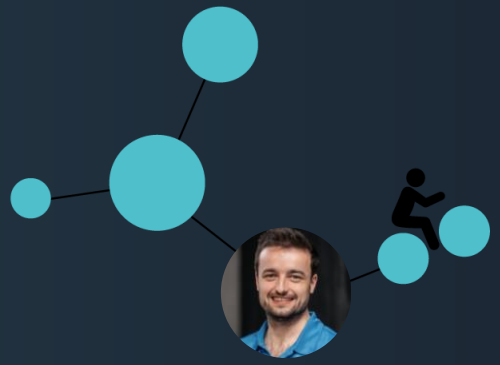
FTP

Functional or fictional threshold power?



Science & Cycling

dr. Kevin Caen

GHENT UNIVERSITY

PACE.
Coaching & Education

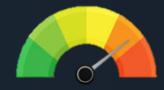
FTP

FUNCTIONAL THRESHOLD POWER

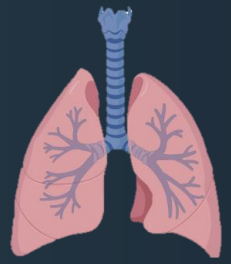
“ The intensity that must be exceeded for a certain reaction, phenomenon, result, or condition to occur or be manifested

Moderate intensity

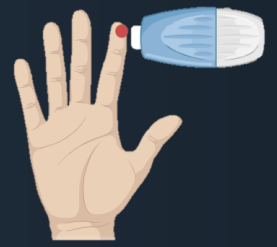
Heavy intensity



Severe intensity



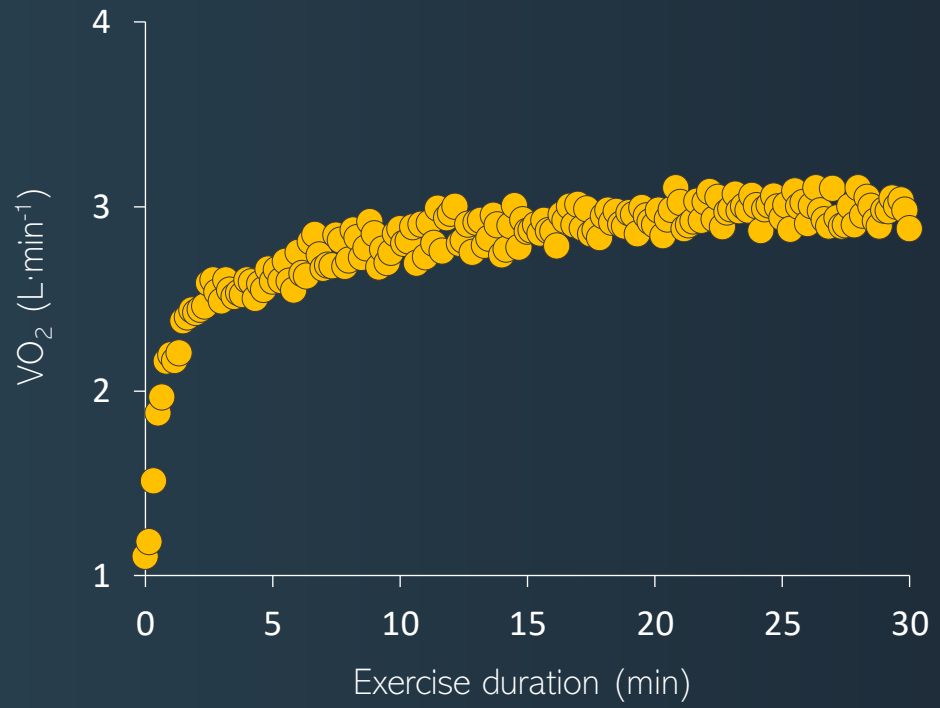
Oxygen uptake
VO_2

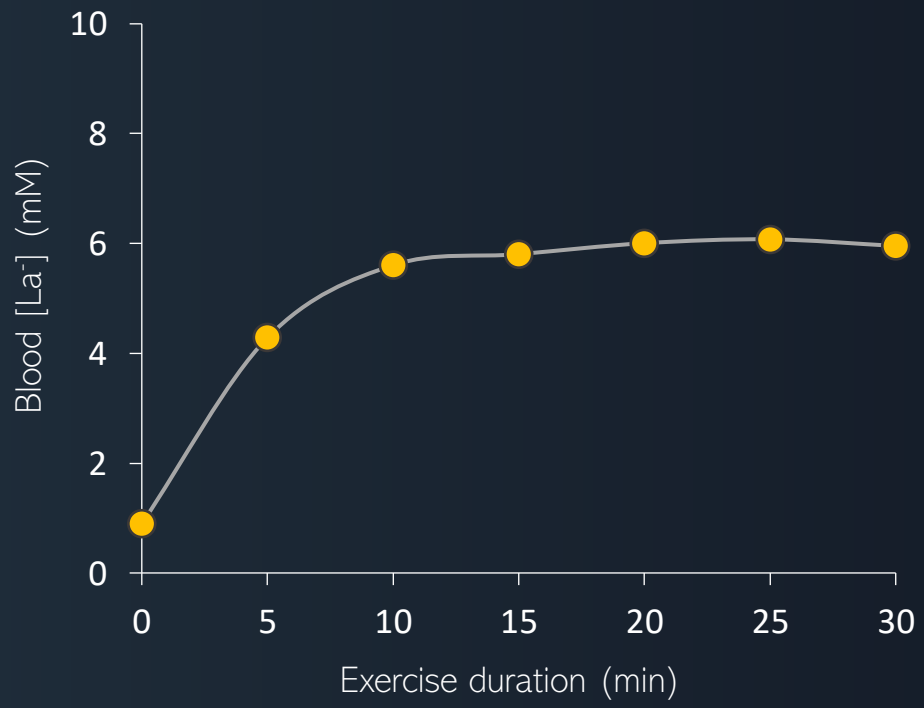


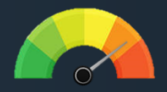
Blood lactate
$[La^-]$

Moderate intensity

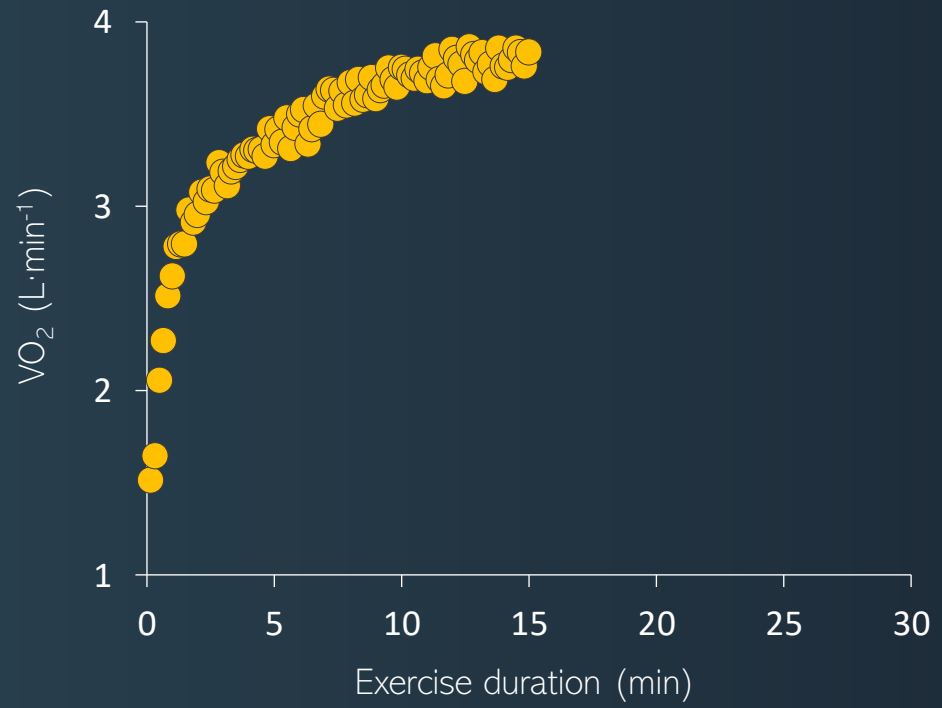
Heavy intensity

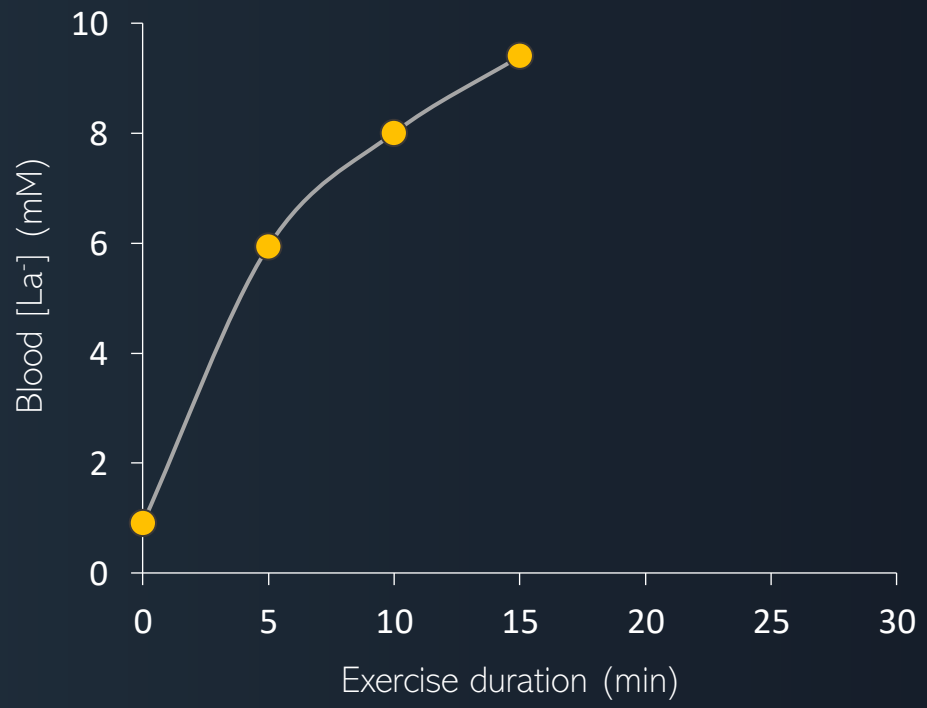






Severe intensity





Heavy

Severe

MAXIMAL METABOLIC STEADY STATE

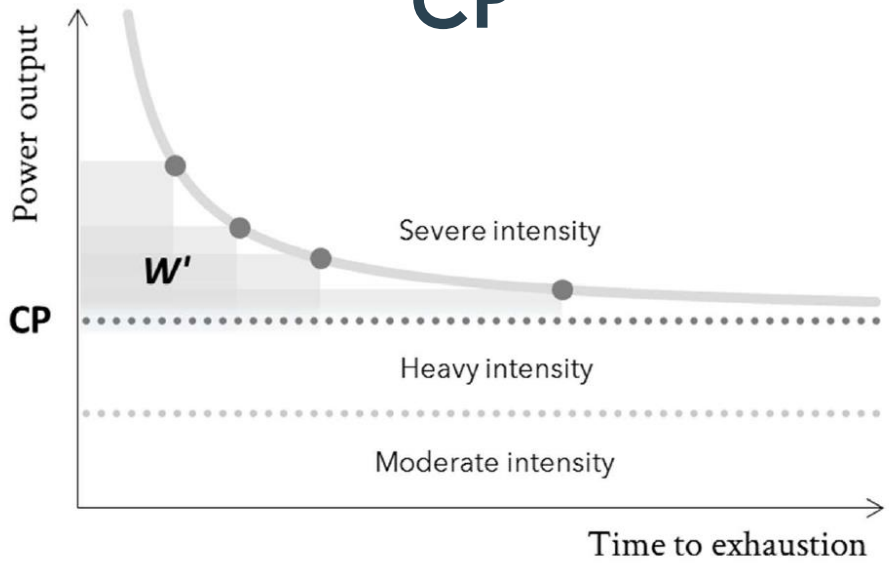
Evaluation of fitness

Training prescription and monitoring

Performance prediction

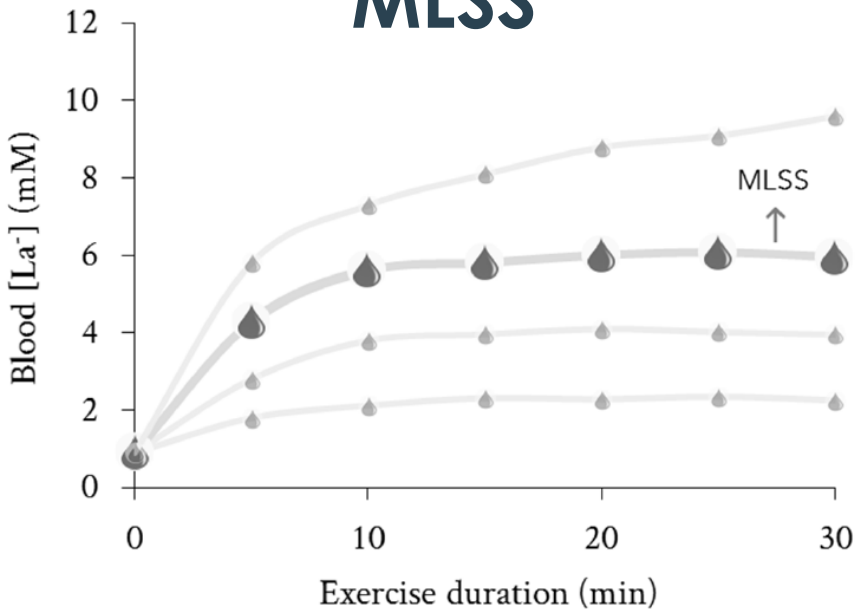
THE REFERENCE METHOD

CP



VS.

MLSS



VALID AND RELIABLE THRESHOLDS

TEM = 6 -7 W or 3.5%

Δ CP-MLSS = 6 W

r = 0.93 - 0.99

r = 0.82 for Δ values

CAEN ET AL. (2022)

Careful determination!

FTP

ALLEN & COGGAN (2006)

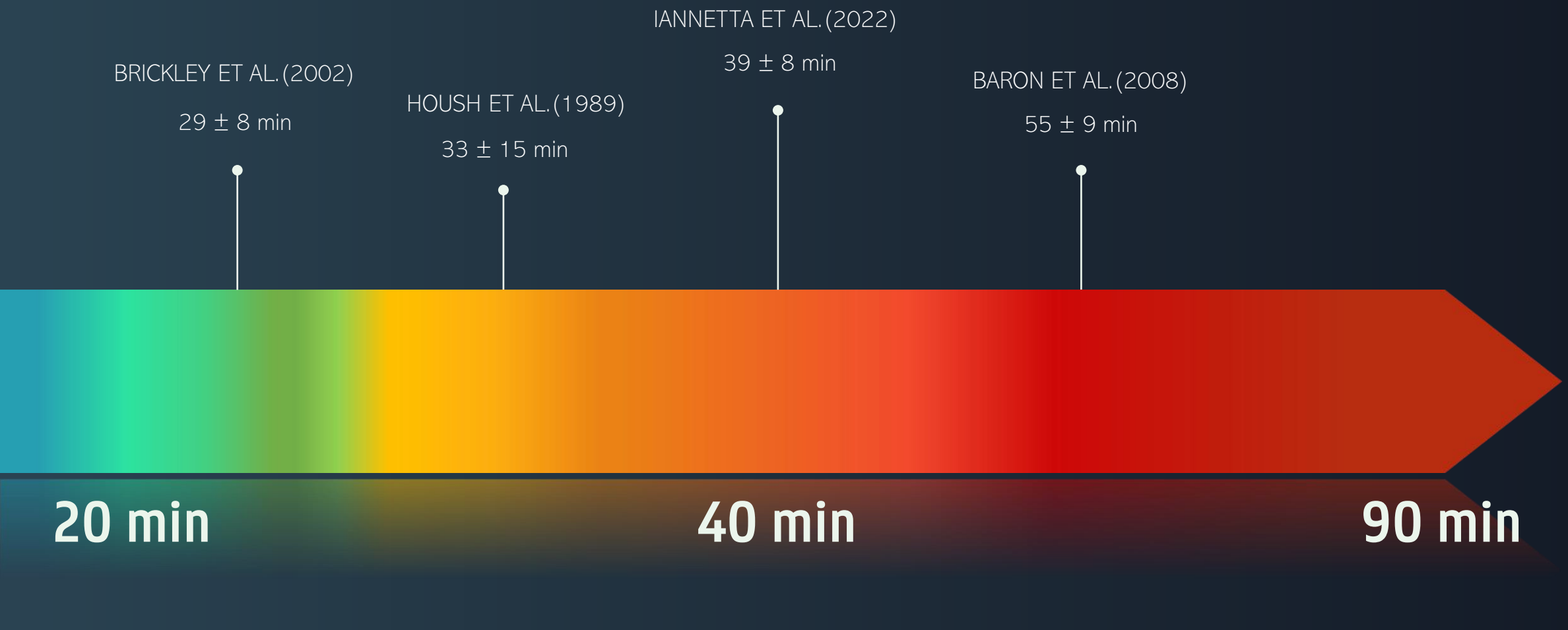
> “The highest power that a rider can maintain in a quasi-steady state for approximately 1 hour without fatiguing

FTP

60-min MMP

> The highest power that a rider can maintain in a quasi-steady state for approximately 1 hour without fatiguing

HOW LONG CAN YOU SUSTAIN ?

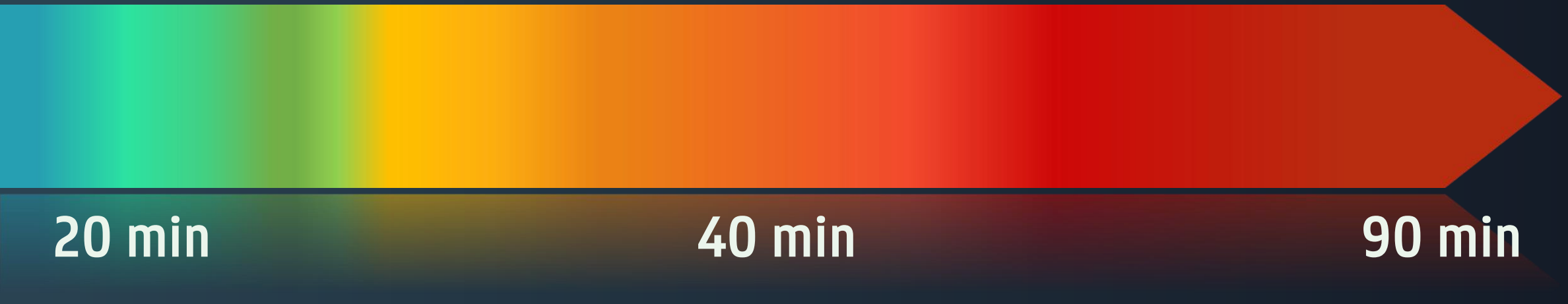


HOW LONG CAN YOU SUSTAIN ?

Methodological variation

Biological variation – Training status

Day-to-day variation



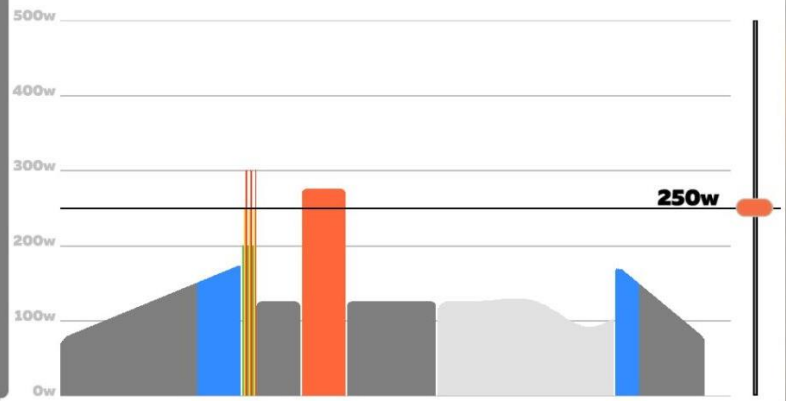
TRAINING

WORKOUTS | PLANS (NEW)

- 90+ minutes to burn
- Whoop Workout Series | Bike
- FTP Tests
  - **FTP Test** 1:13
  - FTP Test (shorter) 0:45
  - Ramp Test 0:43
  - Ramp Test Lite 0:39
- Le Col - Training With Legends
- Athlete-Inspired
- Fun is Fast 2021
- Voxwomen Tour 2021
- Build Me Up
- Gran Fondo

FTP Test

The standard FTP test starts off with a long easy warmup, a few ramps, and a 5 minute effort to get the legs pumping. After that it's time to give it your all - and go as hard as you can for 20 solid minutes. Pace yourself and try to go as hard as you can sustain for the entire 20 minutes - you will be scored on the final 20 minute segment.



...or create your own

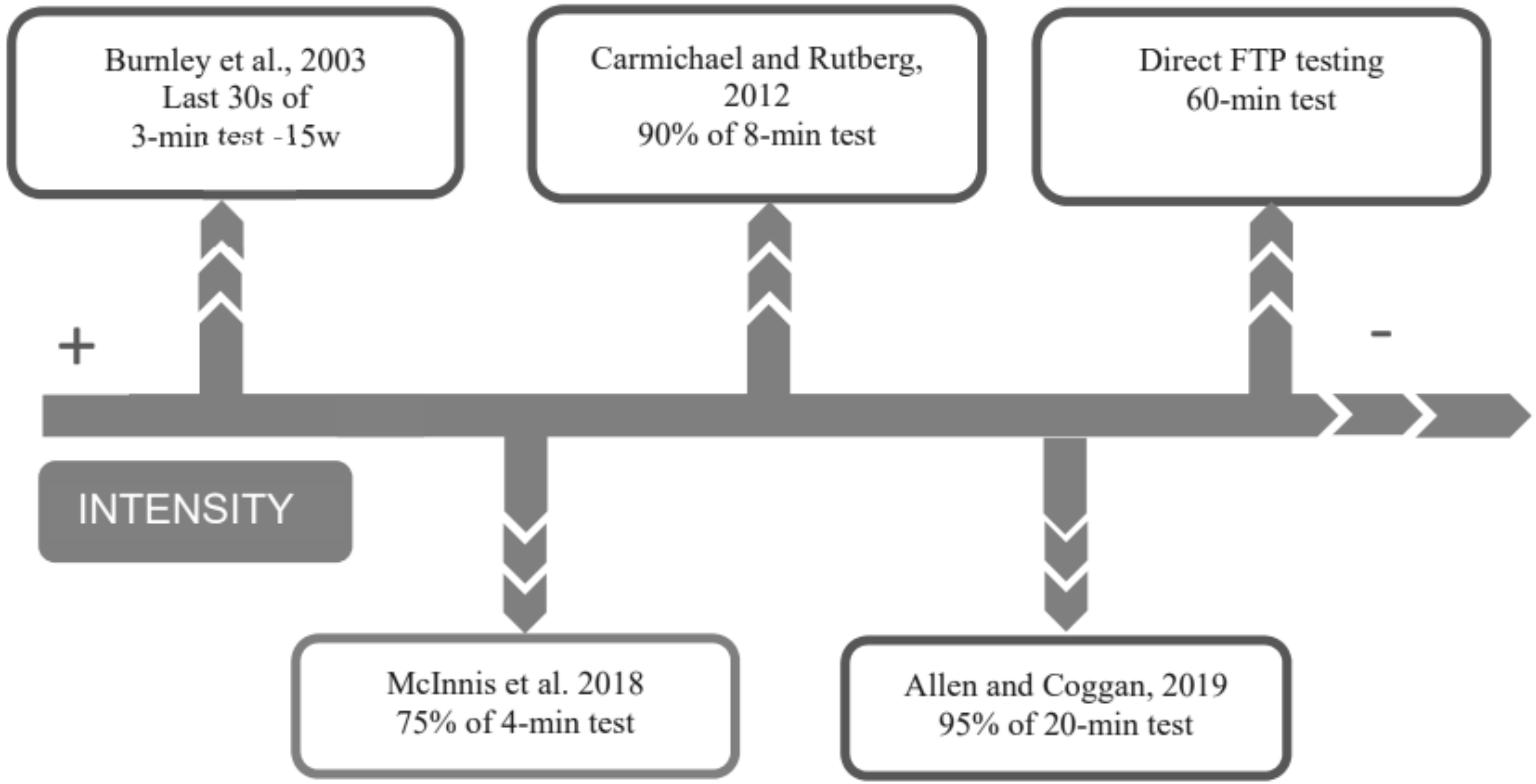
FTP: 250

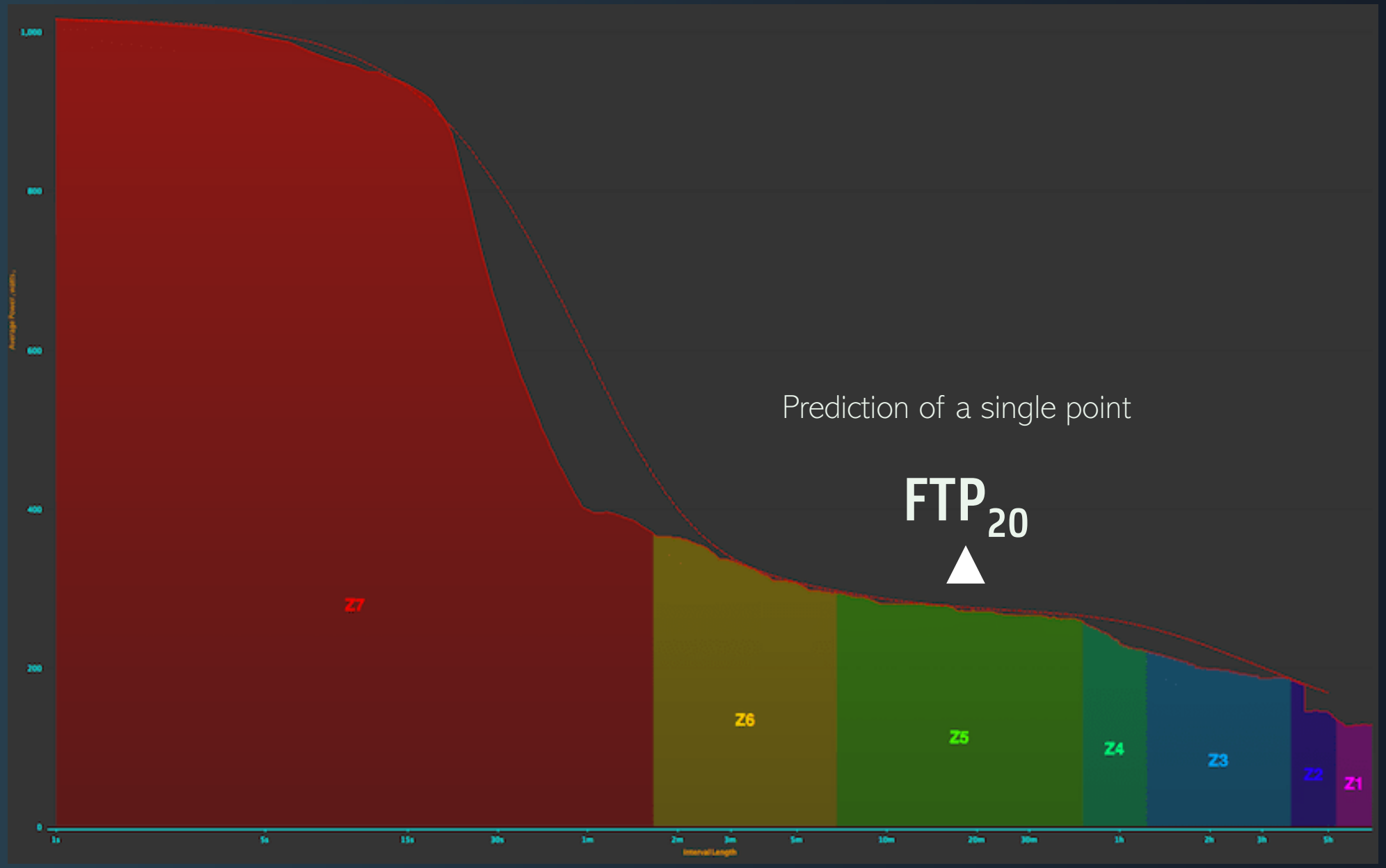
BACK

WORKOUT

FTP_{60} » FTP_{20} » FTP_{8} » FTP_{4}

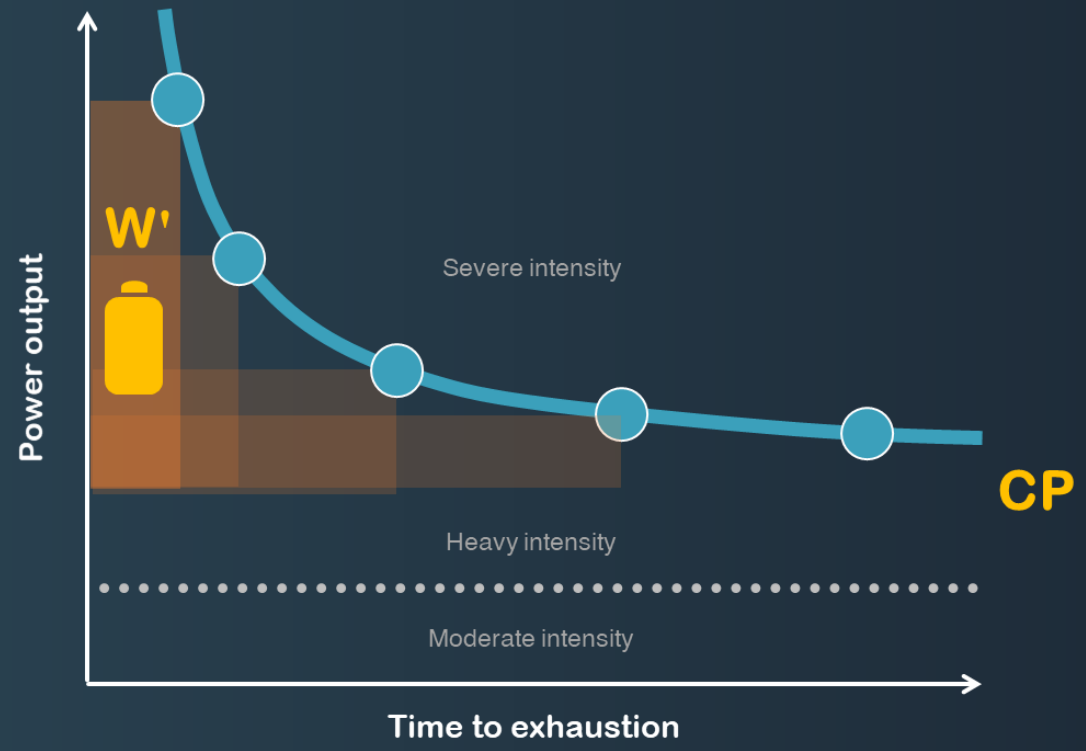
SITKO ET AL. (2020)




Prediction of a single point
FTP20
Z7
Z6
Z5
Z4
Z3
Z2
Z1

FTP_{60} = 95% FTP_{20}

CP = 94% P20



n = 153

26 ± 4 yr | 73 ± 10 kg

VO_{2peak} = 51.4 ± 7.6 $mL \cdot min^{-1} \cdot kg^{-1}$

CP = 243 ± 46 W

W = 18.7 ± 4.7 kJ

P20 = 259 ± 48 W

CP = 93.9 ± 1.4% P20

min = 89.4% | max = 97.8%

FTP_{60} = 95% FTP_{20}

90% FTP_{20}

International Journal of Sports Physiology and Performance, 2019, 14, 38-45
https://doi.org/10.1123/ijspp.2018-0100

Human Kinetics
ORIGINAL INVESTIGATION

The Reliability of 4-Minute and 20-Minute Time Trials and Their Relationships to Functional Threshold Power in Trained Cyclists

Martin J. MacInnis, Aaron C.Q. Thomas, and Stuart M. Phillips

Purpose: The mean power output (MPO) from a 60-min time trial (TT)—also known as functional threshold power, or FTP—is a standard measure of cycling performance; however, shorter performance tests are desirable to reduce the burden of performance testing. The authors sought to determine the reliability of 4- and 20-min TTs and the extent to which these short TTs were associated with 60-min MPO. ***Methods:*** Trained male cyclists (n = 8; age = 25 [5] y; VO_2max = 71 [5] mL/kg/min) performed two 4-min TTs, two 20-min TTs, and one 60-min TT. Critical power (CP) was estimated from 4- and 20-min TTs. The typical error of the mean (TEM) and intraclass correlation coefficient (ICC) were calculated to assess reliability, and R^2 values were calculated to assess relationships with 60-min MPO. ***Results:*** Pairs of 4-min TTs (mean: 417 [SD: 45] W vs 412 [49] W, $P = .25$; TEM = 8.1 W; ICC = .98), 20-min TTs (342 [36] W vs 344 [33] W, $P = .41$; TEM = 4.6 W; ICC = .99), and CP estimates (323 [35] W vs 328 [32] W, $P = .25$; TEM = 6.5; ICC = .98) were reliable. The 4-min MPO ($R^2 = .95$), 20-min MPO ($R^2 = .92$), estimated CP ($R^2 = .82$), and combination of the 4- and 20-min MPO (adjusted $R^2 = .98$) were strongly associated with the 60-min MPO (309 [26] W). ***Conclusion:*** The 4- and 20-min TTs appear useful for assessing performance in trained, if not elite, cyclists.

Keywords: cycling, exercise performance, critical power, constant duration, blood lactate

In cycling, time trials (TTs) are commonly used to establish performance benchmarks, prescribe training intensities, and determine the effectiveness of research interventions (eg, manipulations of diet, training, or equipment). Cycling TTs generally involves completing a set distance as quickly as possible (eg, 40-km TT) or covering as much distance as possible in a set amount of time (eg, 60-min TT). In general, both TT varieties are reliable measures of cycling performance[1,2]; however, as most cycling races are distance based, there is considerably less research examining fixed-duration TTs than there is examining fixed-distance TTs.

The mean power output (MPO) achieved during a 60-minute TT is a standard performance measure in cycling. In a study by Coyle et al,[3] 60-minute MPO was the strongest predictor for the time required by well-trained cyclists to complete 40-km TTs in the field during their competitive seasons. Indeed, the 60-minute MPO was a better predictor of cycling performance than maximum oxygen uptake or skeletal muscle capillarization, fiber type, or mitochondrial content.[3] The 60-minute TT is reproducible[4] and has been used to with 60-minute TT performance (FTP) would be useful in practical and research settings. As the 20-minute TT is still a demanding performance test, we also sought to examine the association between the 4-minute TT and 60-minute TT. We chose a 4-minute TT, because it closely approximates the time required to complete the 4-km individual pursuit in track cycling.[8]

A concept that is related to FTP is critical power (CP), the asymptote of the hyperbolic relationship between power output and the duration for which power outputs can be maintained.[9,10] Although it has been suggested that CP approximates FTP,[7] time to exhaustion at estimated CP is generally <60 minutes.[11] Estimates of CP are highly dependent on the protocol from which CP is derived[12,13] and are not necessarily equivalent to the physiological CP.[14,15] Yet, CP estimation provides a method to estimate power outputs for longer durations (eg, 60-min MPO) from 2 or more maximal efforts of fixed intensity or fixed duration—typically lasting between 1 and 20 minutes.[9,16] The inclusion of 2 relatively

88% FTP_{20}

International Journal of Sports Physiology and Performance, 2020, 15, 541-547
https://doi.org/10.1123/ijspp.2019-0214

Human Kinetics
ORIGINAL INVESTIGATION

Maximal Lactate Steady State Versus the 20-Minute Functional Threshold Power Test in Well-Trained Individuals: "Watts" the Big Deal?

Erin Calaine Inglis, Danilo Iannetta, Louis Passfield, and Juan M. Murias

Purpose: To (1) compare the power output (PO) for both the 20-minute functional threshold power (FTP_{20}) field test and the calculated 95% ($FTP_{95\%}$) with PO at maximal lactate steady state (MLSS) and (2) evaluate the sensitivity of $FTP_{95\%}$ and MLSS to training-induced changes. ***Methods:*** Eighteen participants (12 males: 37 [6] y and 6 females: 28 [6] y) performed a ramp-incremental cycling test to exhaustion, 2 to 3 constant-load MLSS trials, and an FTP_{20} test. A total of 10 participants returned to repeat the test series after 7 months of training. ***Results:*** The PO at FTP_{20} and $FTP_{95\%}$ was greater than that at MLSS ($P = .00$), with the PO at MLSS representing 88.5% (4.8%) and 93.1% (5.1%) of FTP and $FTP_{95\%}$, respectively. MLSS was greater at POST compared with PRE training (12 [8] W) ($P = .002$). No increase was observed in mean PO at FTP_{20} and $FTP_{95\%}$ ($P = .75$). ***Conclusions:*** The results indicate that the PO at $FTP_{95\%}$ is different to MLSS, and that changes in the PO at MLSS after training were not reflected by $FTP_{95\%}$. Even when using an adjusted percentage (ie, 88% rather than 95% of FTP_{20}), the large variability in the data is such that it would not be advisable to use this as a representation of MLSS.

Keywords: exercise testing, cycling, performance, FTP, MLSS

Identifying the critical intensity of exercise is a crucial aspect for predicting performance, prescribing exercise training, and evaluating the effectiveness of training interventions.[1,2] This critical intensity is thought to represent the upper boundary of sustainable performance (ie, the boundary separating tolerable and nontolerable exercise) and is often identified by measures including the maximal lactate steady state (MLSS) or critical power (CP).[3] Although the accuracy for determining this intensity is best obtained in a laboratory setting, this is not always feasible due to cost, accessibility, and time constraints. Thus, field-test protocols are popular among cyclists because they are easily conducted with minimal equipment. Given the practical nature of field tests, they do not entail direct measurement of the physiological responses normally used to confirm the level of exertion (eg, blood lactate concentration [BLa], oxygen uptake [VO_2]), instead they rely on the maximal voluntary performance.

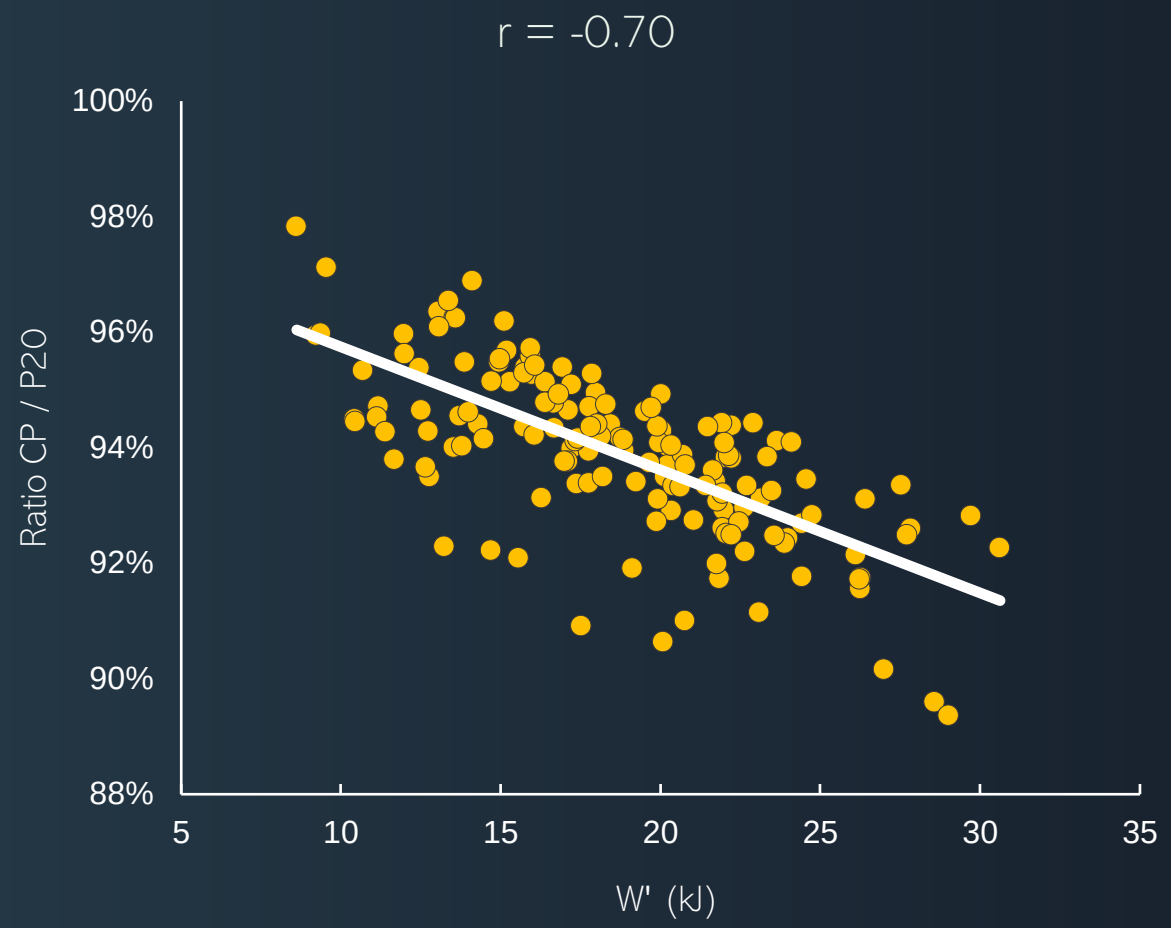
with the 60-minute time trial (ie, FTP_{60}) and suggested that it may be an appropriate tool for performance assessment and tracking. However, these authors concluded that the use of 95% could result in an overestimation of FTP_{60} and suggested that a reduction in the percentage of the $FTP_{95\%}$—from 95% to 90%—might be a better predictor of this intensity.[5] By contrast, others have found no difference between the $FTP_{95\%}$ and the lactate threshold,[6] nor between the $FTP_{95\%}$ and the individual anaerobic threshold.[7] Moreover, a comparison between $FTP_{95\%}$ and CP (also closely related with the anaerobic threshold[8]) found a strong correlation and no difference[9] between the 2 variables. However, large limits of agreement were reported and it was concluded that CP and $FTP_{95\%}$ should not be considered equivalent nor used interchangeably.[9]

According to Allen and Cogan,[4] FTP_{60} and $FTP_{95\%}$ represent the highest PO that can be maintained for an extended period

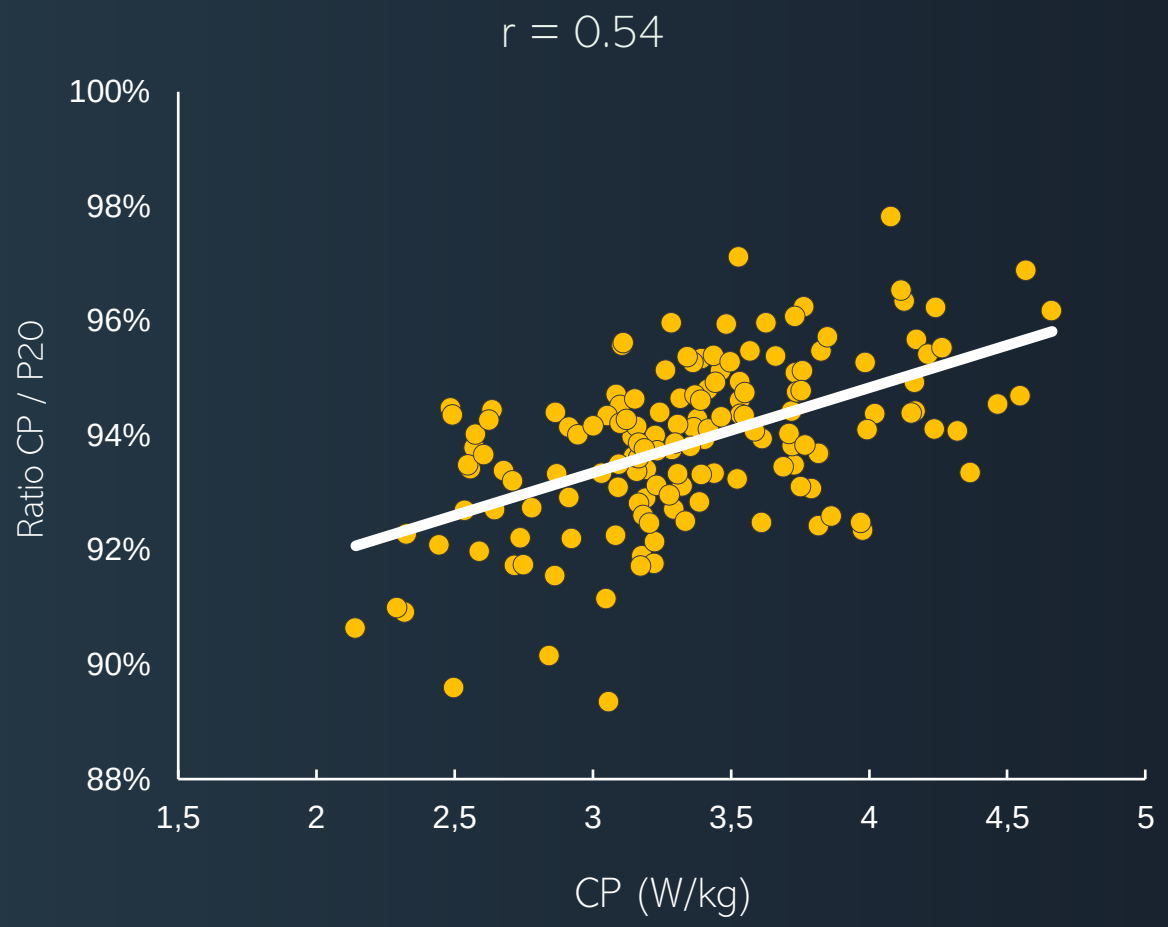
INDIVIDUAL CORRECTION FACTOR?

Endurance type	VS.	Explosive type
< 5%		> 5%

Higher W' = higher correction



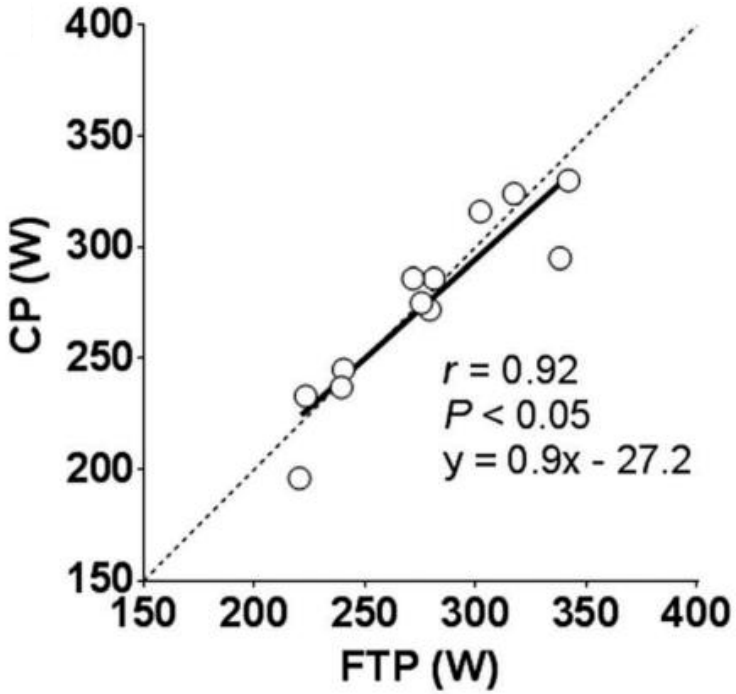
Higher CP = lower correction

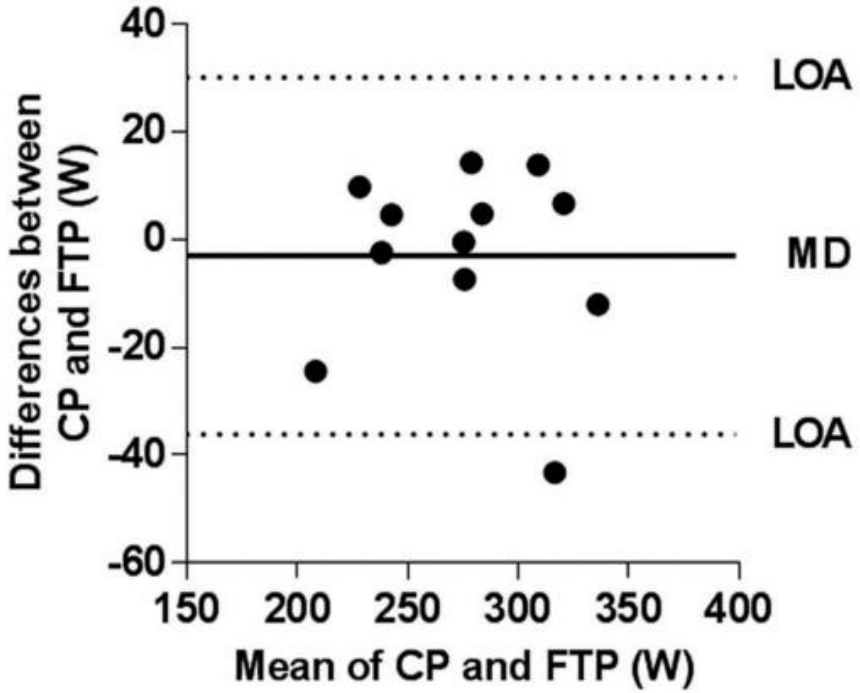


VALIDITY AS THRESHOLD?

Strong correlations
Large individual differences

MORGAN ET AL. (2019)

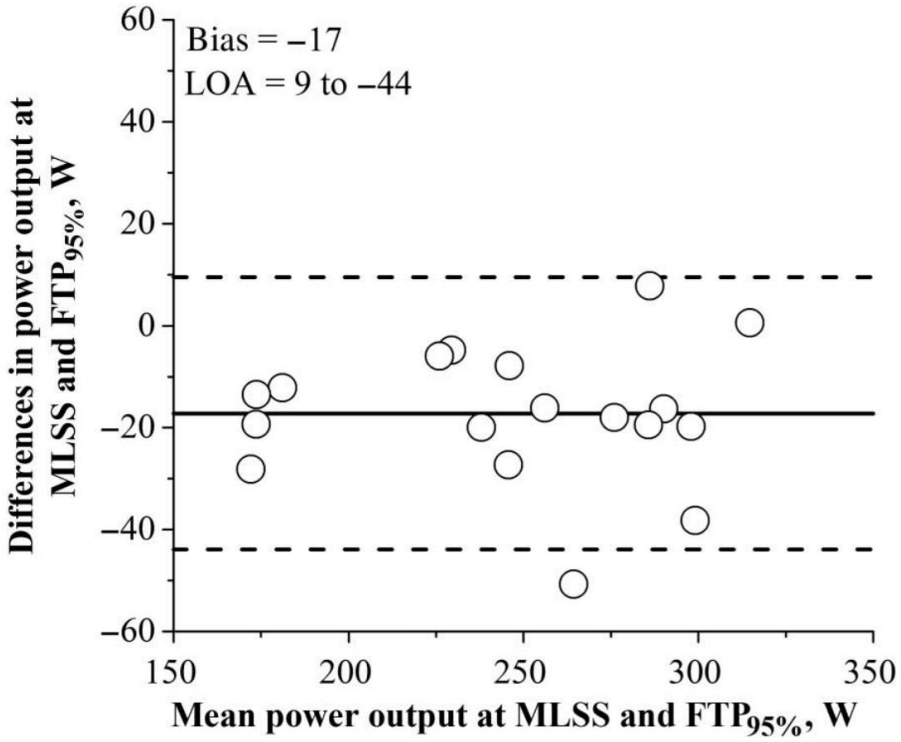


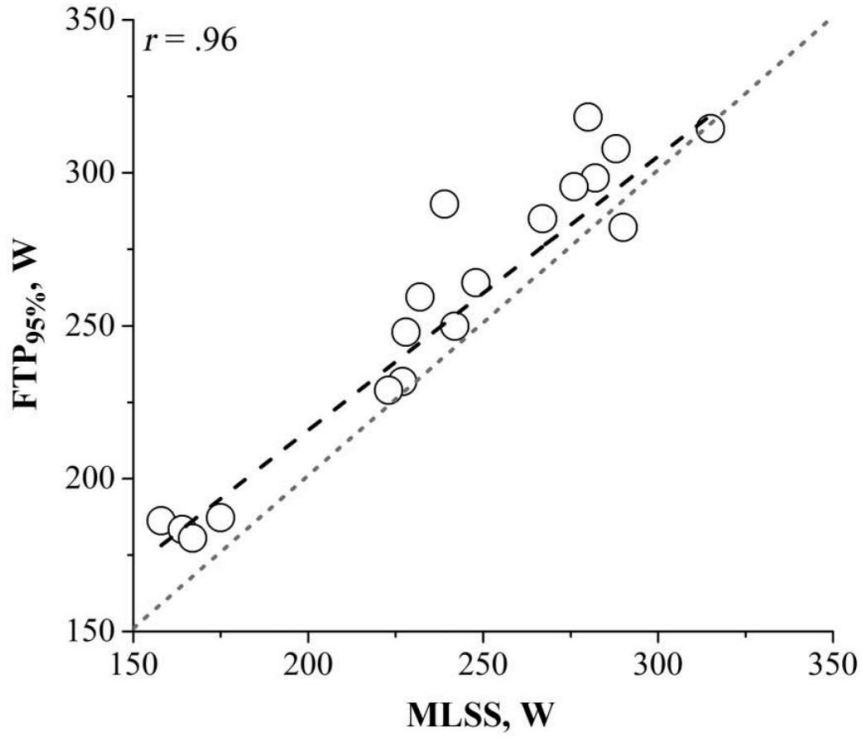


VALIDITY AS THRESHOLD?

Strong correlations
Large individual differences

INGLIS ET AL. (2020)





RELIABLE PERFORMANCE ?

CV = 1 to 3%

ICC = 0.97 to 0.98

MACKEY ET AL. (2021)

MACINNIS ET AL. (2019)

Table 2 Reliability of the MPO Achieved for Pairs of 4- and 20-Minute TTs and Estimates of CP

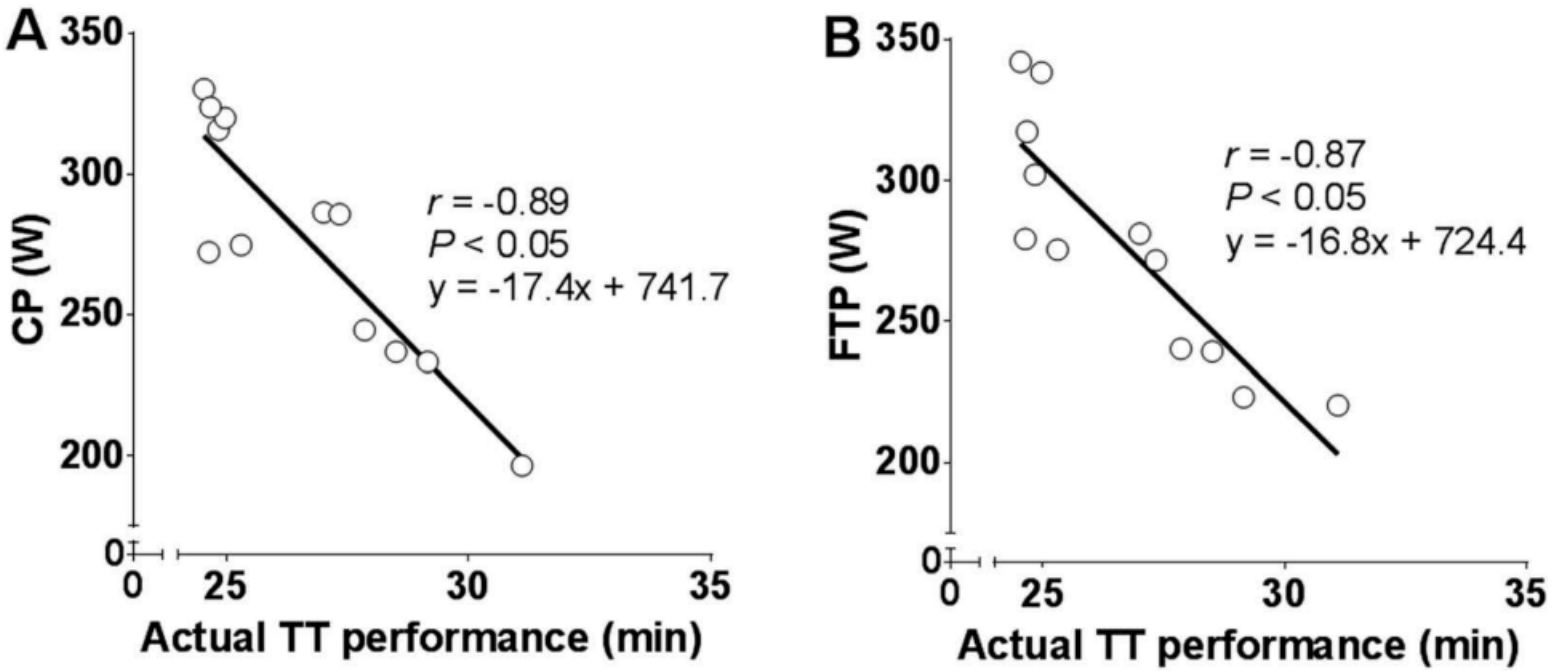
Test	Trial 1 MPO, W[a]	Trial 2 MPO, W[a]	Average MPO, W[a]	Change in mean, %[b]	TEM, W[b]	TEM, CV, %[b]	ICC[b]	Bias, W[c]
4-min TT	417 (45)	412 (49)	414 (47)	−1.3 (−3.9 to 1.2)	8.1 (5.4 to 16.6)	2.2 (1.5 to 4.6)	.98 (.91 to 1.0)	5.1 (−17.4 to 27.7)
20-min TT	342 (36)	344 (33)	343 (35)	+0.7 (−0.90 to 2.3)	4.6 (3.0 to 9.4)	1.4 (0.9 to 2.8)	.99 (.95 to 1.0)	−2.0 (−14.9 to 10.8)
CP	323 (35)	328 (32)	325 (29)	+1.4 (−1 to 3.8)	6.5 (4.3 to 13.3)	2.1 (1.4 to 4.2)	.98 (.89 to 1.0)	−4.1 (−22.2 to 13.9)

Abbreviations: CV, coefficient of variation; CP, critical power; ICC, intraclass correlation coefficient; MPO, mean power output; TEM, typical error of the mean; TT, time trials.
[a] Data are shown as mean (SD). [b] Values in parentheses represent 95% confidence intervals. [c] Values in parentheses represent 95% limit of agreement.

RELATED TO PERFORMANCE ?

FTP as predictor of TT performance

MORGAN ET AL. (2019)



Functional power

FTP is a reliable performance measure

FTP is closely related to MMSS

VS.

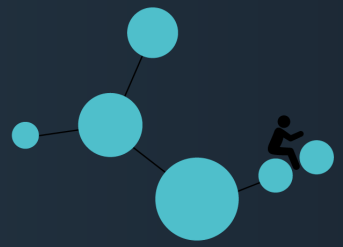
Fictional threshold

FTP lacks physiological meaning

FTP does not represent MMSS

FTP

Functional power - fictional threshold



Science & Cycling

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PACE.
Coaching & Education