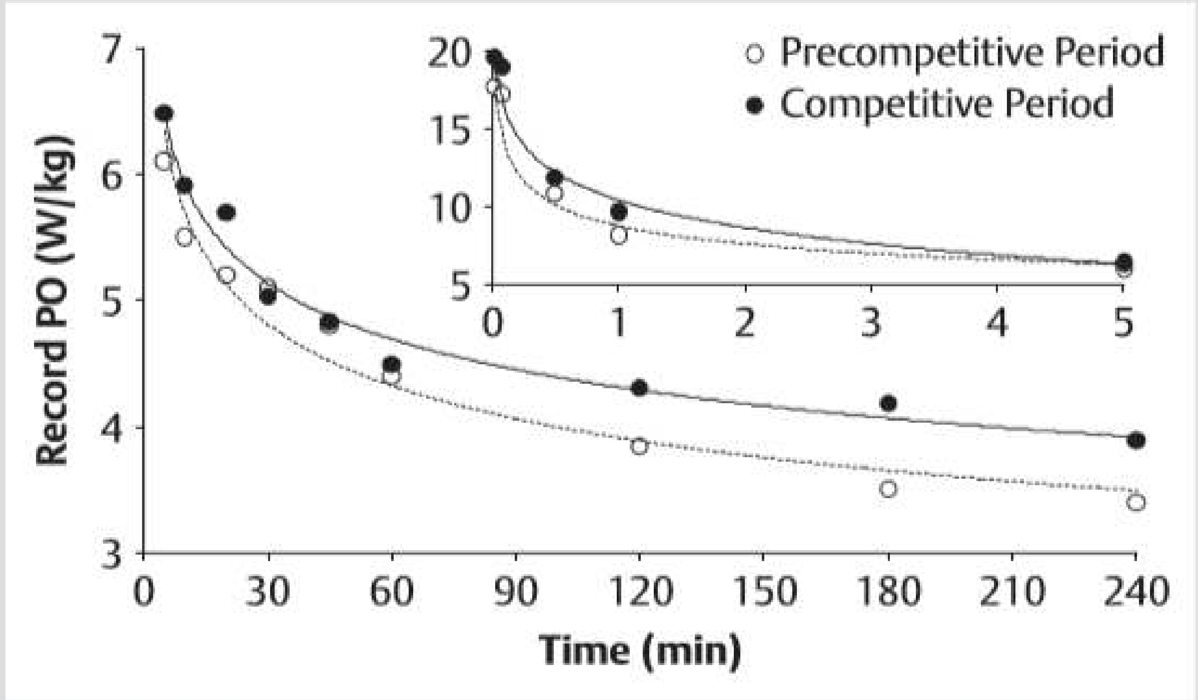


Fig. 3 Changes in cyclist's RPP between the pre-competitive period (December to March) and the competitive period (March to September) on time durations between 1 s–5 min (top panel) and between 5 min–4 h (bottom panel).

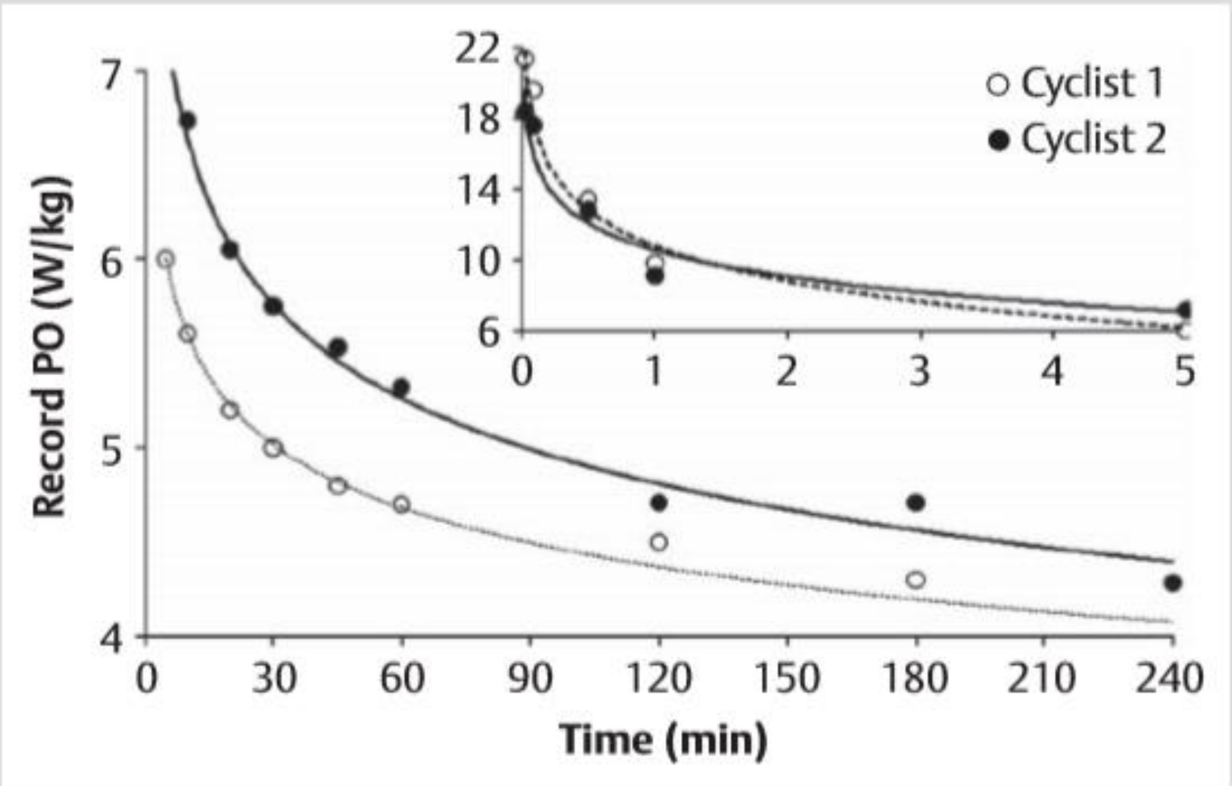


Fig. 4 Comparison of the RPP of 2 cyclists on time durations between 1 s–5 min (top panel) and between 5 min–4 h (bottom panel).

Pinot & Grappe, 2011

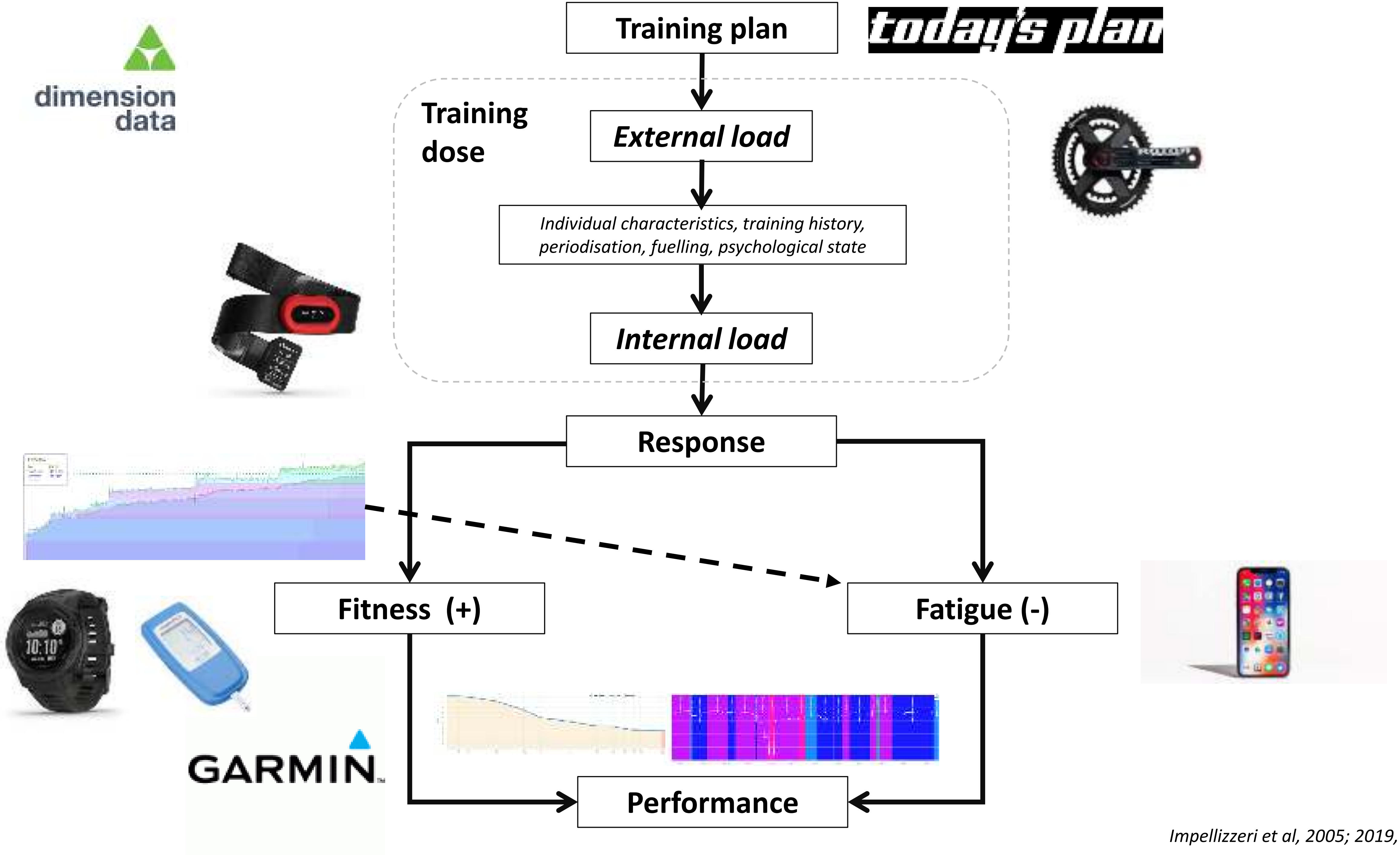
Summary

- ➢Training load metrics that integrate individual physiological characteristics show the strongest dose-response validity with changes in the training outcome

- ➢A multivariate approach, including a combination of subjective (e.g. RPE) and objective (e.g. HR, power output) measures can provide valuable information regarding the adaptive response to training (i.e. “fitness”) or fatigue

- ➢Establishing power-duration curves assist in identifying and tracking performance capabilities of road cyclists.


ADELAIDE
Santos
Santos
Santos
Santos
UCI
UCI
dimension data
ADELAIDE



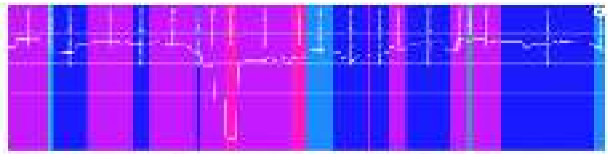
Impellizzeri et al, 2005; 2019, Coutts, 2016


Data collection


dimension data

Direct analysis & visualisation

today's plan



Direct outcomes

Reporting & Analysis

Thanks for listening!

team dimension data

Maastricht University

Qhubeka™