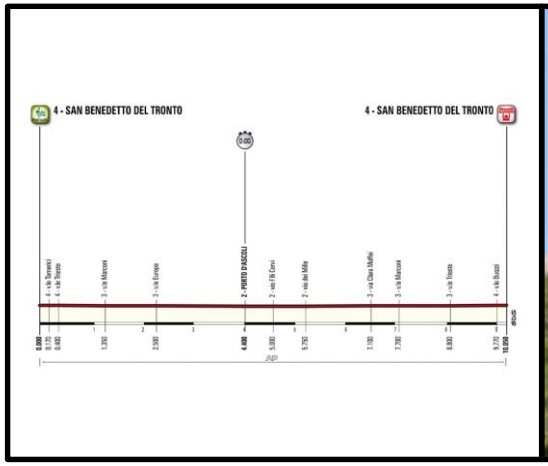
Science & Cycling
28-29 June 2017, Düsseldorf, Germany

Exposure Variation Analysis (EVA) method to monitor ability to optimally regulate exercise intensity of professional cyclists during time-trial competitions



Théo OUVRARD, Julien Pinot, Alain GROSLAMBERT, Fred GRAPPE

EA4660, C3S Health - Sport Department, Sports University, Besancon, France

U-SPORTS Université de Franche-Comté

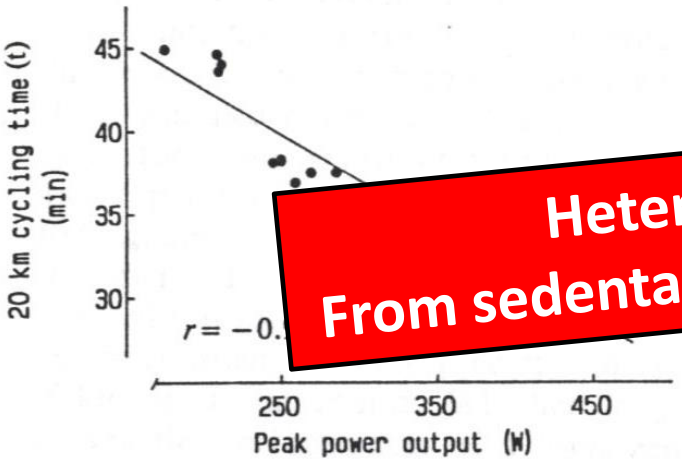
CSS Culture Sport Santé Société

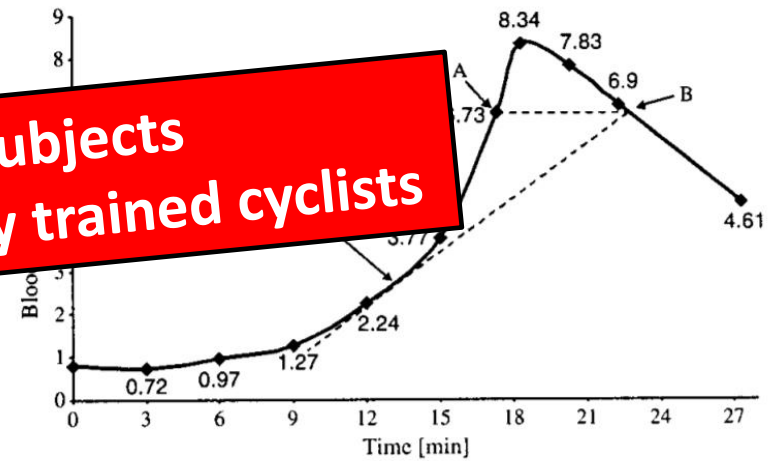
ÉQUIPE CYCLISTE | FDJ

INTRODUCTION

Determinants of Individual Time-Trial performance

Physiological determinants





Heterogenous subjects
From sedentary to highly trained cyclists

Peak Power Output

Hawley and Noakes, 1992…

PO at lactic/ventilatory threshold

Amann et al., 2006…

ITT Mean PO

INTRODUCTION

Individual Time-Trial performance during World-Tour races

Elite cyclists

Mean PO

Well trained and talented

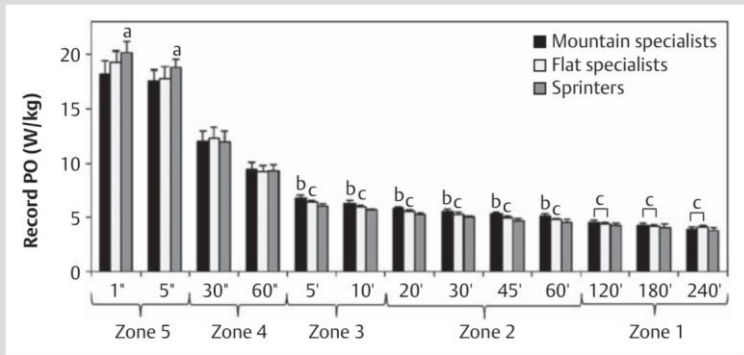


Fig. 2 RPP according to the cyclist's skills and exercise intensity zones.
[a] significant difference between climbers and flat specialists ($p<0.05$),
[b] significant difference between sprinters and flat specialists ($p<0.05$),
[c] significant difference with sprinters ($p<0.05$).

No significant differences of mean maximal PO amongst elite cyclists

Pinot and Grappe, 2011

High ITT mean PO
Optimal use

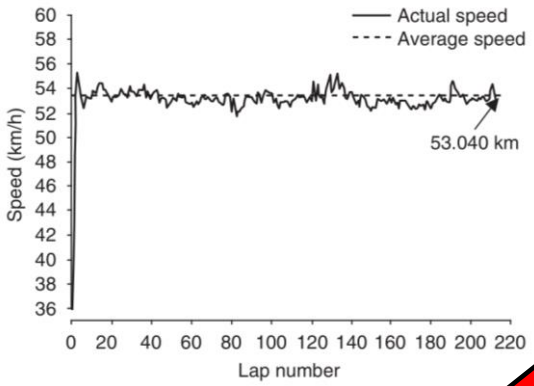
→

Good performance in World-Tour ITT

INTRODUCTION

Pacing strategies and Individual Time-Trial performance

Abbiss and Laursen, 2008



Central control mechanisms to maintain high constant PO

Constant pacing strategy

Best ITT performances

Reduce fatigue

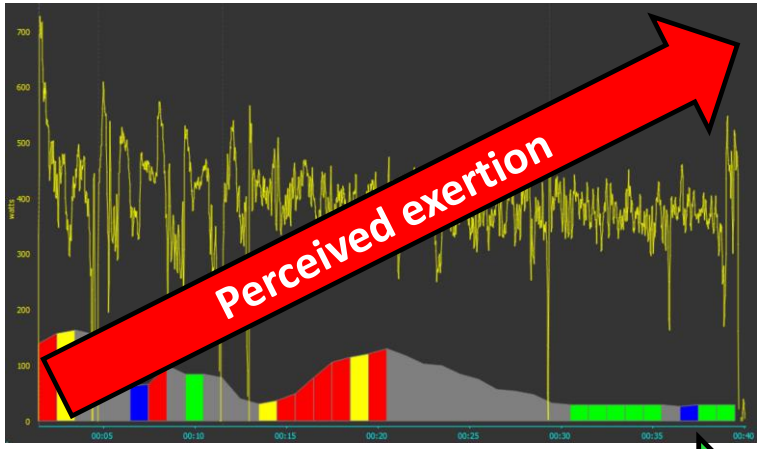
Reduce mechanical losses due to speed variations

INTRODUCTION

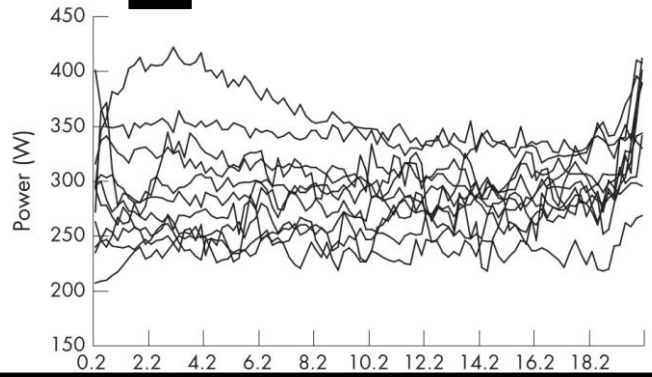
Control of exercise intensity during Individual Time-Trial

Noakes, 2011; Tucker, 2009; Marcora, 2008

Exhaustion occurring at the finishing line



Estimated time remaining



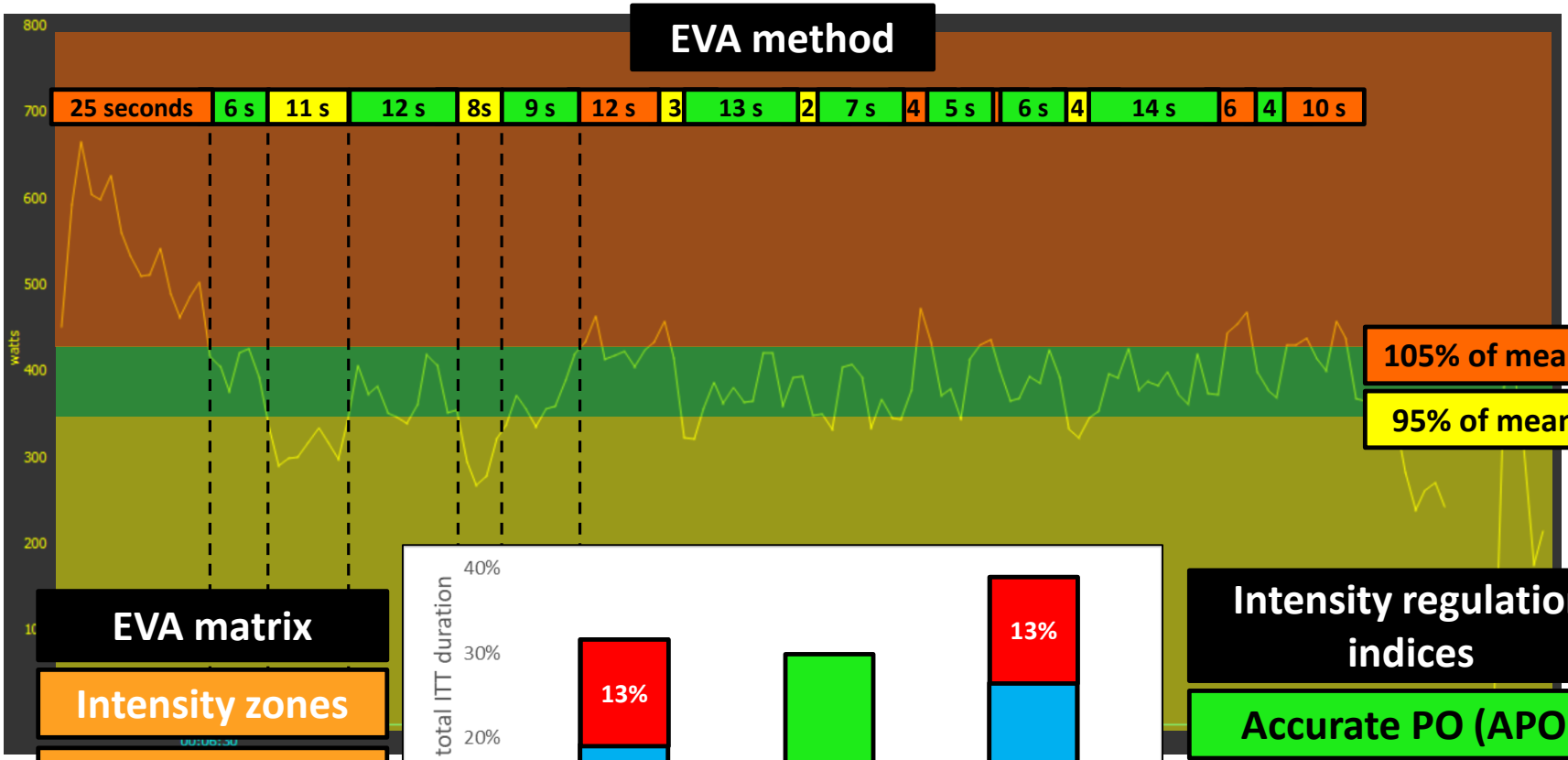
Self-paced Individual Time-Trials involves a lot of intensity fluctuations that influence perceived exertion and performance

Tucker et al., 2006; Landers et al., 2009

INTRODUCTION

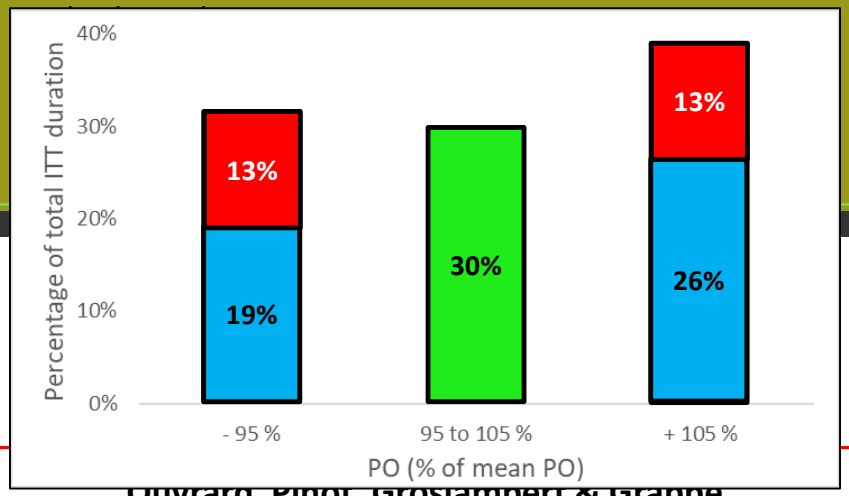
Exposure Variation Analysis to study exercise intensity regulation during ITT

Abbiss et al., 2010; Mathiassen and Winkel, 1991



EVA matrix

- Intensity zones
- Acute time zones
- < 10 s | > 10 s



Intensity regulation indices

- Accurate PO (APO)
- Inaccurate PO (IPO)
- Short time regulations (REG)

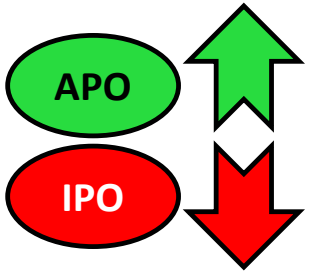
INTRODUCTION

Exposure Variation Analysis to study exercise intensity regulation during ITT

Ouvrard et al., under review

APO	**Each seconds spent at a constant mean PO, optimal for performance**
IPO	**Each prolonged effort at a too low or too high PO regarding optimal pacing strategy**
REG	**Short-time regulations to avoid prolonged efforts at too low or too high PO**

Parameters the more significantly related to performance during national ITT championship



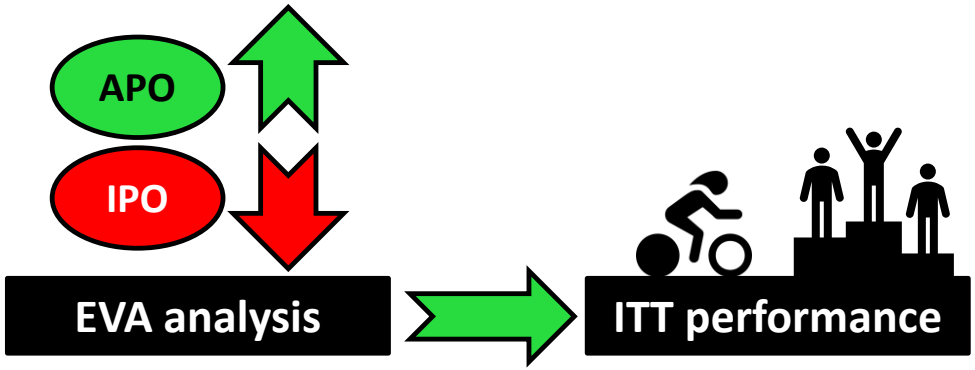
Better effort regulation

Greater use of the cyclist's physical capacity during the race

Better performance

INTRODUCTION

Study aims and hypothesis



Date	Race	Ranking	Mean PO	EVA analysis
17/02	Andalucia-3	4th	[redacted] w	?
14/03	Tirreno-Adriatico-7	17th	[redacted] w	
16/05	Giro d'Italia-10	19th	[redacted] w	
28/05	Giro d'Italia-21	28th	[redacted] w	

EVA analysis never performed for several ITT of the same riders

Are changes in IPO and APO related to performance changes ?

METHODS

Data collecting

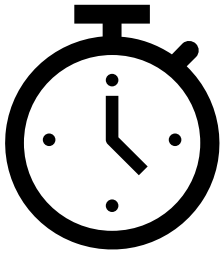
6 World-Tour riders = 1 GC leader, 2 TT specialists, 2 climbers and 2 domestics

2 World-Tour official ITTs performed on the same course for 2 consecutive years

PO recorded thanks to SRM power meters

METHODS

Data analysis



Performance changes

- Mean speed TT1
- Mean speed TT2

Physical performance variations

Mean PO TT1
Mean PO TT2

Effort regulation differences

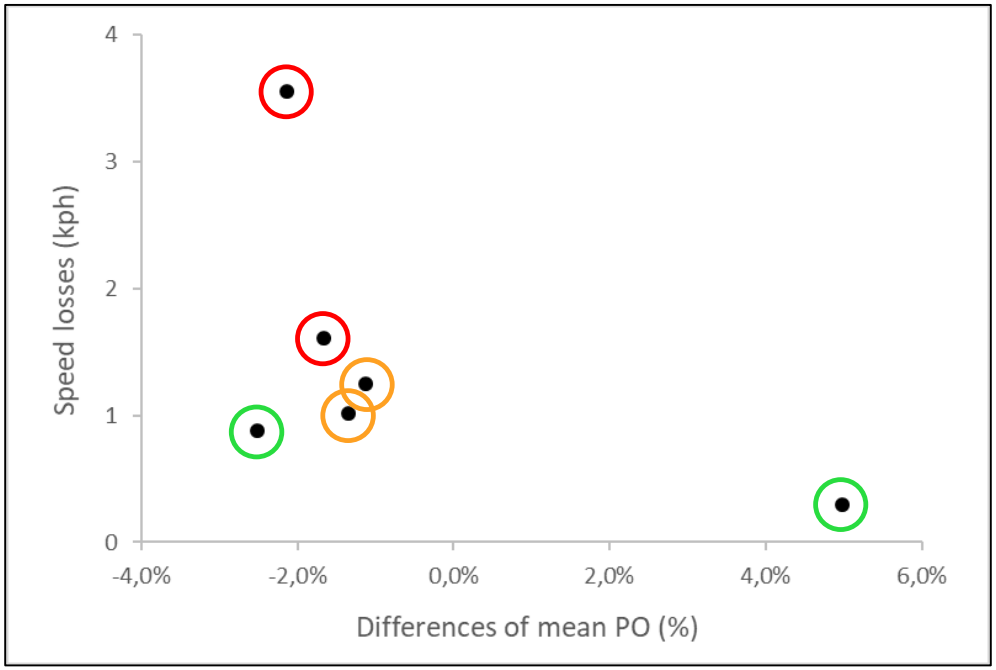
EVA Analysis TT1	APO	IPO	REG
EVA Analysis TT2	APO	IPO	REG

- Pearson correlation coefficients to analyse relationship between performance changes, mean PO variations and EVA analysis differences ($p < 0,05$)

RESULTS

Performance and mean PO variations

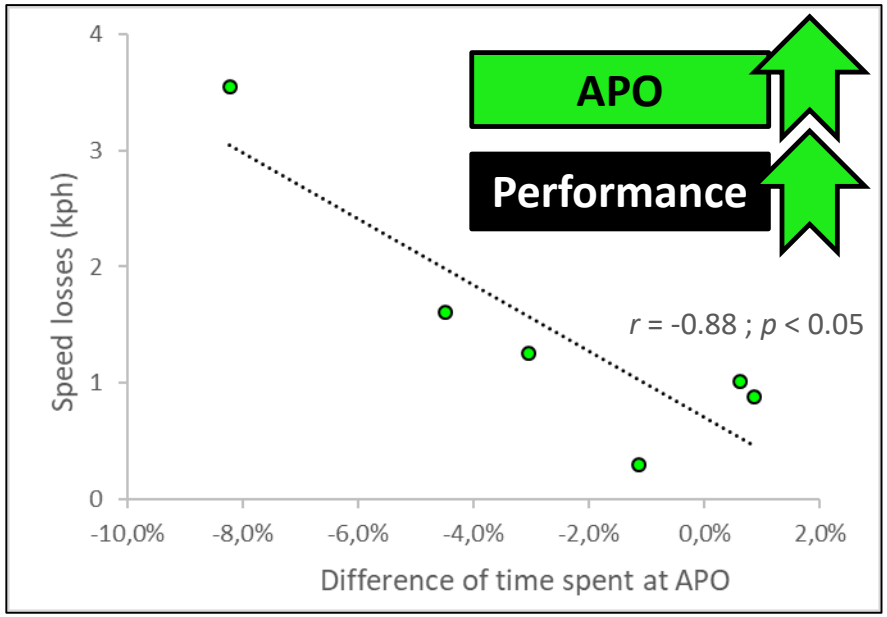
Differences of	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6
Ranking	14	11	(+2)	(+2)	7	58
Mean speed	0,2 kph	0,8 kph	1,0 kph	1,2 kph	1,6 kph	3,5 kph
Mean PO	20 w	(+11w)	(+6w)	(+5w)	(+7w)	(+9w)

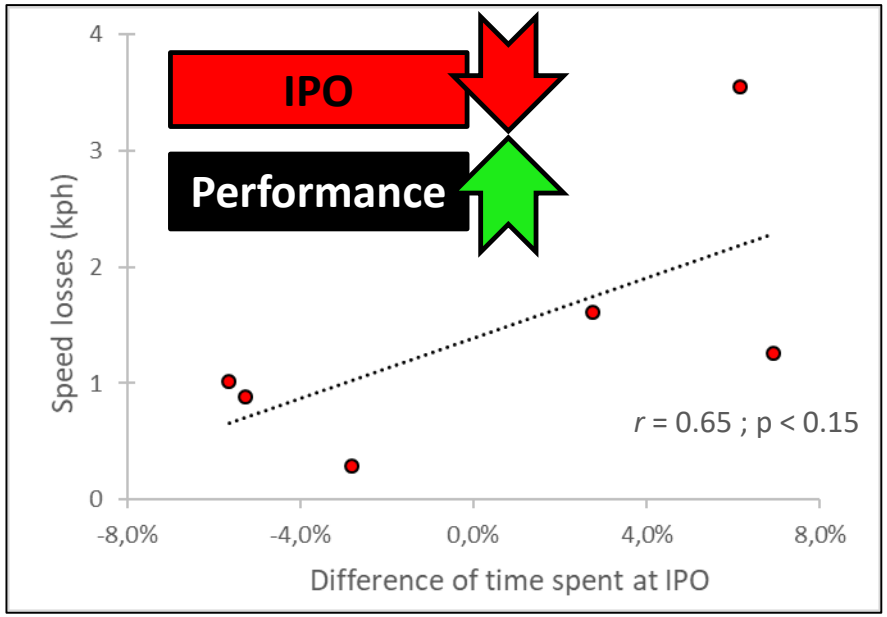


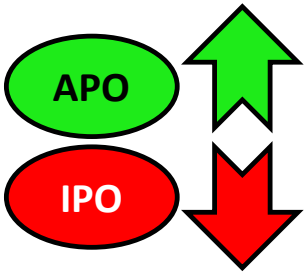
No relationship between performance changes and differences of mean PO (*r* = 0.28)

RESULTS

Performance evolutions and EVA parameters changes







EVA analysis

Better effort regulation

Improved ITT performance

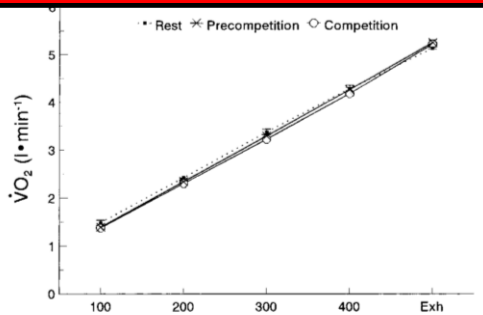
DISCUSSION

Physical capacity and performances changes in World-Tour cyclists

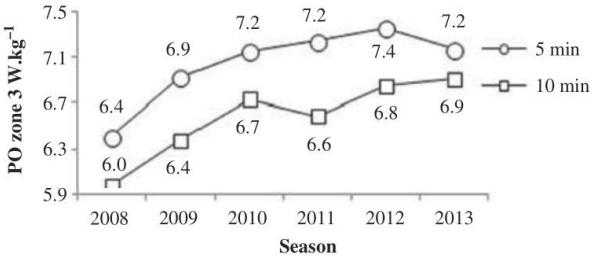
Physical capacity remains mostly stable during professional cycling seasons despite variations of performances

Lucia et al., 2000

Sassi et al., 2008



Pinot et Grappe, 2015



Physical capacity monitoring is insufficient to predict performance variations

DISCUSSION

Central determinants of ITT performance

Noakes, 2011; Tucker, 2009; Marcora, 2008

Pacing strategies and regulation mechanisms

Greater use of the physical capacity during races

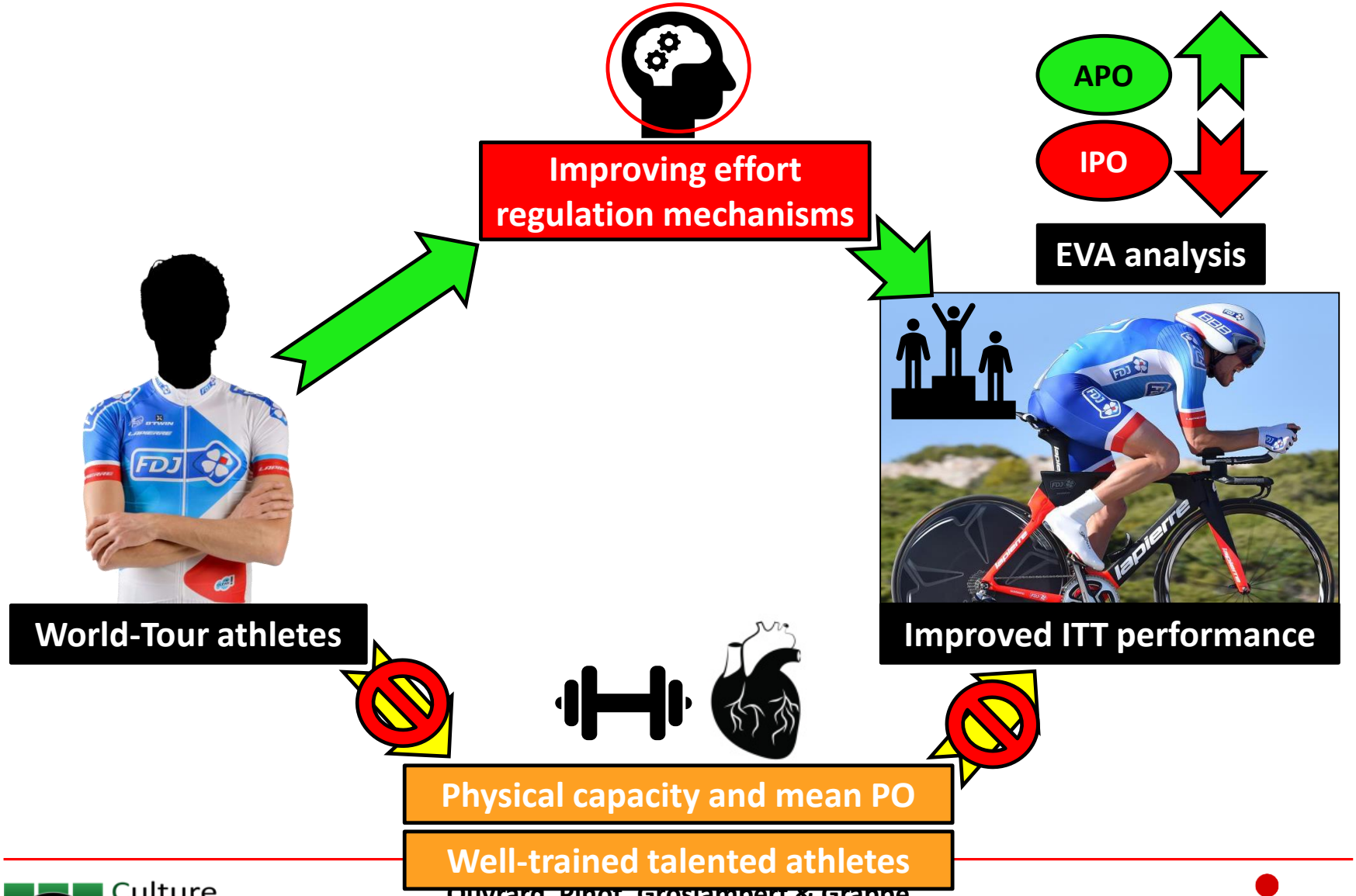
Different mental and psychological parameters

Physical capacity =

Different ITT performances

CONCLUSION

How to improve ITT performance of World-Tour cyclists ?



Theo OUVRARD - *EA4660, C3S Health - Sports University, Besancon, France*

ouvrard.to@gmail.com

REFERENCES

Abbiss CR & Laursen PB (2008). Describing and understanding pacing strategies during athletic competition. *Sports Med* 38(3): 239-52.

Abbiss C, Straker L, Quod M, Martin D, & Laursen P (2010). Examining pacing profiles in elite female road cyclists using exposure variation analysis. *Br J Sports Med* 44: 437-442

Amann M, Subudhi AW, & Foster C (2006). Predictive validity of ventilatory and lactate thresholds for cycling time trial performance. *Scandinavian Journal of medicine & science in sports, 16*(1), 27-34.

Di Prampero PE, Cortili G, Mognoni P, & Saibene F (1979). Equation of motion of a cyclist. *J Appl Physiol Respir Environ Exerc Physiol, 47*(1), 201-206.

Hawley JA, & Noakes TD (1992). Peak power output predicts maximal oxygen uptake and performance time in trained cyclists. *Eur J Appl Physiol Occup Physiol, 65*(1), 79-83.

Lander PJ, Butterly RJ & Edwards MA (2009). Self-paced exercise is less physically challenging than enforced constant pace exercise of the same intensity: influence of complex central metabolic control. *Br J Sports Med* 43: 789–795

Lucía A, Hoyos J, Pardo J, & Chicharro JL (2000). Metabolic and neuromuscular adaptations to endurance training in professional cyclists: a longitudinal study. *The Japanese journal of physiology, 50*(3), 381-388.

Marcora S (2008). Do we really need a central governor to explain brain regulation of exercise performance? *Eur J Appl Physiol* 104: 929-931

Mathiassen SE, & Winkel J (1991). Quantifying variation in physical load using exposure-vs-time data. *Ergonomics, 34*(12), 1455-1468.

Pinot J, & Grappe F (2015). A six-year monitoring case study of a top-10 cycling Grand Tour finisher. *J Sports Sci, 33*(9), 907-914.

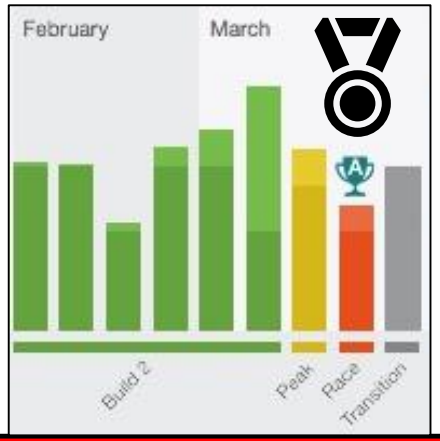
Pinot J, & Grappe F (2011). The record power profile to assess performance in elite cyclists. *Int J Sports Med, 32*(11), 839-844.

Sassi A, Impellizzeri FM, Morelli A, Menaspa P, & Rampinini E (2008). Seasonal changes in aerobic fitness indices in elite cyclists. *Applied Physiology, Nutrition, and Metabolism, 33*(4), 735-742.

Tucker R, Bester A, Lambert EV, Noakes TD, Vaughan CL, & St Clair Gibson A (2006). Non-random fluctuations in power output during self-paced exercise. *Br J Sports Med* 40: 912-917

Tucker R (2009). The anticipatory regulation of performance: the physiological basis for pacing strategies and the development of a perception-based model for exercise performance. *Br J Sports Med* 43: 392-400

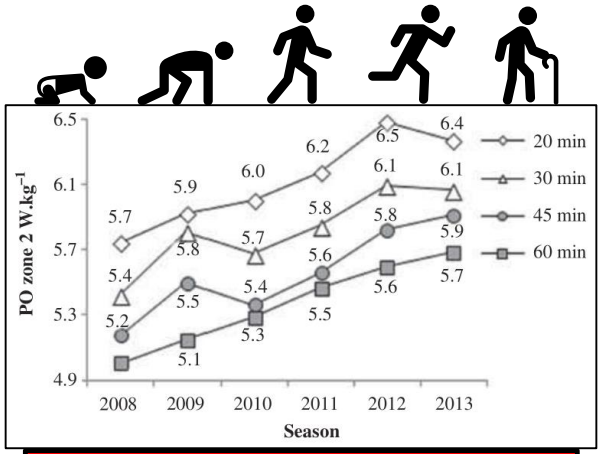
PERSPECTIVES



Progress during specific ITT training program ?

Same training status

Only 1 year of difference



Long-term progress over several years of a career ?

EVA analysis