THE SECRETS OF COMPETITION: PACING, DECISION-MAKING AND PERFORMANCE WHEN RACING AGAINST OTHERS

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Exercise & training at home

How about athletes?

Survey of more than 12000 athletes: How did they train?

Table 2. Training and exercise during lockdown (n = 12,526).

During lockdown, the governing authority allowed:	Number	%
Exercising at home only	8330	67
Using available spaces for exercise around my housing area / compound	5256	42
Outdoor cycling	3354	27
Running in a recreational park or stadium	3317	27
Outdoor hiking or trekking in non-public facilities	2577	21
Receive/borrow equipment from sports bodies or institutes, and train at home	2105	17
Access to gymnasium (muscle strengthening / resistance training)	579	5
Access to sports academy or institute's school or university's facilities	510	4
Other	100	1

N.B. – for all questions, athletes were allowed to select multiple answers, does not total 12,526 or 100%

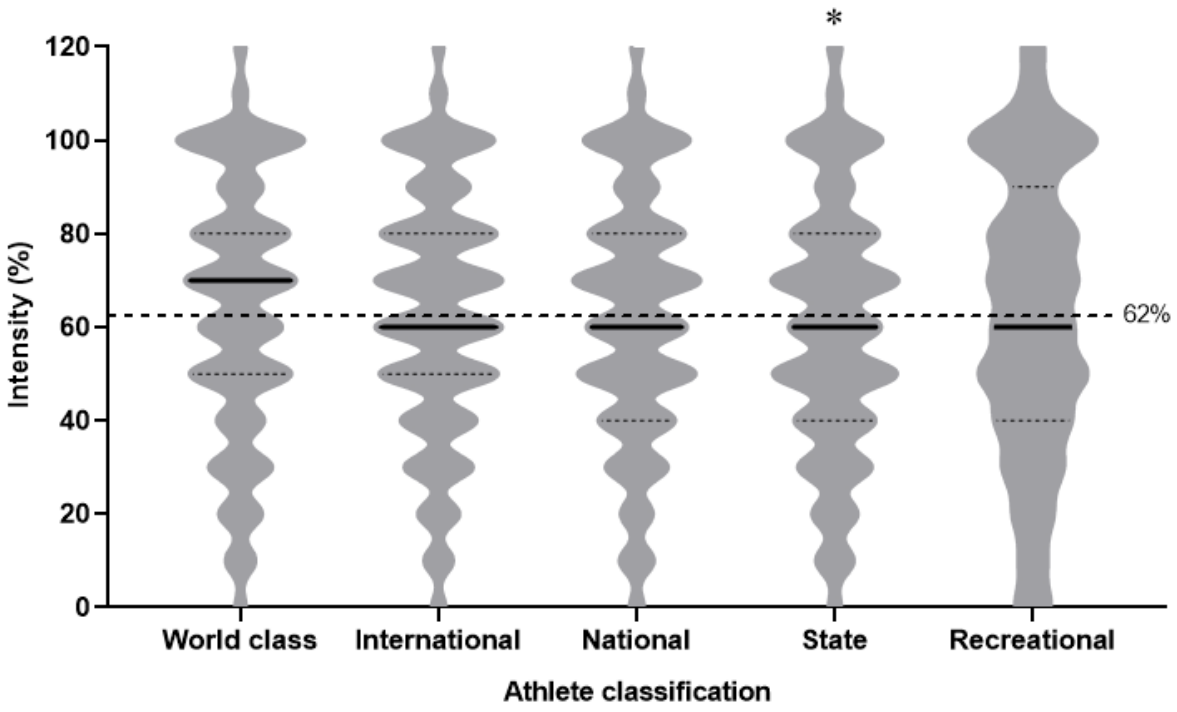
Jad Adrian Washif et al. (submitted). *Sports Medicine.* Training during the COVID-19 lockdown: Knowledge, beliefs, and practices of 12,526 athletes from 142 countries and 6 continents.

Impact on training quality, for example reduced intensity: 62%

Figure 2. Training intensity during lockdown (62% represents average reported %intensity).

Question: Do/did you maintain your pre-lockdown intensity for sports specific training (practicing your sport) during the lockdown?

Can you estimate how much in percentage? (100% represents the same intensity as before the lockdown (N = 12,518).



Competition and Training **alone** in times of lockdown

1) Reduced training frequency (5-7 to ≤4 sessions/wk.), shorter training sessions (≥60-min to <60-min), lower sport-specific intensity (-38% reduction) compared to pre-lockdown.

2) **80% of athletes trained alone**. Remote training (i.e., alone) reduced motivation (53%) amplified by the lack of competition (58%). **Training modifications reduced motivation in over half the athletes surveyed (and likely affected mental health in many more).** Lack of social facilitation, encouragement, interaction.

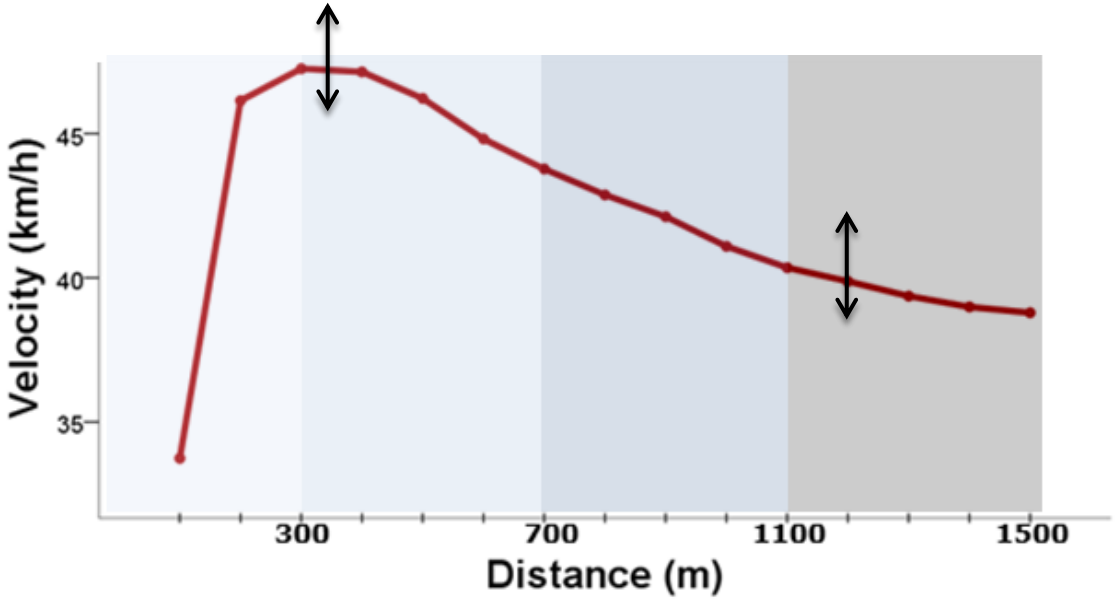
3) **Virtual reality & technology** to improve motivation and engagement and simulate **impact of competitors** is advised.

Jad Adrian Washif et al. (submitted). *Sports Medicine.* Training during the COVID-19 lockdown: Knowledge, beliefs, and practices of 12,526 athletes from 142 countries and 6 continents.

Impact of Competitors: Pacing and decision-making in time trial and head to head competition

The secrets of competition: Pacing in a time trial

- Goal directed way of using available energy resources in such a way that:
  - No premature fatigue occurs
  - No resources left at the finish line



I.K. Stoter, B.R. MacIntosh, J.R. Fletcher, S. Pootz, C.A.T. Zijdewind, F.J. Hettinga. Pacing Strategy, Muscle Fatigue and Technique in 1500m speed skating and cycling. Int. J. Sports Physiol. Perform. 11(3) (2016) 337-343

Pacing against others: determinants of initial pace

Behaviour of other competitors

Sex

Altitude

Competition importance

Number of competitors per race

Stage of competition

Time fastest qualification

Season

Ahead of Print

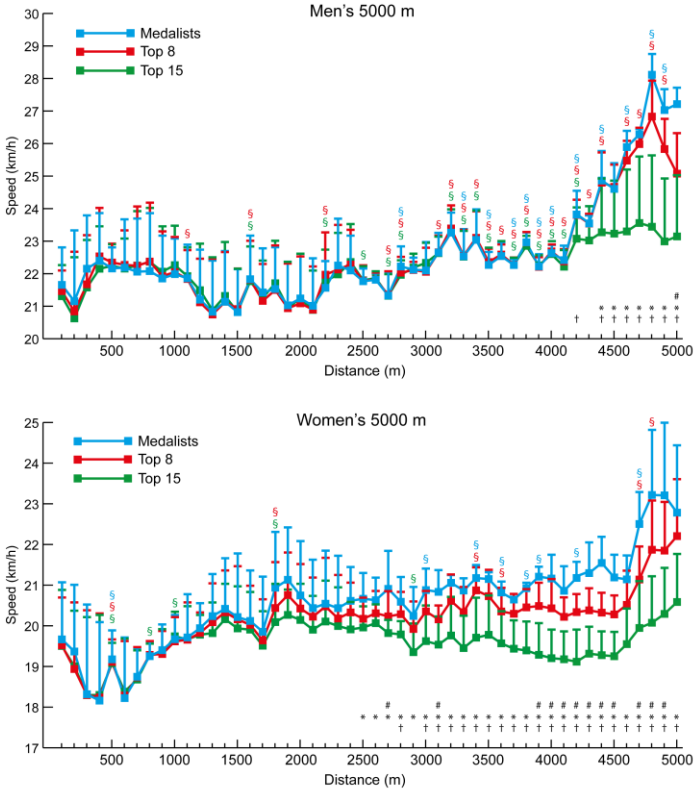
ORIGINAL INVESTIGATION

The Impact of Different Competitive Environments on Pacing and Performance

Authors: Marco J. Konings [1], Florentina J. Hettinga [1*]

World championships IAAF

- Trying to stay with race leaders: strong motivation to win



F.J. Hettinga, A. M. Edwards, B. Hanley. The Science Behind Competition and Winning in Athletics: Using World-Level Competition Data to Explore Pacing and Tactics. *Frontiers in Sports and Active Living*. 1 (2019) 11.

Pacing, a process of decision-making

- The performance environment surrounds athletes with a multitude of invitations for action, but also internal factor play a role to make the decision to:
  - Persist in given behaviour: remain on current pace
  - Change to a different one

Multitude of competing inputs, internal and external

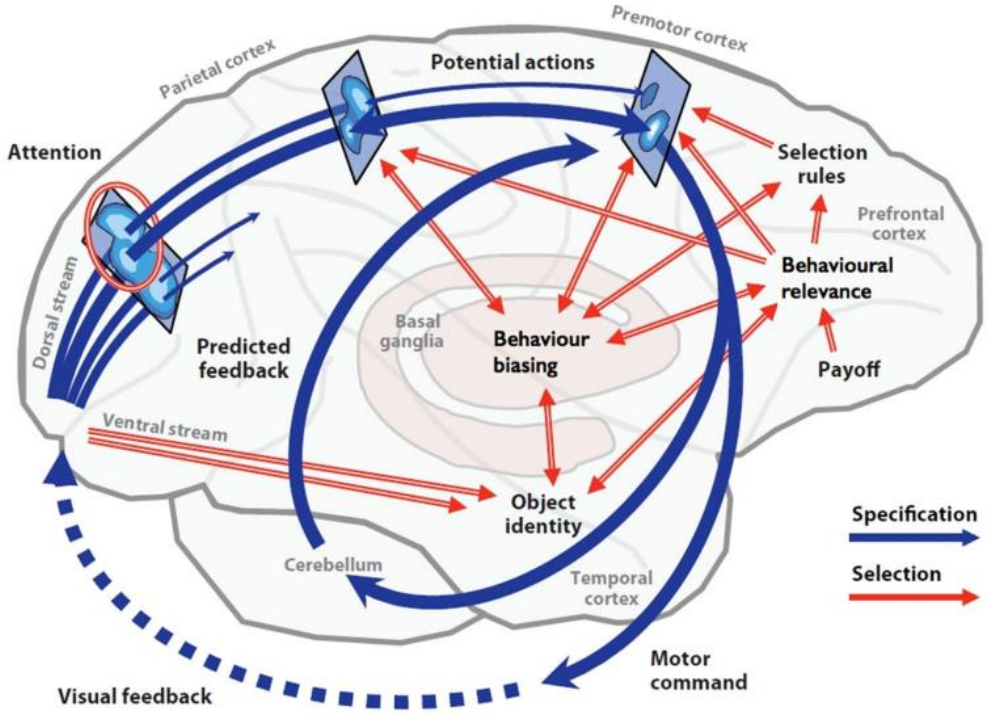


Fig. 1 Summary of the affordance competition hypothesis in the context of visually guided movement. The *filled dark blue arrows* represent processes of action specification. These are launched by the occipital cortex and go into the direction of the premotor cortex via the dorsal visual stream, suggesting that this stream mainly mediates visually guided actions, instead of building a unified representation of the world. *Polygons* represent three neural populations along the stream, which are depicted as maps where the *lightest regions* correspond to peaks of tuned activity. Peaks that appear simultaneously within a single cortical region compete for further processing. This is biased by input from the basal ganglia and prefrontal cortical regions (*red double-line arrows*) that collect information for action selection. Cells with similar parameter preferences excite each other, while cells with different preferences inhibit each other. If activity associated with a given choice eventually becomes sufficiently strong by exceeding a certain threshold, it suppresses its opponents and conclusively wins the competition. The final selected action is released into execution and causes overt feedback through the environment (*dotted blue arrow*) as well as internal predictive feedback through the cerebellum [87, 88]. Reproduced from Cisek and Kalaska [88], with permission

Relevant to sport:

Sports Medicine
June 2014, Volume 44, Issue 6, pp 763–775 | Cite as

Pacing and Decision Making in Sport and Exercise: The Roles of Perception and Action in the Regulation of Exercise Intensity

Authors | Authors and affiliations

Benjamin L. M. Smits, Gert-Jan Pepping, Florentina J. Hettinga

PERSPECTIVE ARTICLE
Front. Physiol., 28 February 2017 | https://doi.org/10.3389/fphys.2017.00118

The Science of Racing against Opponents: Affordance Competition and the Regulation of Exercise Intensity in Head-to-Head Competition

Florentina J. Hettinga[1*], Marco J. Konings[1] and Gert-Jan Pepping[2]

Sports Medicine
August 2018, Volume 48, Issue 8, pp 1829–1843 | Cite as

Pacing Decision Making in Sport and the Effects of Interpersonal Competition: A Critical Review

Authors | Authors and affiliations

Marco J. Konings, Florentina J. Hettinga

Construct virtual opponents in the lab to evoke pacing related decisions

Visual avatar(s) on screen

Straight, flat 4-km course

Only feedback relative distance

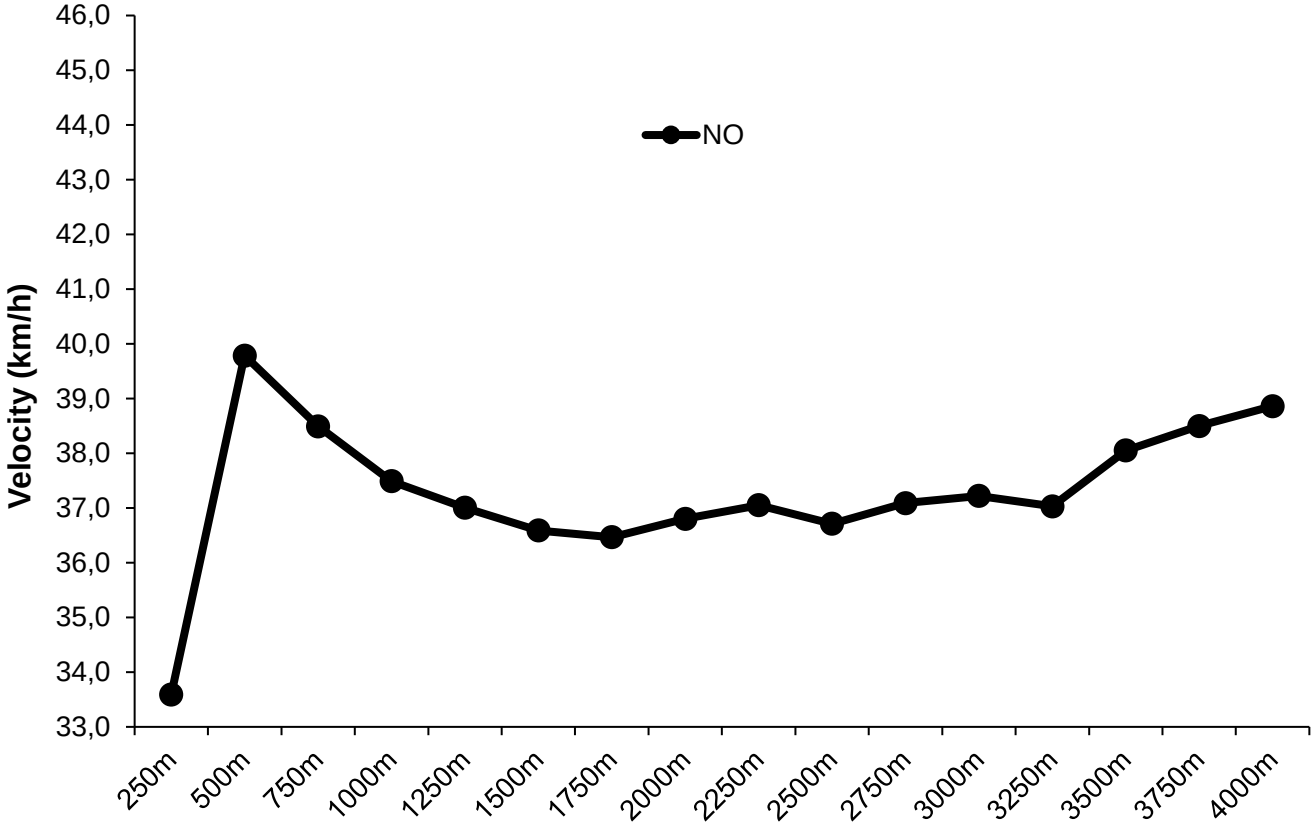
“complete TT as fast as possible”

Physiology & Behavior
Volume 158, 1 May 2016, Pages 1–5
ELSEVIER

The behavior of an opponent alters pacing decisions in 4-km cycling time trials

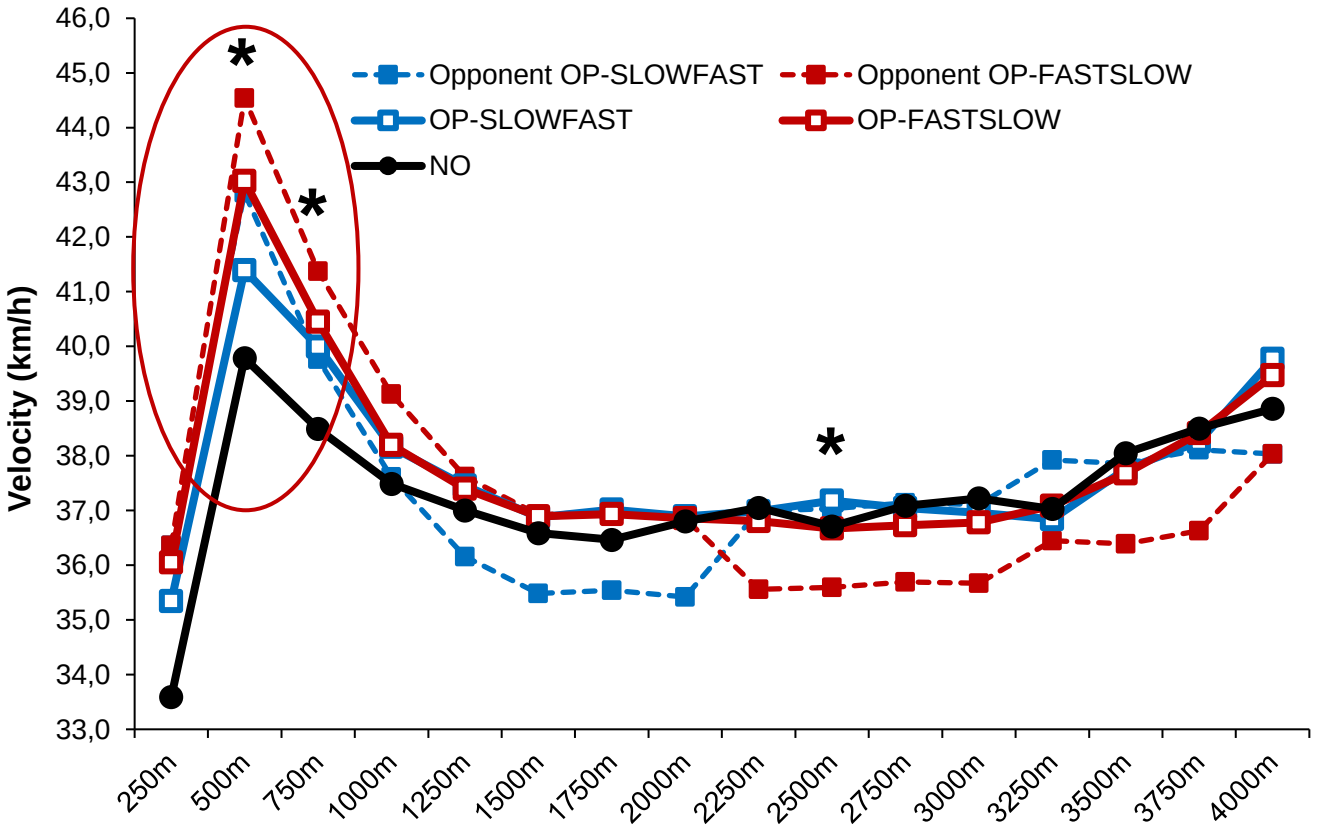
Marco J. Konings, Patrick P.J.M. Schoenmakers, Andrew J. Walker, Florentina J. Hettinga
Show more

Different virtual opponents evoke different behavioural responses



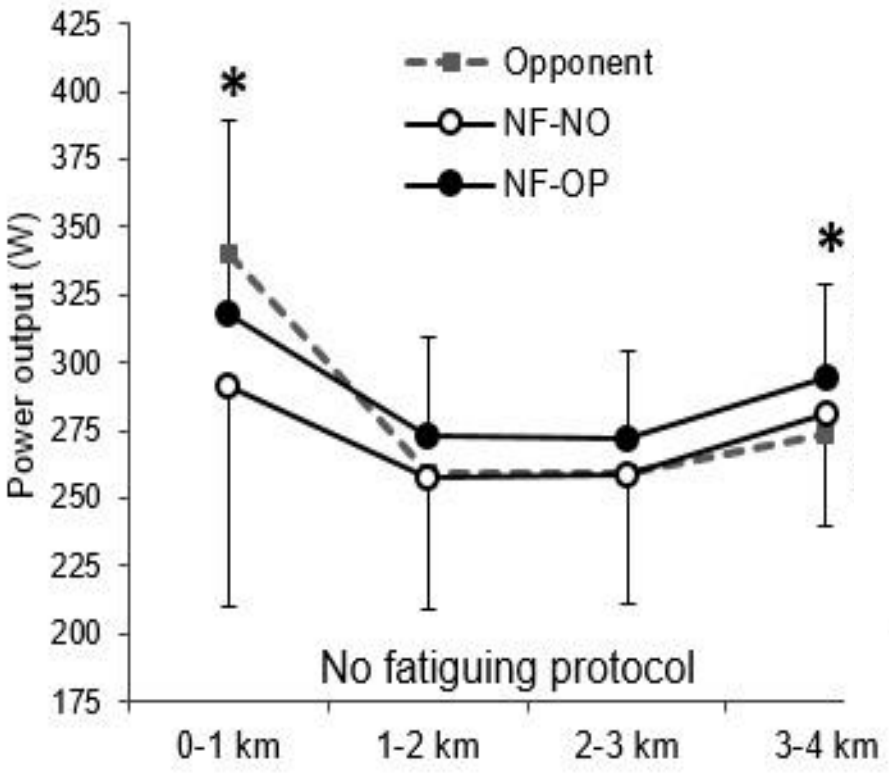
M. Konings, P. Schoenmakers, A. Walker, F. Hettinga. The behaviour of an opponent alters pacing decisions in 4km time trials. *Physiology and Behaviour* 158 (5) (2016), 1-5. DOI: 10.1016/j.physbeh.2016.02.023

Different virtual opponents evoke different behavioural responses



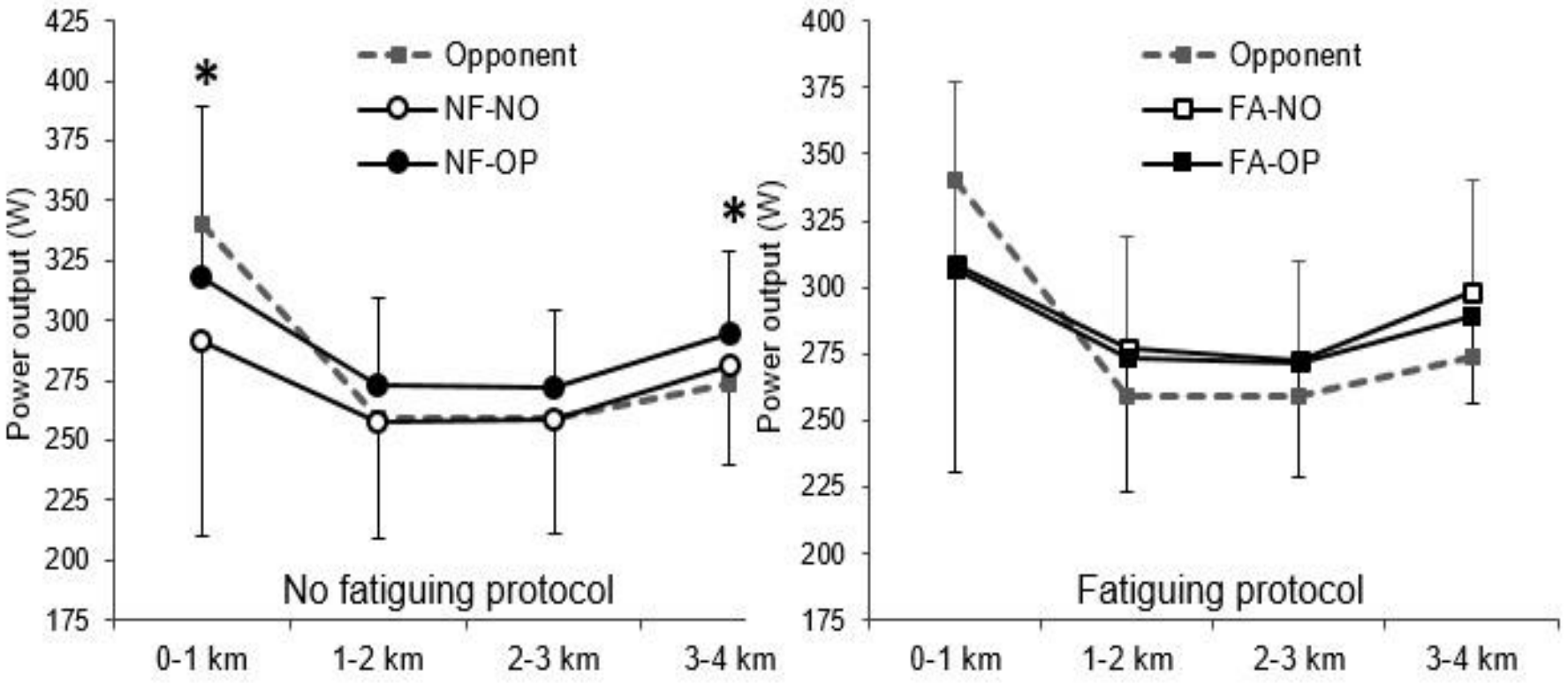
M. Konings, P. Schoenmakers, A. Walker, F. Hettinga. The behaviour of an opponent alters pacing decisions in 4km time trials. *Physiology and Behaviour* 158 (5) (2016), 1-5. DOI: 10.1016/j.physbeh.2016.02.023

How does the internal factor **fatigue** (67%PPO) affect decision-making?



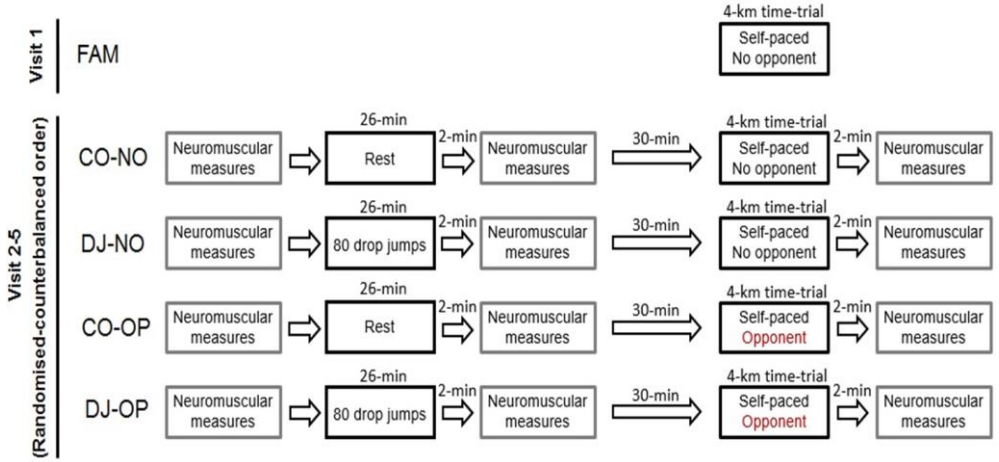
M. Konings, **F. Hettinga.** The impact of a pre-exercise cycling protocol on pacing regulation with and without an opponent. *IJSPP* 15(9) (2020), 1303-1308.

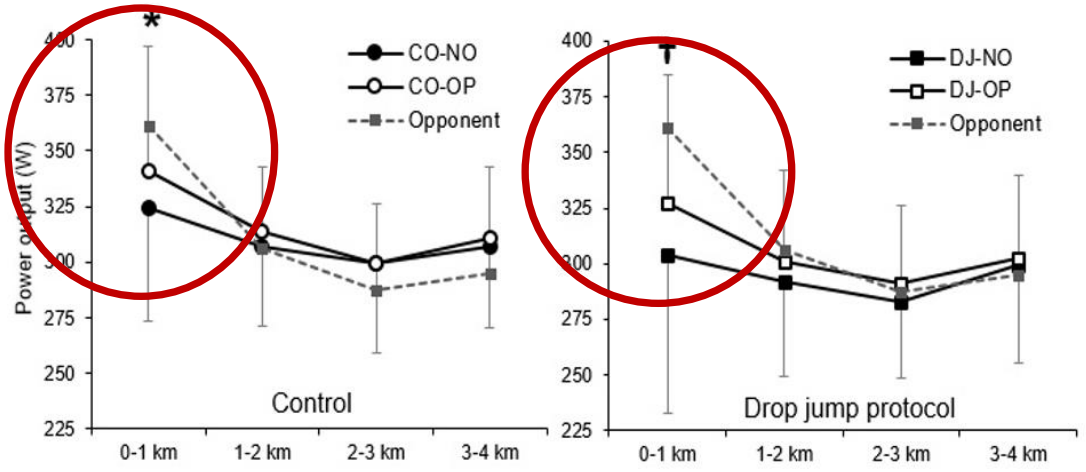
The behavioural response evoked by the opponent disappears…



M. Konings, F. Hettinga. The impact of a pre-exercise cycling protocol on pacing regulation with and without an opponent. *IJSPP* 15(9) (2020), 1303-1308.

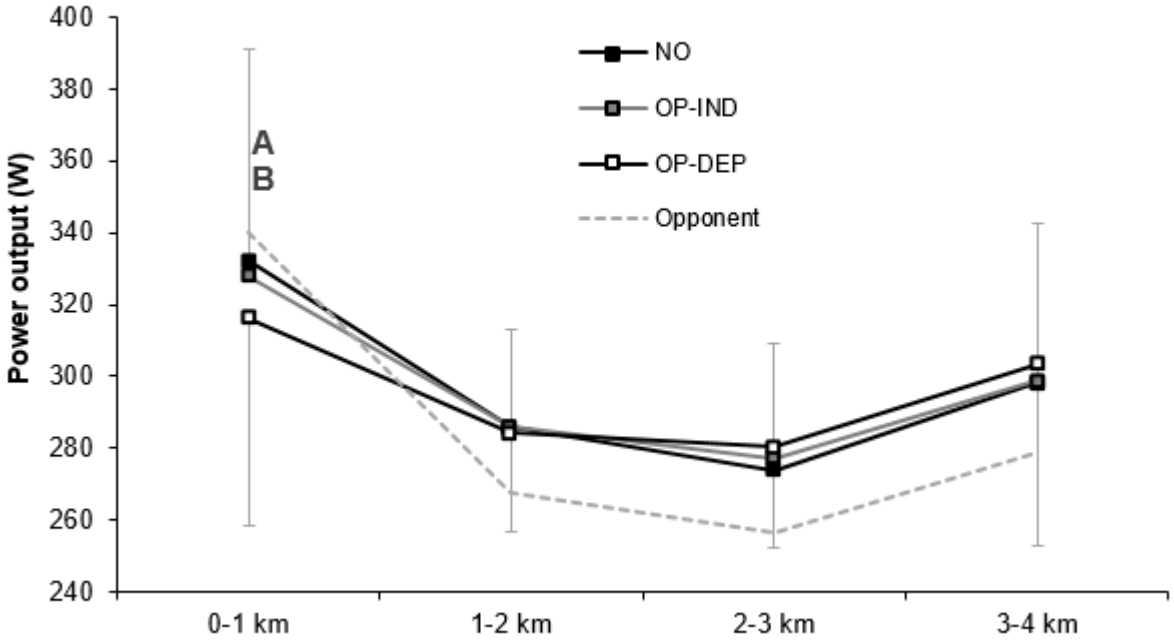
But no differences in decision-making with muscle fatigue protocol





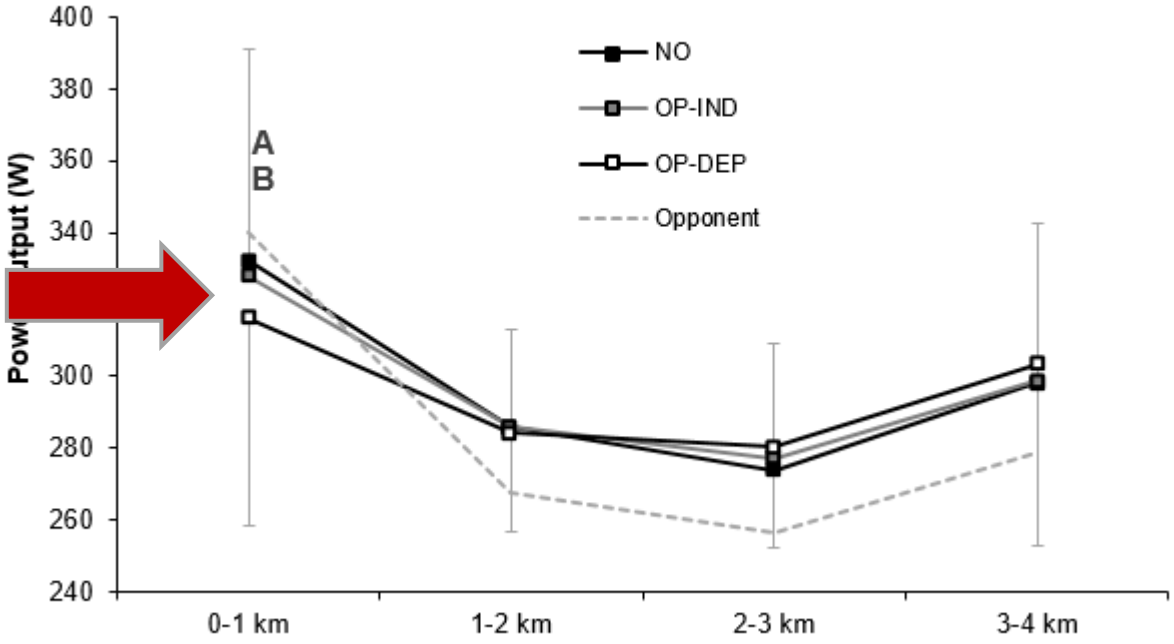
M. Konings, F. Hettinga. Impact of isolated locomotor muscle fatigue on pacing decision-making with and without virtual competitor (in preparation)

Interdependancy manipulation: Only one overtake allowed



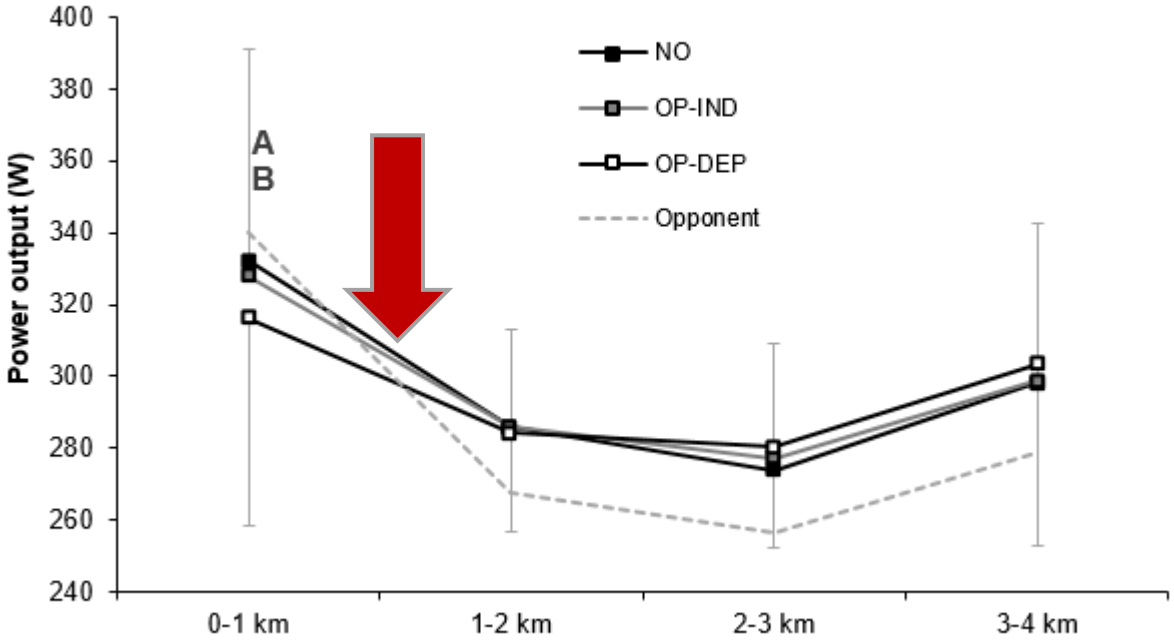
M. Konings, T. Foulsham, D. Micklewright, F. Hettinga. Athlete-opponent interdependency alters pacing and information-seeking behaviour. MSSE 52(1). (2020) 153-160.

Slower first km when dependent



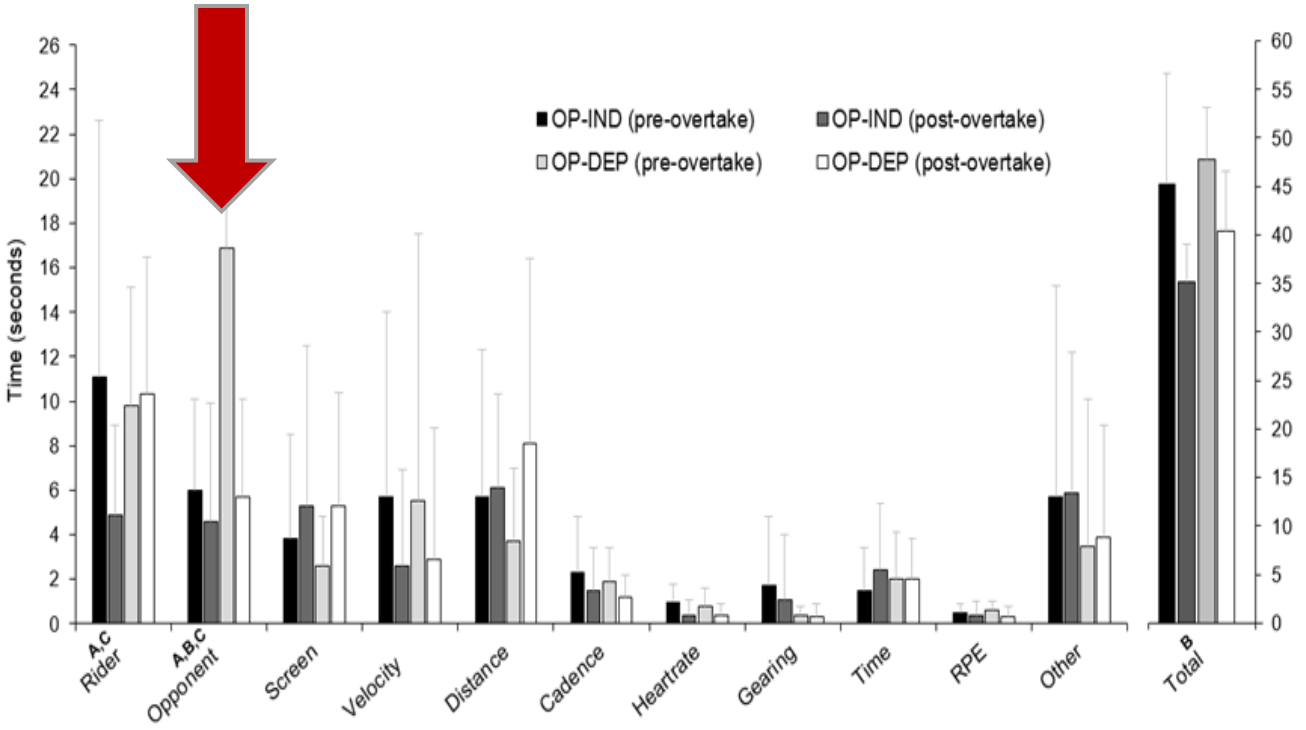
M. Konings, T. Foulsham, D. Micklewright, F. Hettinga. Athlete-opponent interdependency alters pacing and information-seeking behavior. *MSSE 52(1). (2020) 153-160.*

Delayed overtake when dependent



M. Konings, T. Foulsham, D. Micklewright, F. Hettinga. Athlete-opponent interdependency alters pacing and information-seeking behavior. *MSSE 52(1). (2020) 153-160.*

Total fixation time avatar/opponent higher when dependent



[A] difference between OP-IND and OP-DEP in fixation time spent ($p < 0.05$), [B] difference between pre-overtake and post-overtake in fixation time spent ($p < 0.05$), [C] difference between pre-overtake and post-overtake between OP-IND and OP-DEP in fixation time spent ($p < 0.05$).

Attentional cues are likely to be used in an adaptive way according to their availability and situational relevance, consistent with a decision-making framework based on the interdependence of perception and action

Important applications of competition principles and VR: future research

1) Competition and human-environment interactions are crucial aspects of sports performance. **80% of trials we compared to controls resulted in better performance against avatar**

2) Does pacing and racing need to be included in talent development programs for youth athletes?

3) Avatar scenario's and VR can be interesting to explore (Zwift, digital competition)

The development of pacing behaviour in adolescence in 2 km cycling trial

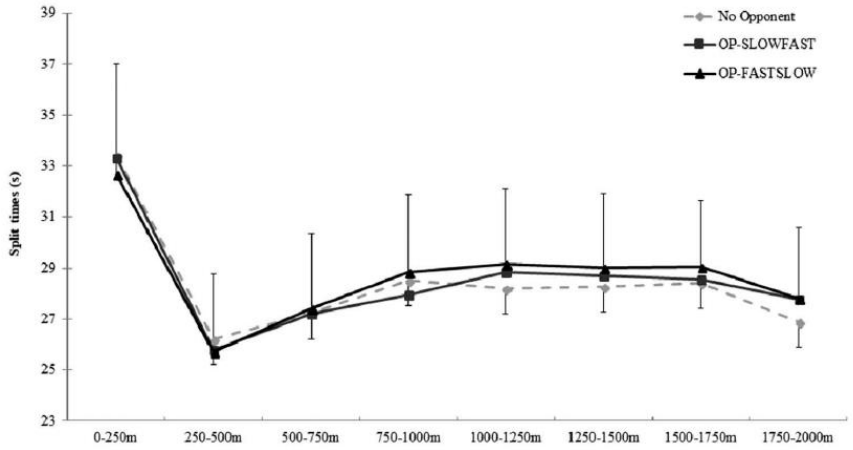


Figure 3. Split times of 250 m segments for each condition.

	Mean Power Output (Watt)	Finish time (s)	Expected finish time (s)	Δ Expected and actual finishing time (s)
No Opponent	196.73±39.15	227.16±17.17	303.00±135.98	75.85±129.00
OP-SLOWFAST	197.33±42.35	228.19±20.39	294.00±121.49	65.81±114.49
OP-FASTSLOW	194.68±43.48	229.64±22.61	312.00±147.11	82.36±138.72

S. G. P. Menting, M. T. Elferink-Gemser, A.M. Edwards, F. J. Hettinga. Pacing behaviour of novice youth cyclists: analysing the influence of experience and opponents in a 2km cycling trial. Research Quarterly of Sport and Exercise 90(4) (2020), 609-618.

No impact of opponent in 2 km time trials for adolescents

- Menting et al. 2020: External factors (opponent) have no impact on pacing
- Detrimental effect of opponent was found in children (Lambrick et al 2013)
- Beneficial effect of opponent was found in adults (Konings et al 2016)

- **Successful integration of external factors thus seems to be part of pacing behaviour development**

- Future research is needed on how youth athletes learn to balance multiple competing stimuli and optimize their decision-making and pacing patterns towards adult patterns

Virtual Reality: Reliability of training and competition with Zwift

INDEPENDENT

Sport > Cycling

Coronavirus: Cycling 'explodes' into virtual world as crisis leaves sport with uncertain future

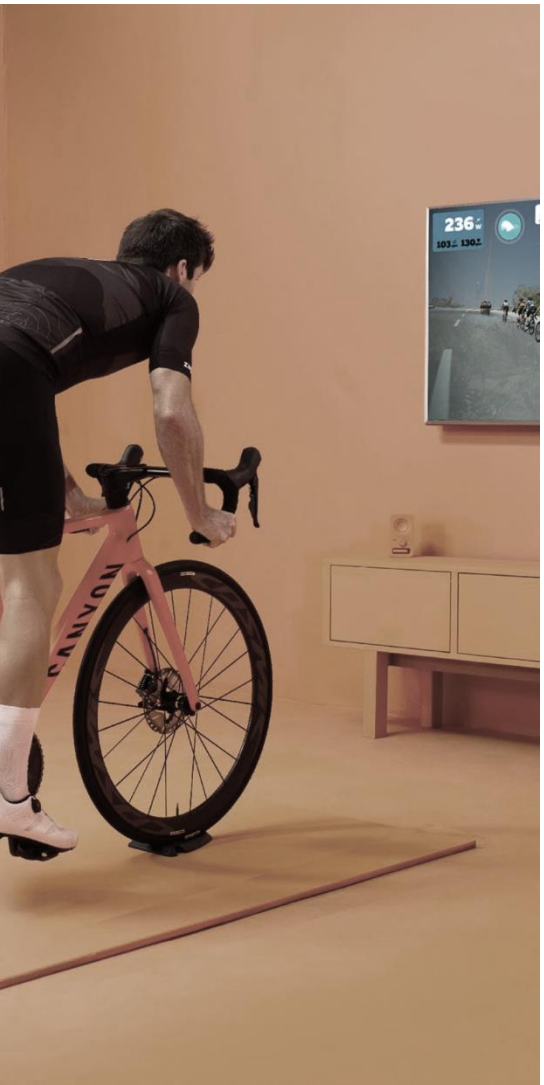
Apps like Zwift have transported new, experienced and professional riders into virtual cycling worlds as the sport finds a futuristic distraction from reality

IOC makes landmark move into virtual sports by announcing first-ever Olympic Virtual Series

OLYMPIC VIRTUAL SERIES

Guilherme Matta, Bart Roelands, Florentina Hettinga, Andrew Edwards & Philip Hurst. Reliability of 20-min cycling time-trials performed on Zwift®. (in preparation).

Zwift®



Multiplayer online cycling and running app that enables users to interact, train and compete in a virtual world;

More than 3 million users, in at least 190 countries.

(Long, 2020; McIlroy, 2021)

Reliability Zwift (3x20min time trials, n=44)

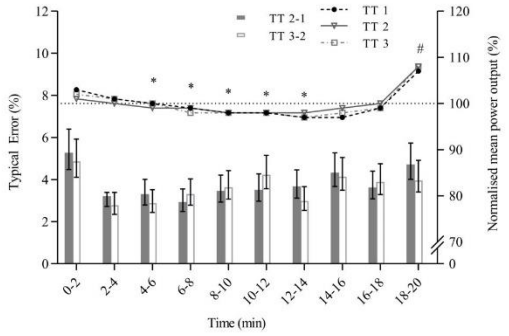
- Average CV: 3.8% agrees with previous studies analysing the reliability of cycling time-trials performed both during laboratory- or field-based studies (Currell and Jeukendrup 2008);
- High reliability of performance outcomes, and pacing is consistent.

Table 1. Differences in power (W), cadence (rpm) and heart rate (bpm) between each time-trial.

	TT1	TT2	TT3	*P*	η_p^2
Power (W)	256 ± 52	254 ± 51	255 ± 52	0.391	0.02
Cadence (rpm)	87 ± 9	86 ± 9	86 ± 8	0.007	0.81
Heart rate (bpm)	161 ± 13	160 ± 13	161 ± 13	0.216	0.04

TT - time-trial; heart rate data based on n = 40 due to missing data

No differences between time trials



Pacing adopted in each time-trial (right Y-axis) and Typical Error [90%CL] between time-trials 2-1 and 3-2 (left Y-axis) for each 2-min time-interval. The dotted line corresponds to 100% of normalised mean power output. * Denotes a main effect of time in comparison to time-interval 2-4 min (all P < .047). # Denotes a main effect of time in comparison to all previous time-intervals (all P < .001), except 0-2 min (P = .359).

Guilherme Matta, Bart Roelands, Florentina Hettinga, Andrew Edwards & Philip Hurst. Reliability of 20-min cycling time-trials performed on Zwift®. (in preparation).

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