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W' in the Critical Power model

The role of W' reconstitution in sports performance

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Ghent University
Belgium

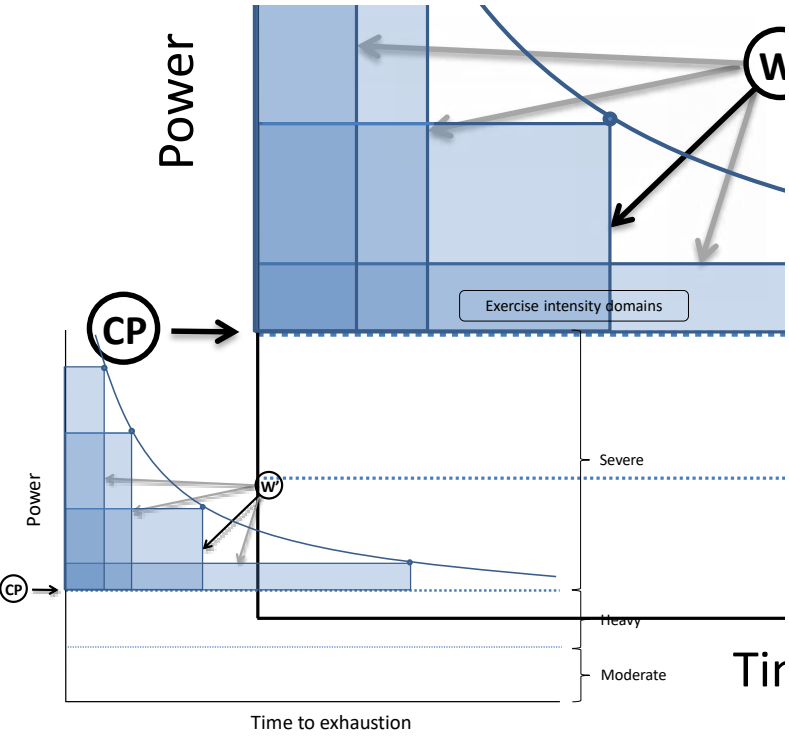
Introduction

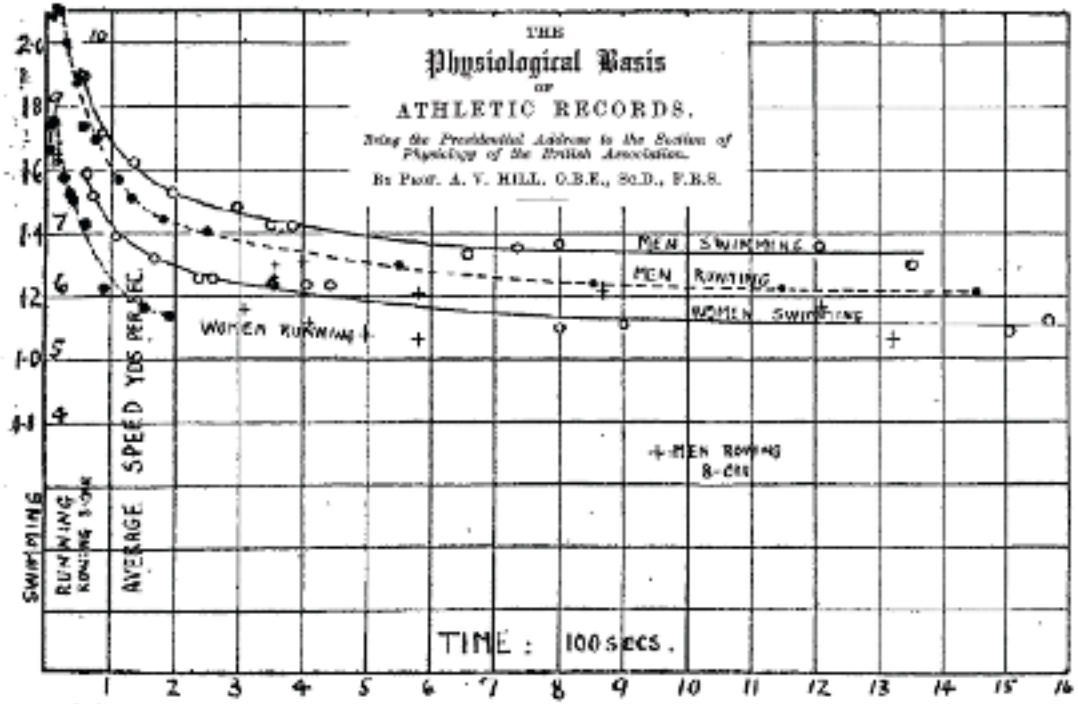
Exercise intensity domains

THE
Physiological Basis
OF
ATHLETIC RECORDS.

Being the Presidential Address to the Section of Physiology of the British Association.

BY PROF. A. V. HILL, O.B.E., SC.D., F.R.S.





Worki's records for men and women swimming and running; average speed in yards per second against time in seconds. *Note.*—The scale for swimming is five times as great as for running. The observations for men rowing on eight-oar boat are on the same scale as running and are referred to later in the text.

Introduction

Exercise intensity domains

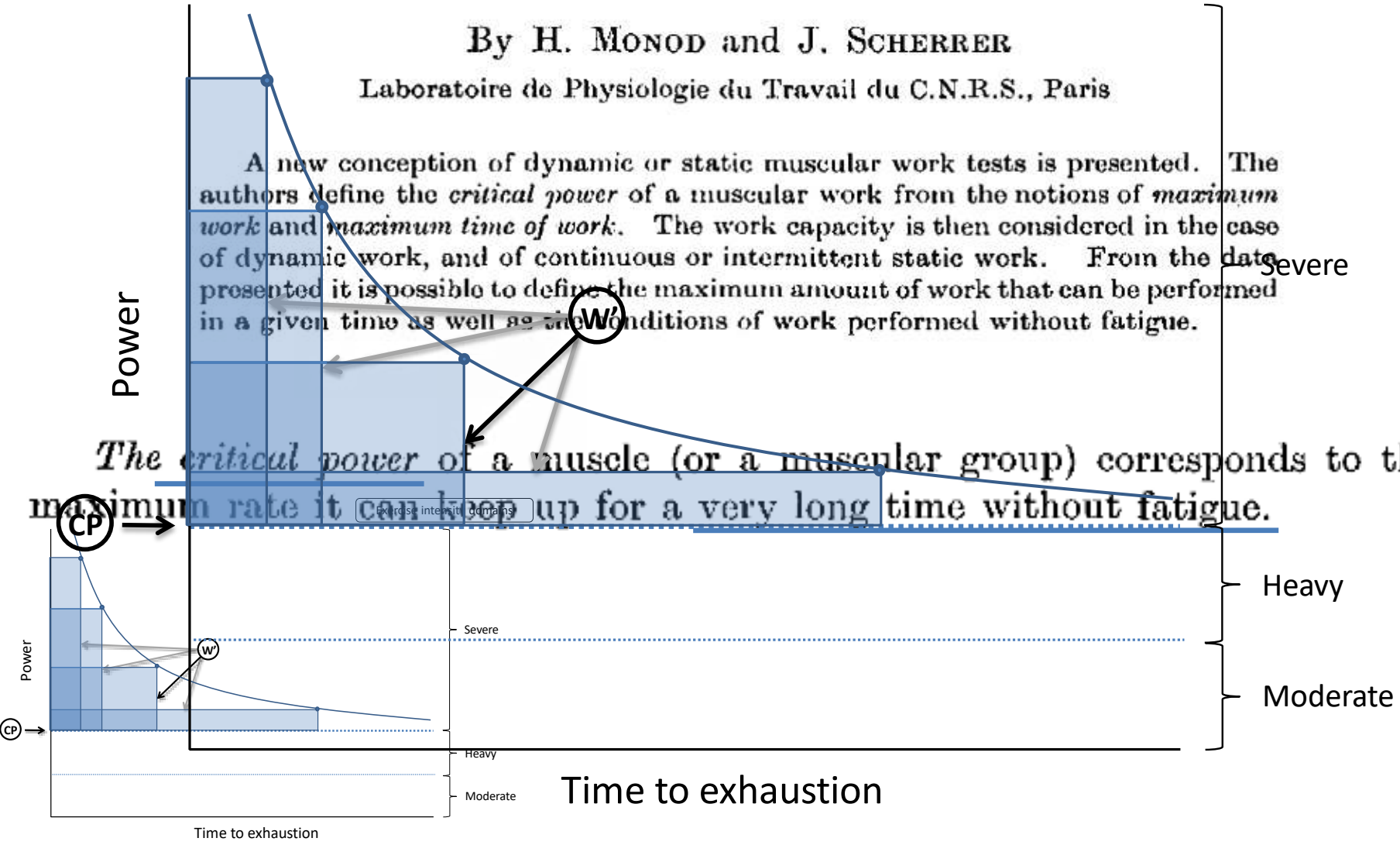
THE WORK CAPACITY OF A SYNERGIC MUSCULAR GROUP

By H. Monod and J. Scherrer

Laboratoire de Physiologie du Travail du C.N.R.S., Paris

A new conception of dynamic or static muscular work tests is presented. The authors define the *critical power* of a muscular work from the notions of *maximum work* and *maximum time of work*. The work capacity is then considered in the case of dynamic work, and of continuous or intermittent static work. From the data presented it is possible to define the maximum amount of work that can be performed in a given time as well as the conditions of work performed without fatigue.

The critical power of a muscle (or a muscular group) corresponds to the maximum rate it can keep up for a very long time without fatigue.



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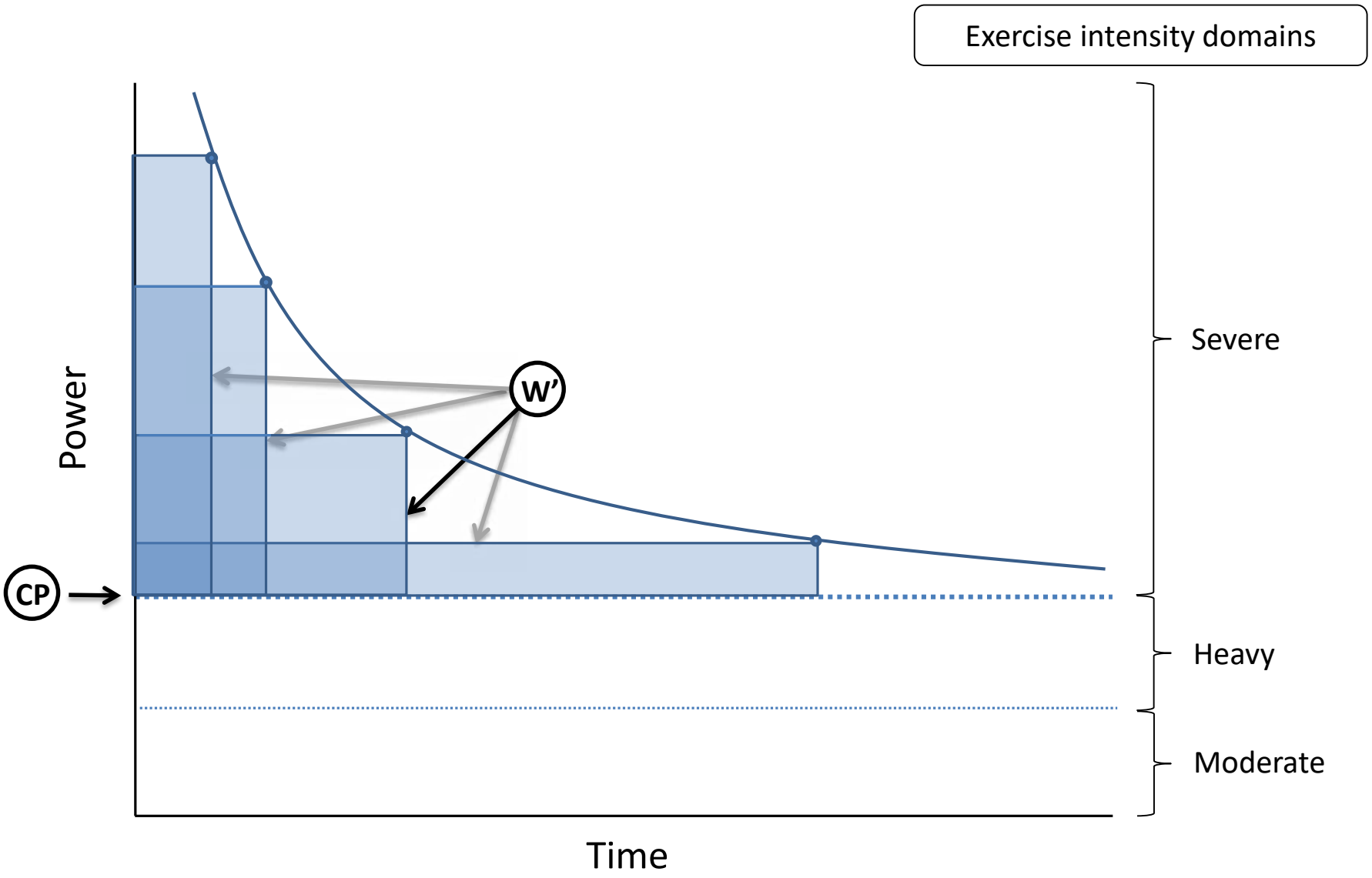
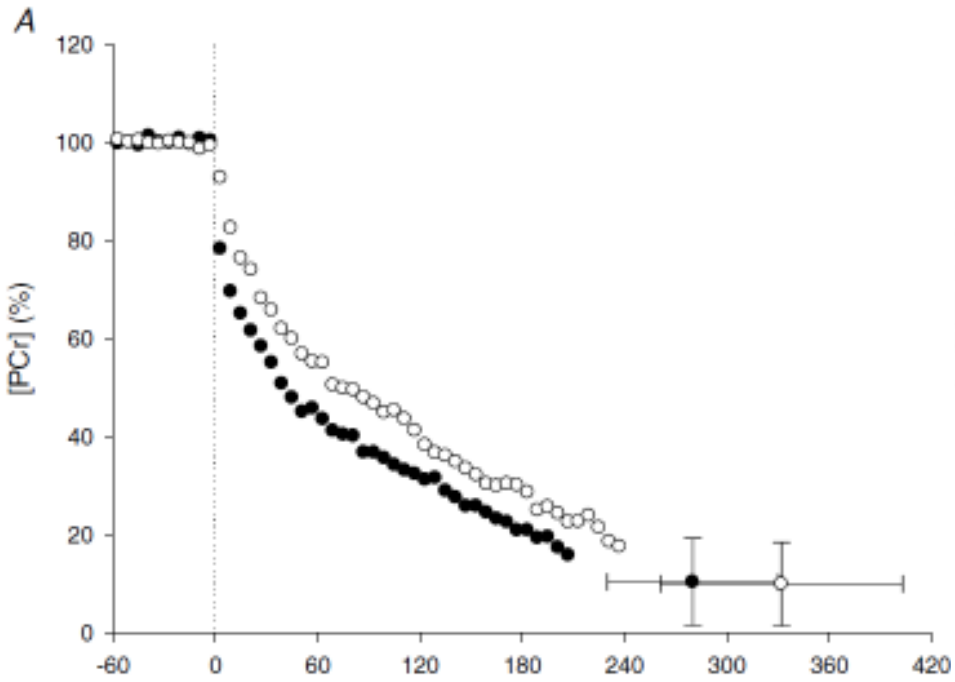
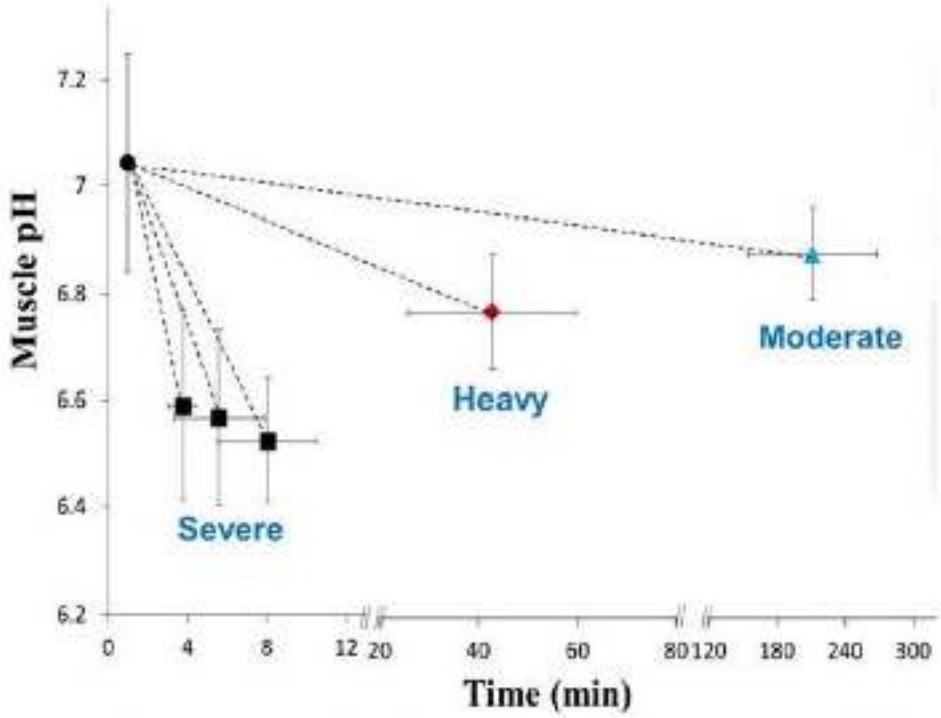


W': definitions



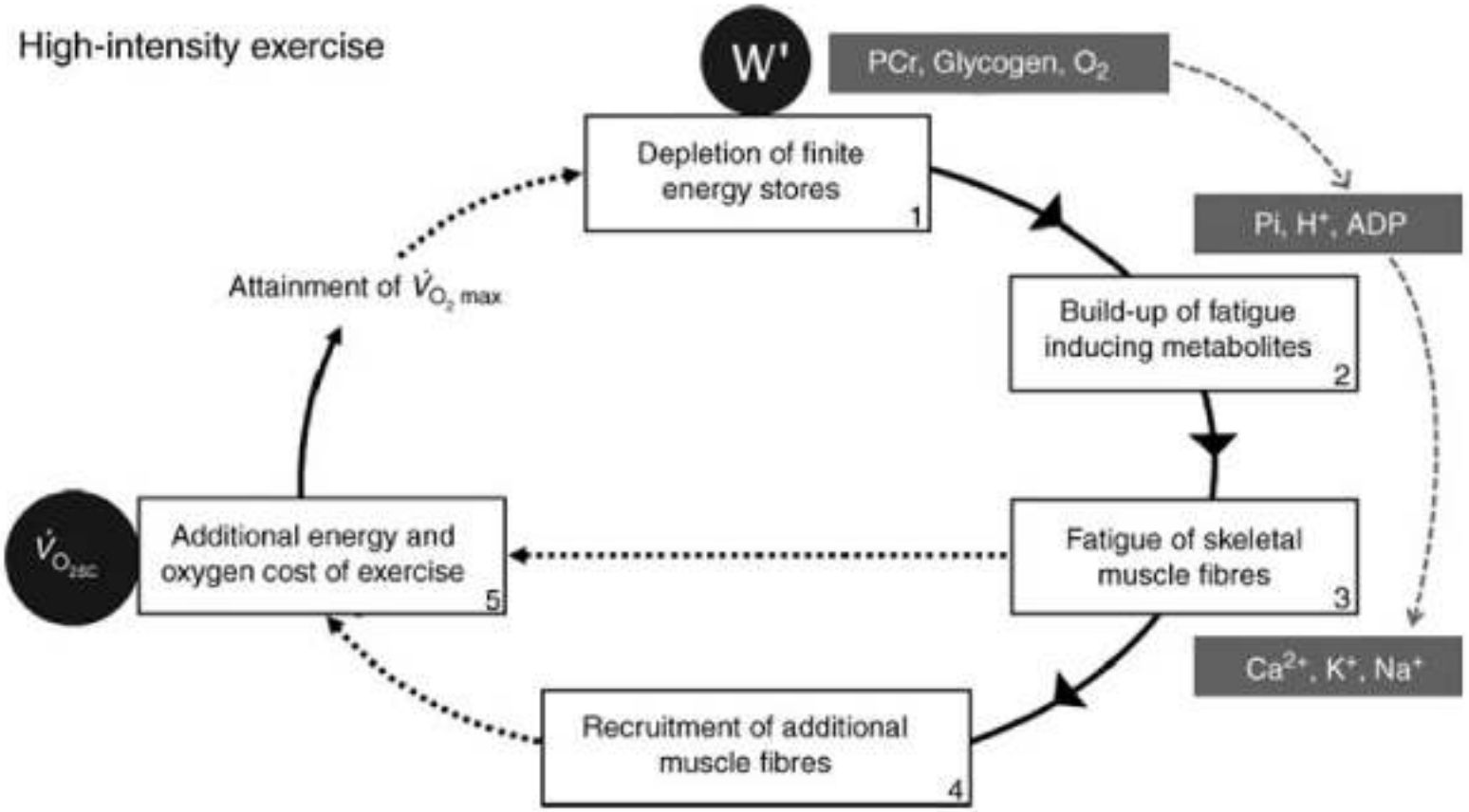


W' size ~ attainment of critical value intramuscular substrates and/of fatigue related metabolites

Vanhatalo et al. 2010

Black et al. 2017

W': definitions



Murgatroyd and Wylde 2011

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W': definitions

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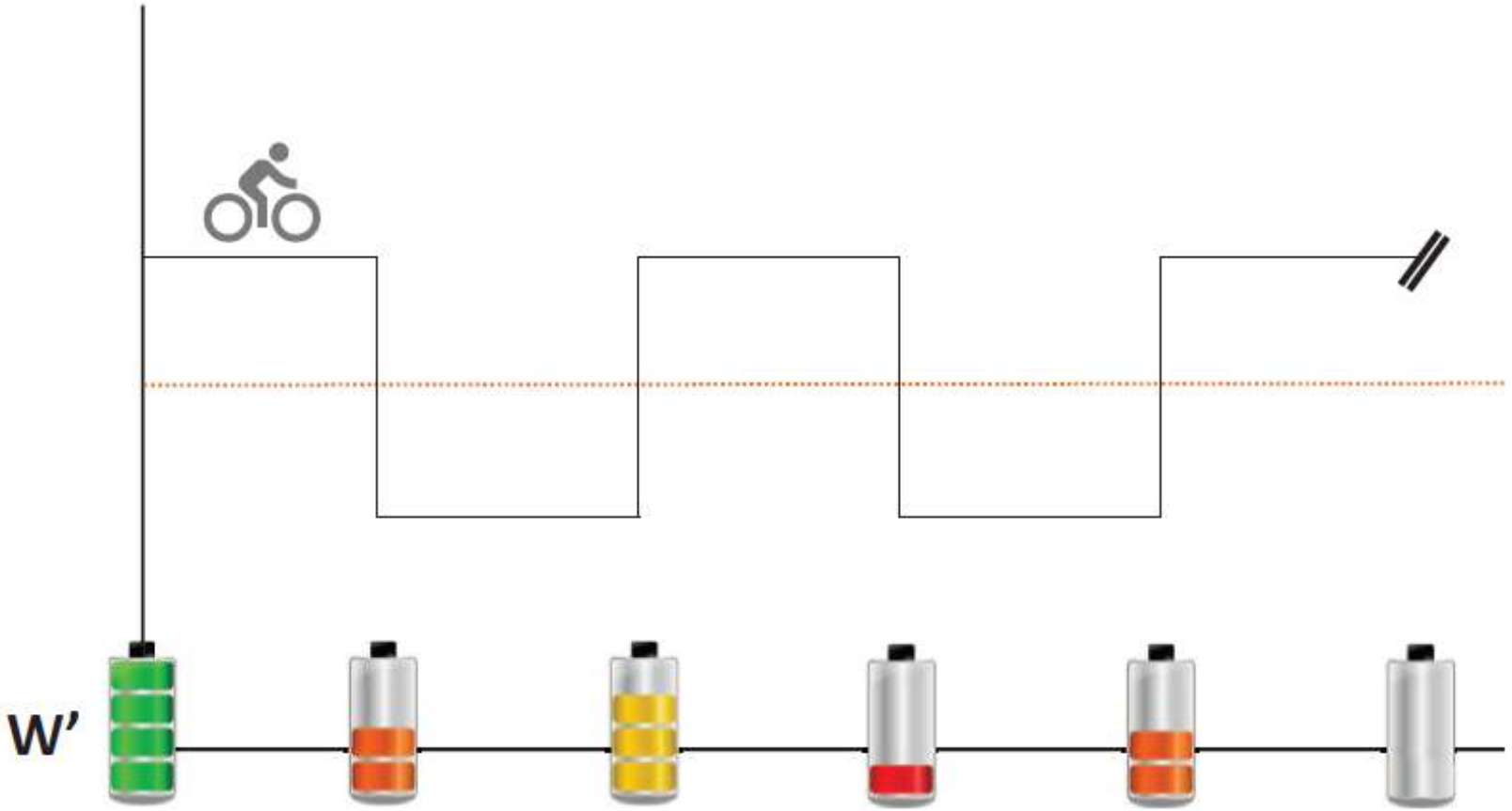

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CP and W’: performance prediction

Constant Load Exercise

Gradual depleted => W' = 0 at finish

$$T_{lim} = W'/(P\text{-}CP)$$

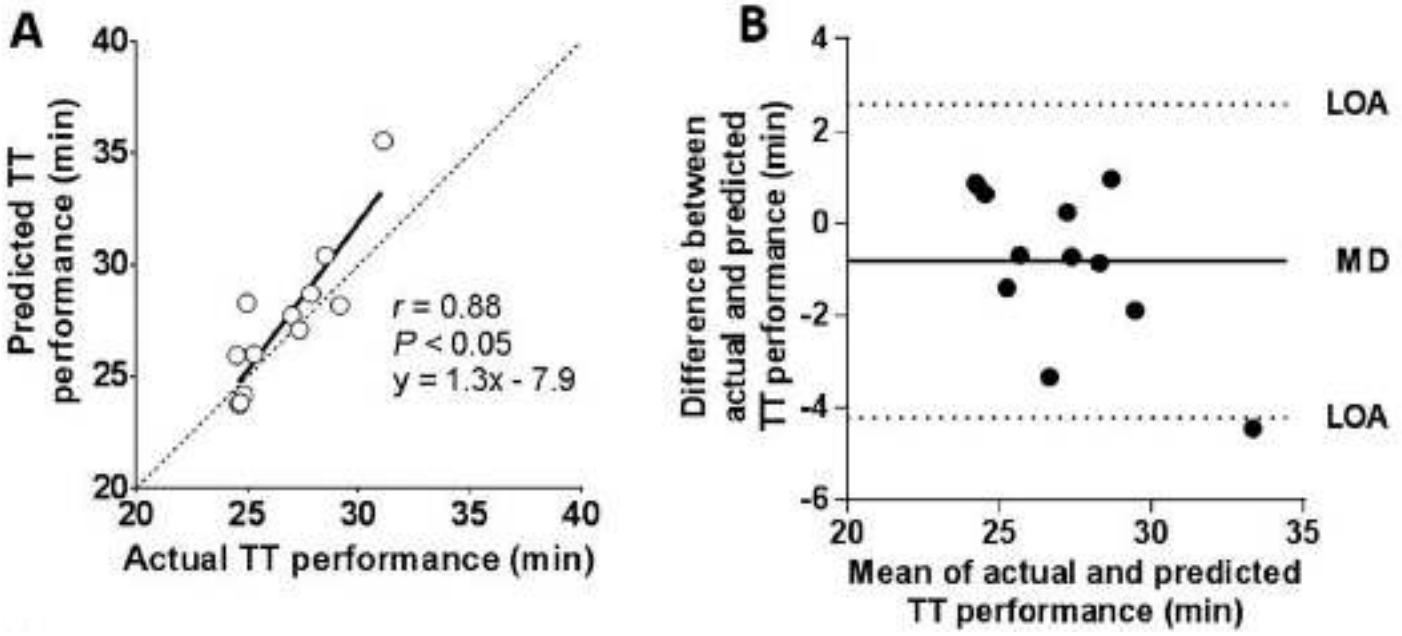
Time Trial

Individual Pursuit

(World Hour Record)

Constant Load Exercise

$$T_{lim} = W'/(P\text{-}CP)$$



Fairly accurate performance prediction

Morgan et al. 2019

Intermittent Exercise

Depleted > CP Reconstituted < CP

$$T_{lim} = W'/(P-CP)$$

Team Pursuit

Madison

Road Cycling

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Intermittent Exercise

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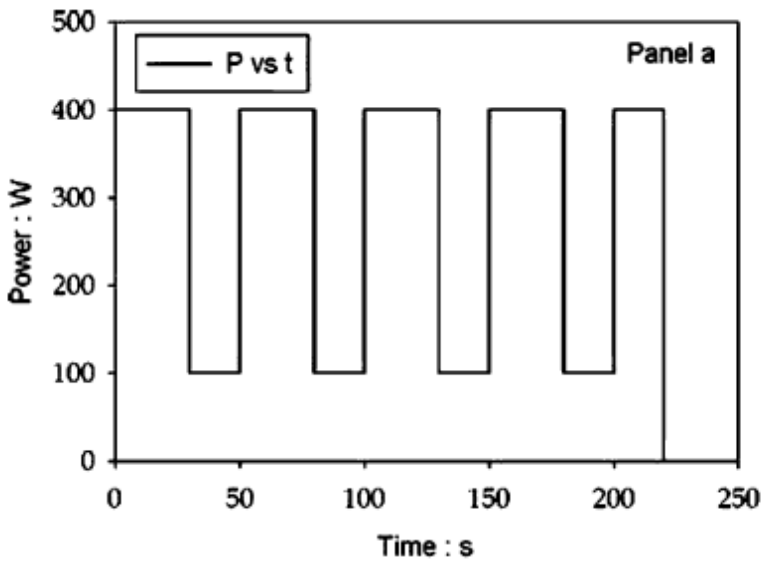
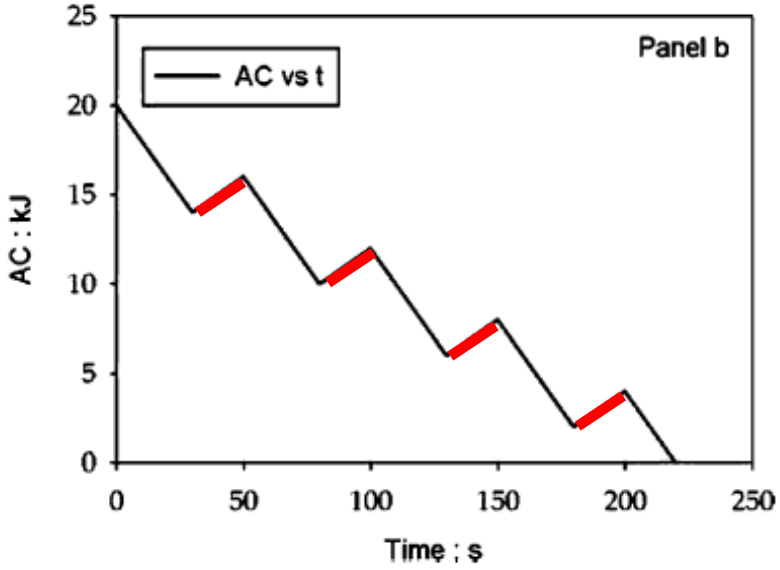
How do the reconstitution kinetics of W' look like?



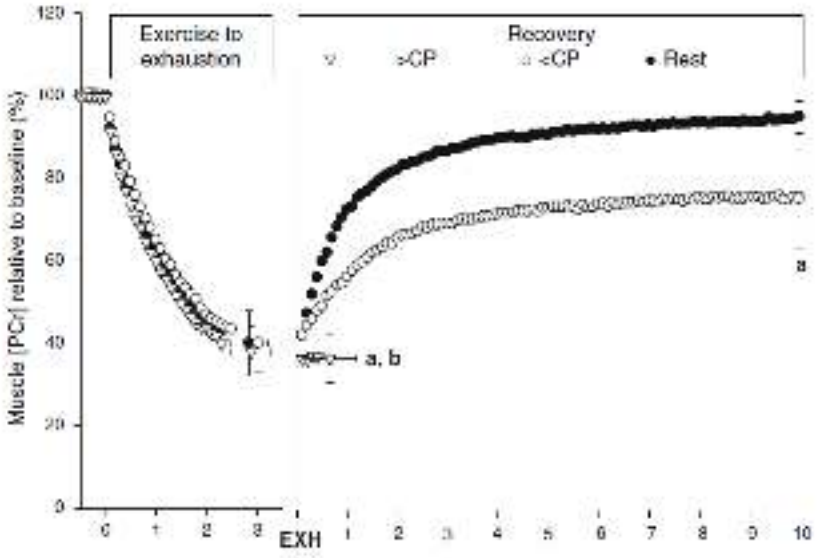


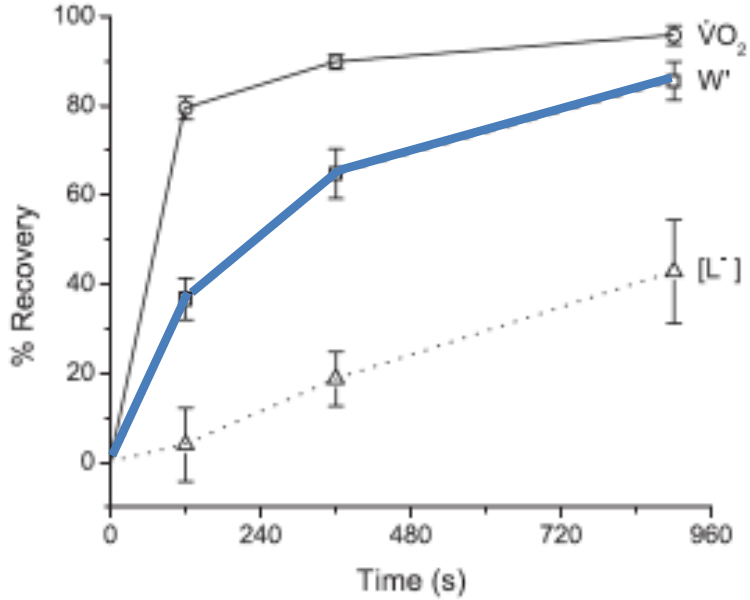
$$t = n(D_W + D_R) + [W' - n([P_W\text{-}CP)D_W - (CP - P_R)D_R] / (P_W\text{-}CP)$$

Morton and Billat 2004

2. Intermittent Exercise

How do the reconstitution kinetics of W' look like?





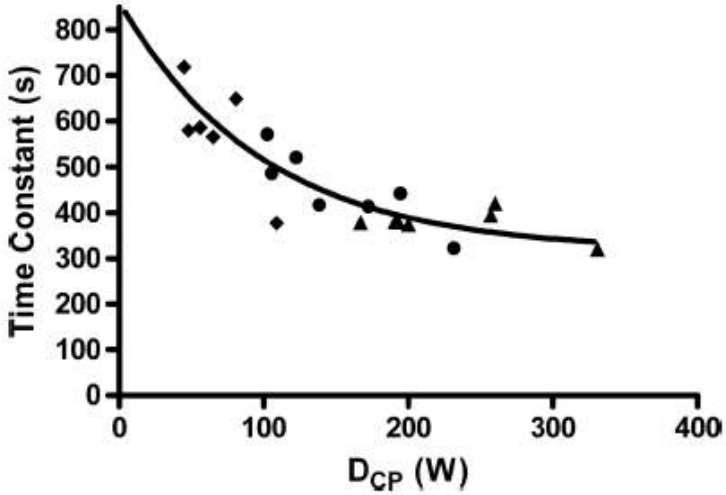
Ferguson et al. 2012

Intermittent Exercise

How do the reconstitution kinetics of W' look like?

$$W'_{bal} = W' - \int_0^t (W'_{exp})\,(e^{-(t-u)/\tau_{W'}}).\,du$$

$$\tau_{W'} = 546e^{(-0.01D_{CP})} + 316$$



- **Exponential recovery**
- **Speed of recovery ($\tau_{W'}$) ~ distance between recovery power output and critical power (D_{CP})**

Skiba et al. 2012

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Intermittent Exercise

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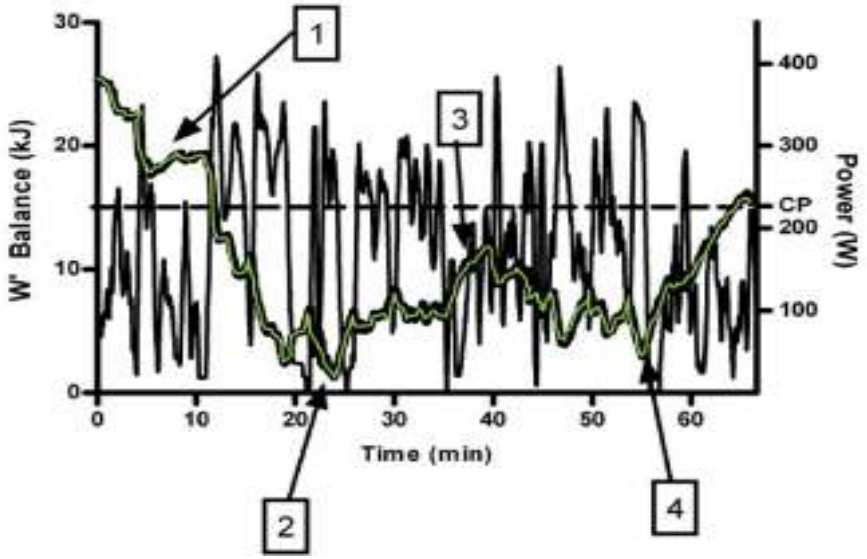
How do the reconstitution kinetics of W' look like?



Skiba et al. 2012

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Intermittent Exercise

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Is the W'_{BAL} correct?

What about individual characteristics?

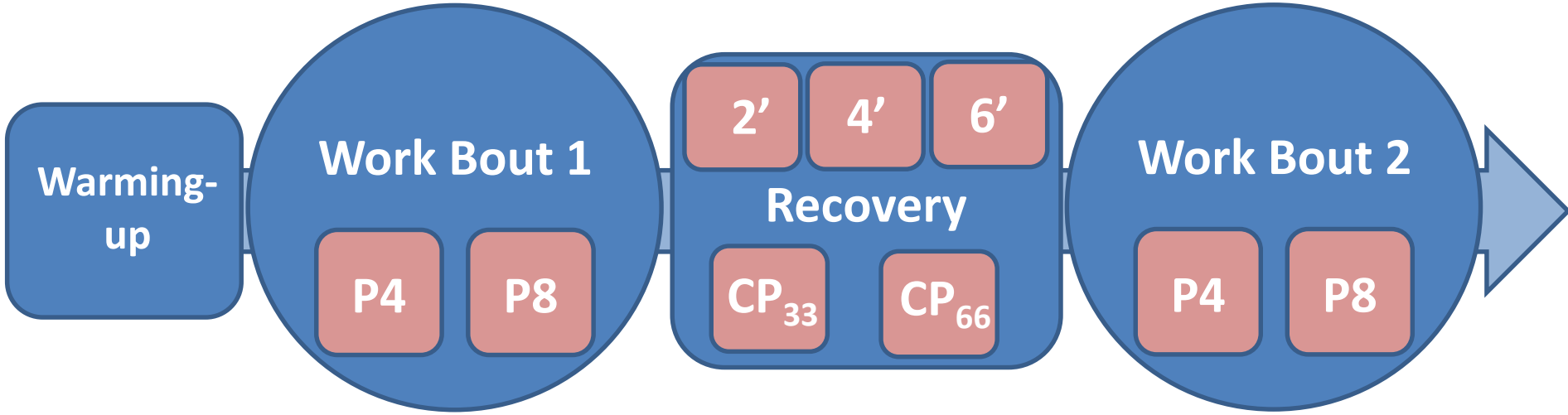
Are CP and W' invariable and constant?

Intermittent Exercise

1. Is the W'_{BAL} model correct?

n = 11 PE students

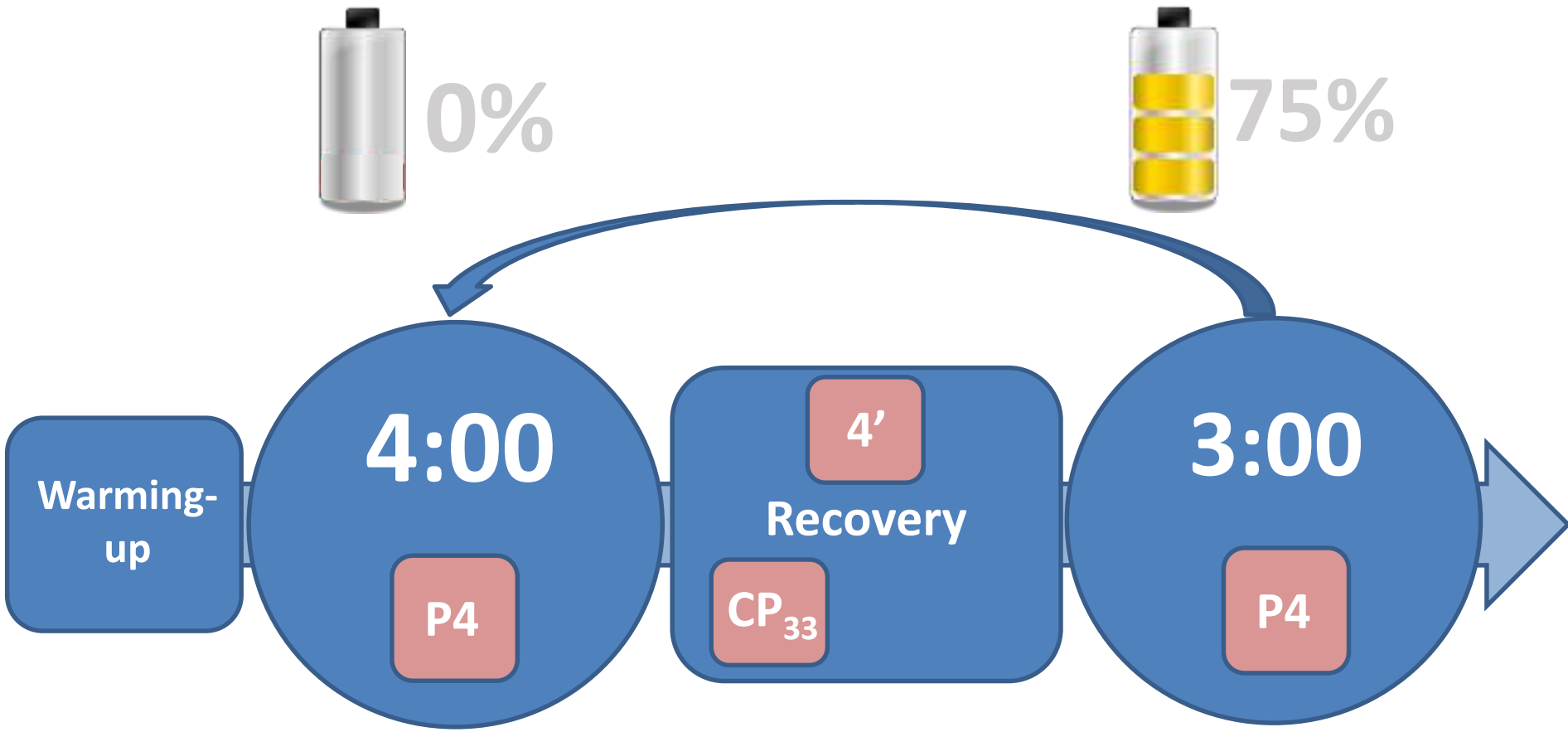
- Incremental ramp test
- Critical Power test
- Experimental test



Caen et al. 2019

Intermittent Exercise

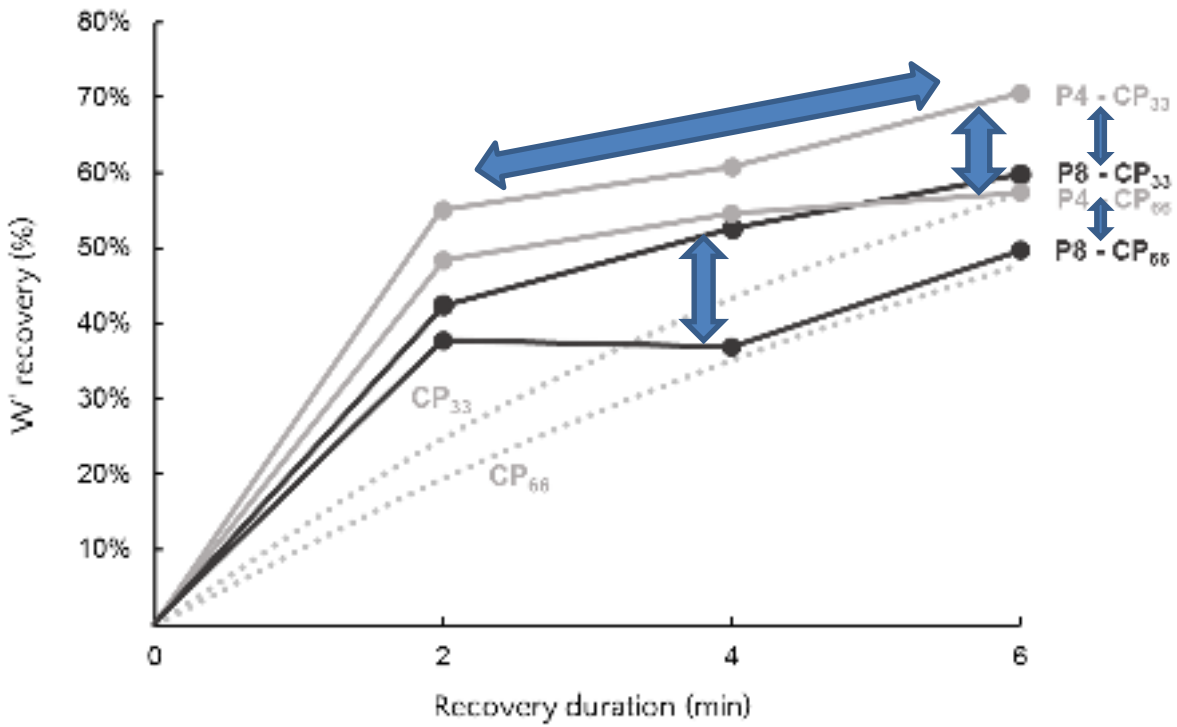
1. Is the W' $_{BAL}$ model correct?



Caen et al. 2019

Intermittent Exercise

1. Is the W'$_{BAL}$ model correct?



RECOVERY DURATION
13.4% difference
(6 min > 2 min)

RECOVERY INTENSITY
9.4% difference
(33%CP > 66%CP)

WORK DURATION
11.4% difference
(P4 > P8)

W' reconstitution kinetics are dependent on the rate of W' expenditure (i.e. work above CP)

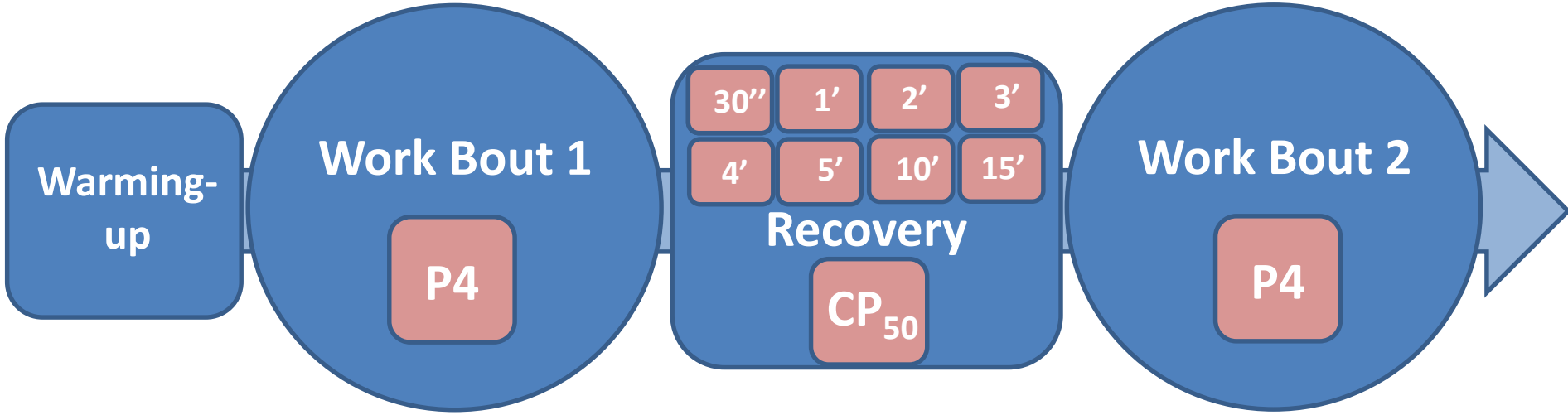
Caen et al. 2019

Intermittent Exercise

1. Is the W'_{BAL} model correct?

n = 21 PE students

- Incremental ramp test
- Critical Power test
- Muscle Biopsy
- Experimental test



Caen et al. 2019

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Intermittent Exercise

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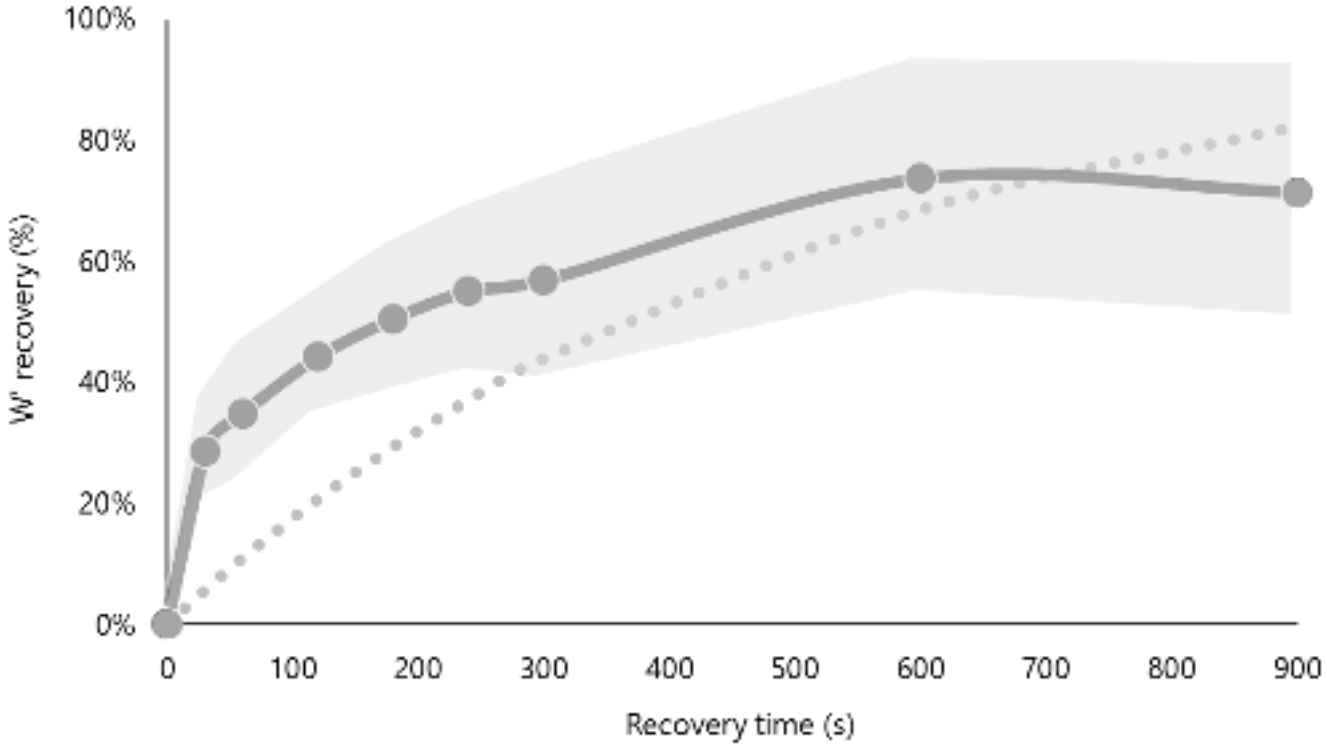
1. Is the W'_{BAL} model correct ?

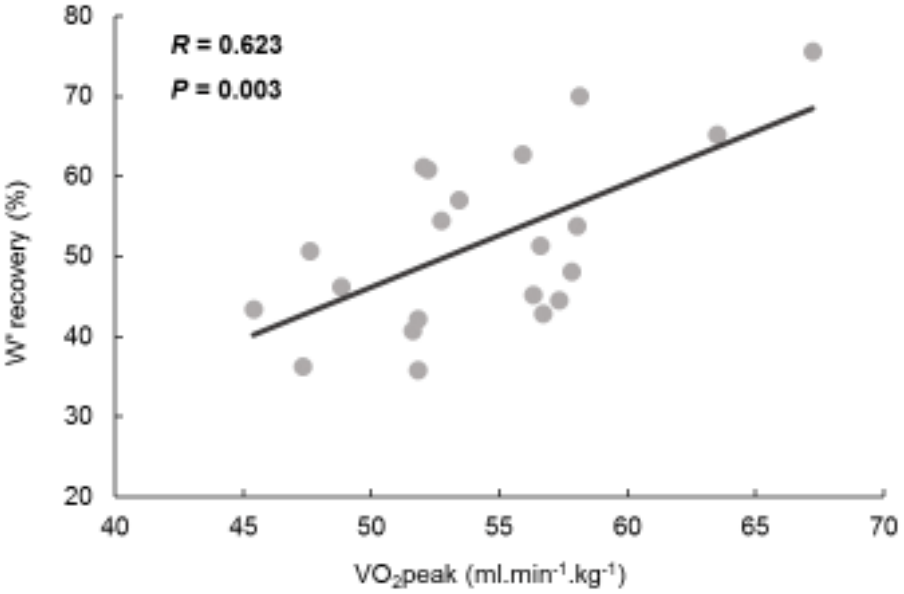


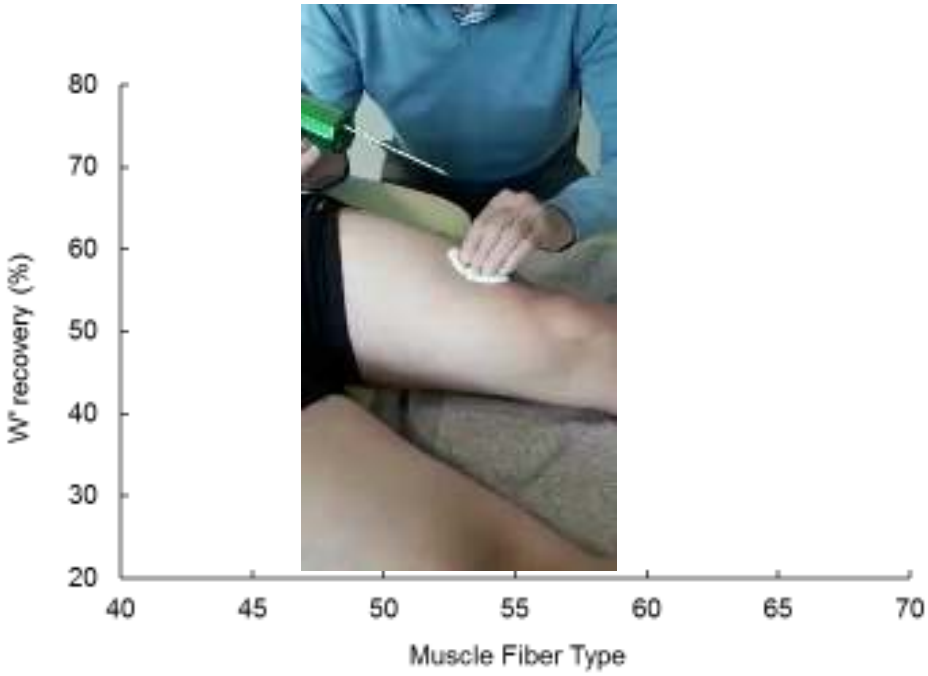
W'_{BAL} underestimates the W' reconstitution when short recovery durations (<4 min) are used!

Caen et al. 2019

Intermittent Exercise

2. What about the individual characteristics?





Higher VO_2peak result in a speeding of the W' recovery kinetics.

Caen et al. 2019

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Intermittent Exercise

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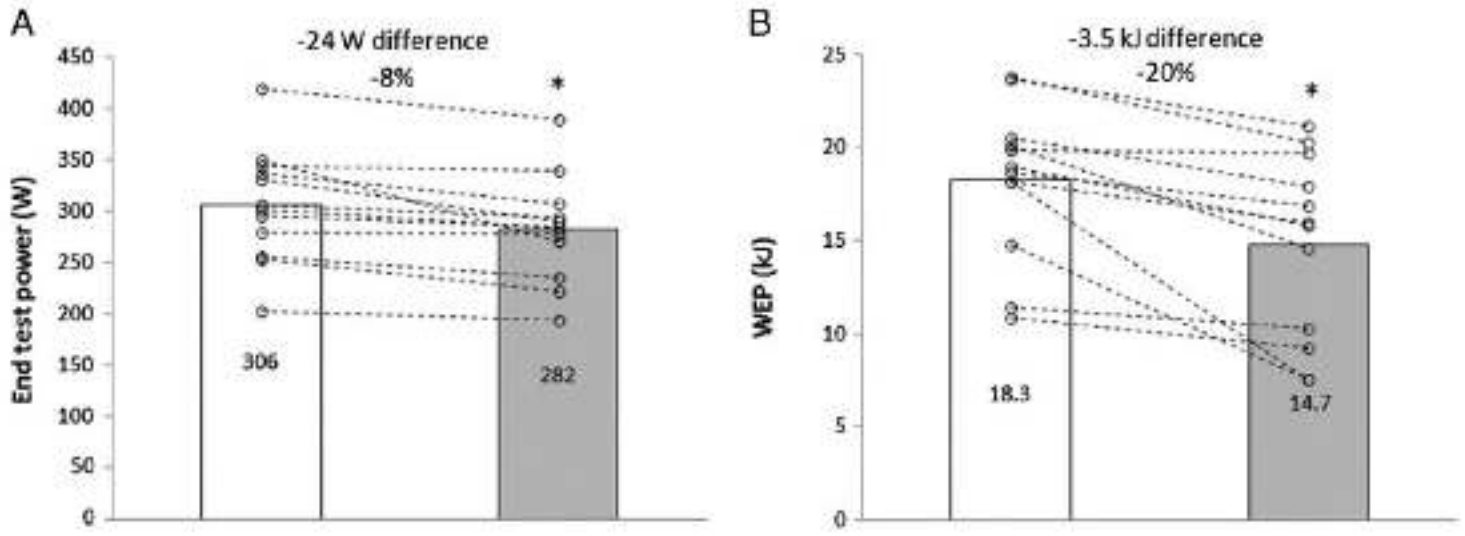
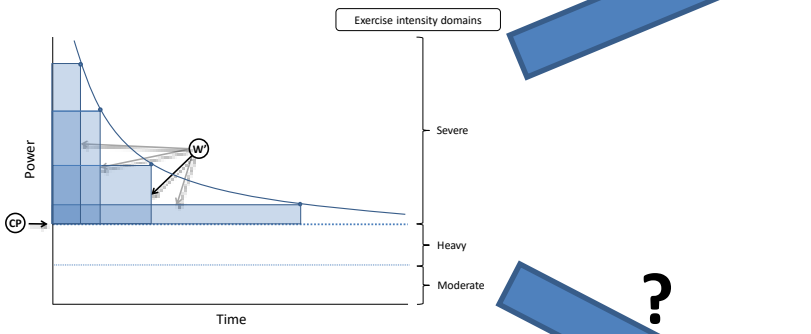
3. Are CP and W' invariable and constant?



W' and CP decrease with prolonged exercise.

Clark et al. 2018

Conclusions



Constant load exercise

Intermittent exercise

?

W' reconstitution kinetics

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Thank you!

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