THE ROLE OF INTELLECTUAL IMPAIRMENT IN PACING IN SPORT

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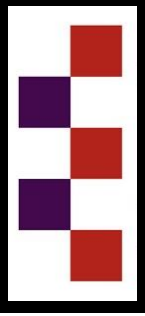

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25/09 / 2018

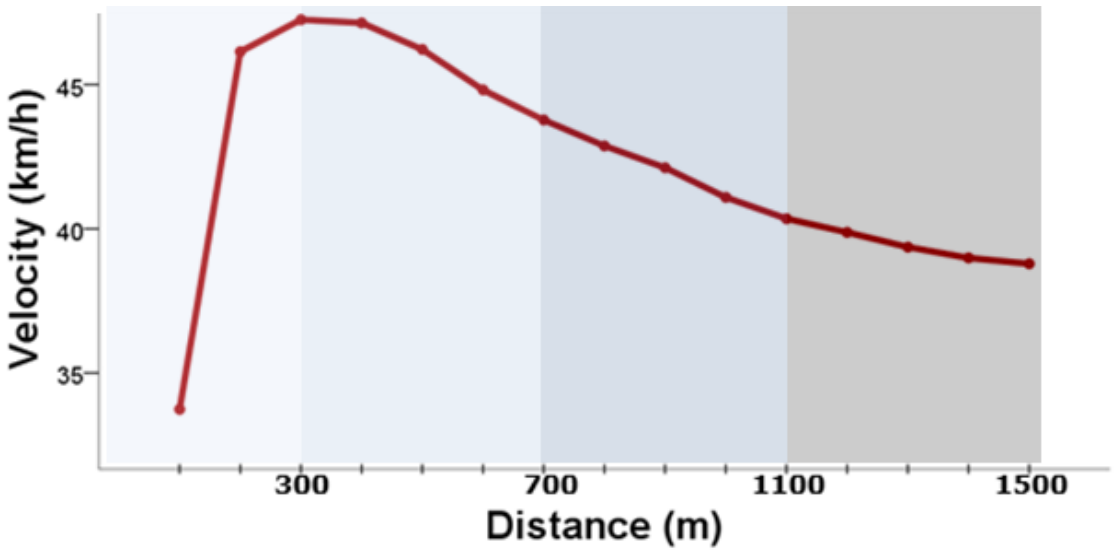
University of Essex
School of Sport, Rehabilitation and Exercise Science
Sport, Performance and Fatigue Research Unit

Aesop's tortoise and hare

Pacing in sport

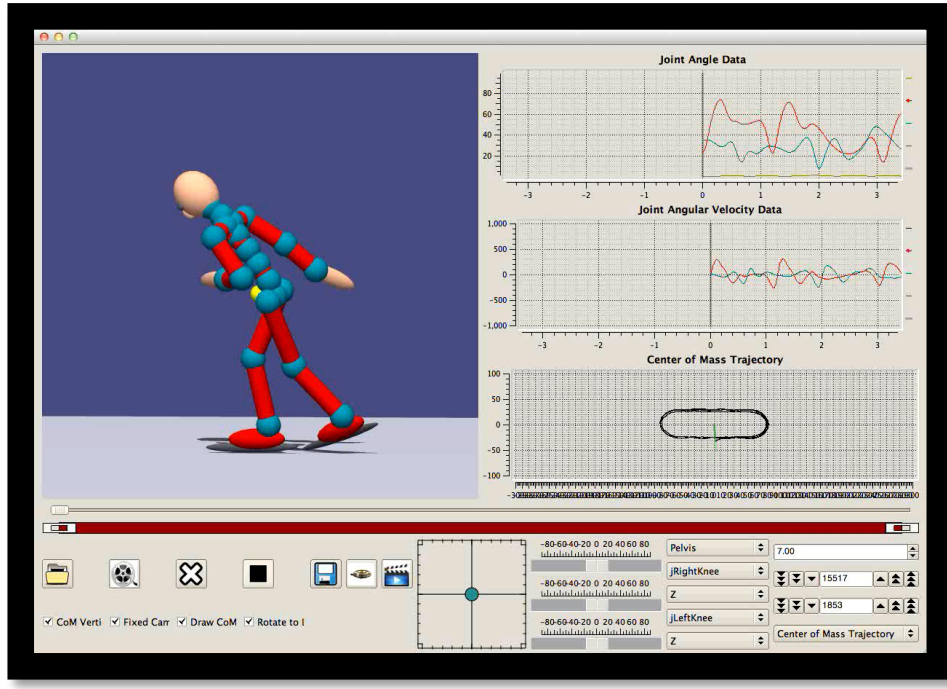
- How to distrubute your energy over the race?

- Goal-directed regulation of the exercise intensity over an exercise bout (Abbiss and Laursen, 2008) and is widely recognized as an essential determinant for performance (Edwards and Polman, 2013).



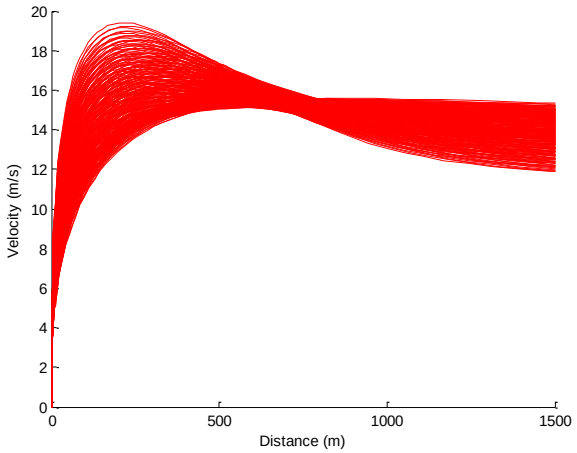
Regulation of exercise intensity of a virtual atlete

- Optimal pacing explored using an energy flow model: numerical simulations using differential equations were performed.



Optimal strategy

- 1000 and 1500m: Fast Start
- 4000m: Even-Paced



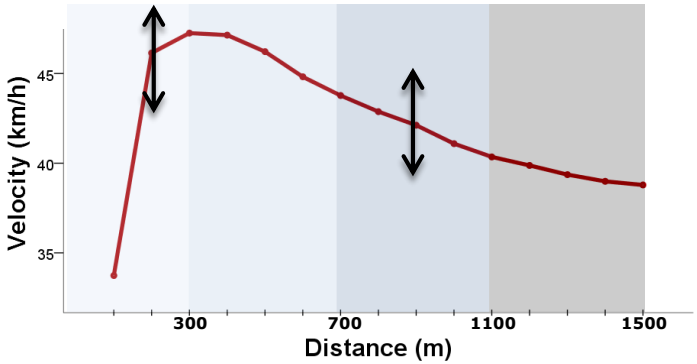
De Koning JJ, Bobbert MF, Foster C. (1999) Determination of optimal pacing strategy in track cycling with an energy flow model. *J. Sci. Med. Sport* 2: 266-277.

Hettinga FJ, De Koning JJ, Schmidt L, Wind N, MacIntosh BR, Foster C. (2011) Optimal pacing strategy: from theoretical modelling to reality in 1500-m speed skating. *British Journal of Sports and Medicine*. 45: 30-35.

Hettinga FJ, de Koning JJ, Hulleman M, Foster C. (2012). Relative importance of pacing strategy and mean power output in 1500-m self-paced cycling. British Journal of Sports Medicine. 46(1): 30-35.

In practice: Optimal pacing strategy for the 1500m in speed skating?

<u>Theoretical models</u>
Faster start is optimal.

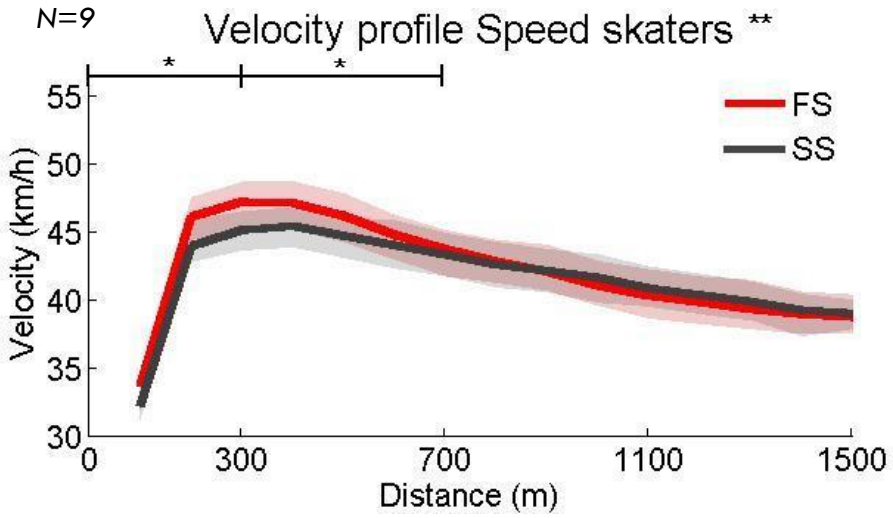


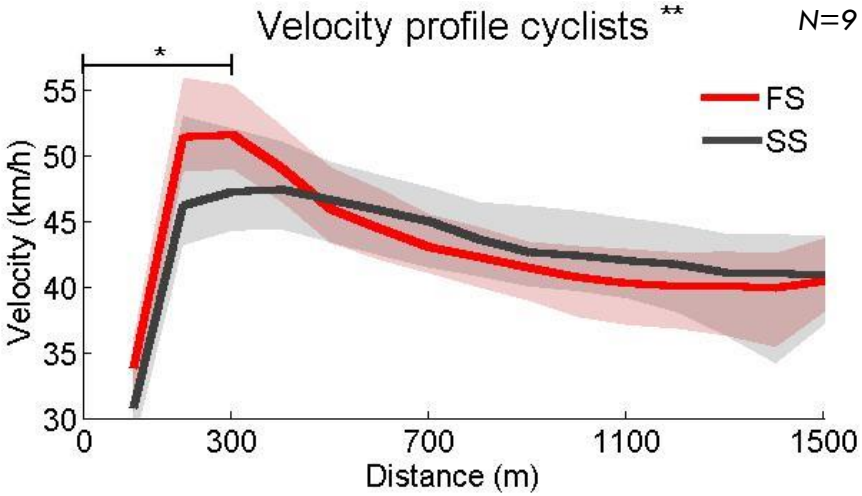
<u>Practice</u>
Speed skaters struggle to benefit from a faster start, due to a larger slowdown in the end of the race.

1. Meuhlbauer et al. (2010)
2. Stoter et al. (2016)

Pacing, fatigue and technique in different sports

Stoter IK, MacIntosh BR, Fletcher JR, Pootz S, Zijdewind I, Hettinga FJ (2016). Pacing strategy, muscle fatigue and technique in 1500-m speedskating and cycling time trials. *IJSPP*. 11(3), 337-343.





* FS and SS trial differ significantly ($p<0.05$)

The science behind racing against opponents

Winning: beating your opponents

- **Therefore, human-environment interactions need to be explored, and are crucial for optimal pacing and tactics**

F.J. Hettinga, M. Konings, G.J. Pepping. Regulation of exercise intensity in head-to-head competition: The science behind racing against opponents. Front. Physiol. 8 (2017) 118.

M.J. Konings, F.J. Hettinga. Pacing Decision Making in Sport and the Effects of Interpersonal Competition: A Critical Review. *Sports Med.* (2018) 48(8), 1829-1843.

Pacing in Sports

- The performance environment surrounds athletes with a multitude of invitations for action
  - Persist in given behaviour
  - Change to a different one

Smits B, Pepping GJ, Hettinga FJ (2014) Pacing and decision-making in sport and exercise: the roles of perception and action in the regulation of exercise intensity. *Sports Medicine*. 44(6); 763-775.

Hettinga FJ, Konings M, Pepping GJ (2017) Regulation of exercise intensity in head-to-head competition: The science behind racing against opponents. *Frontiers Physiol*. 8; 118.

Human-environment interactions

- The performance environment surrounds athletes with a multitude of invitations for action
  - Persist in given behaviour: remain on current pace
  - Change to a different one

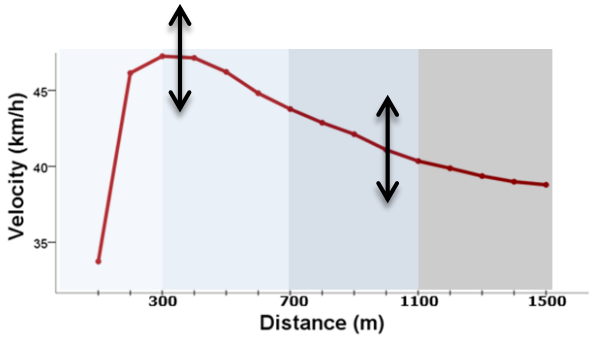
Human-environment interactions

- The performance environment surrounds athletes with a multitude of invitations for action
  - Persist in given behaviour: remain on current pace
  - Change to a different one: speed up/slow down, respond

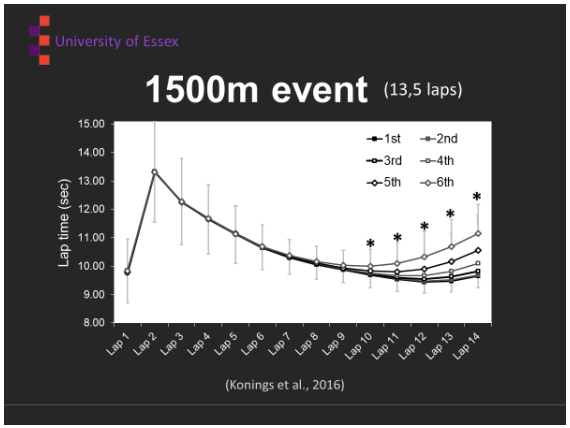
Construct virtual opponents in the lab to evoke pacing related decisions

竞争

In the field: Differences long-track time trial and short track head to head



Pacing and tactics differ between time trial and head to head competition



How is the regulation of exercise intensity linked to cognition?

- Pacing and cognitive ability
  - **Studies in II athletes**

D. Van Biesen, F. Hettinga, K. McCulloch, Y.C. Vanlandewijck. Pacing strategy in competitive track races: is the regulation of exercise intensity linked to cognitive ability? *Front. Physiol.* 7 (2016) 624.

D. Van Biesen, F. Hettinga, K. McCulloch, Y.C. Vanlandewijck. Pacing ability in elite runners with intellectual impairment. *Med. Sci. Sport Exerc.* 49(3) (2017) 588-594.

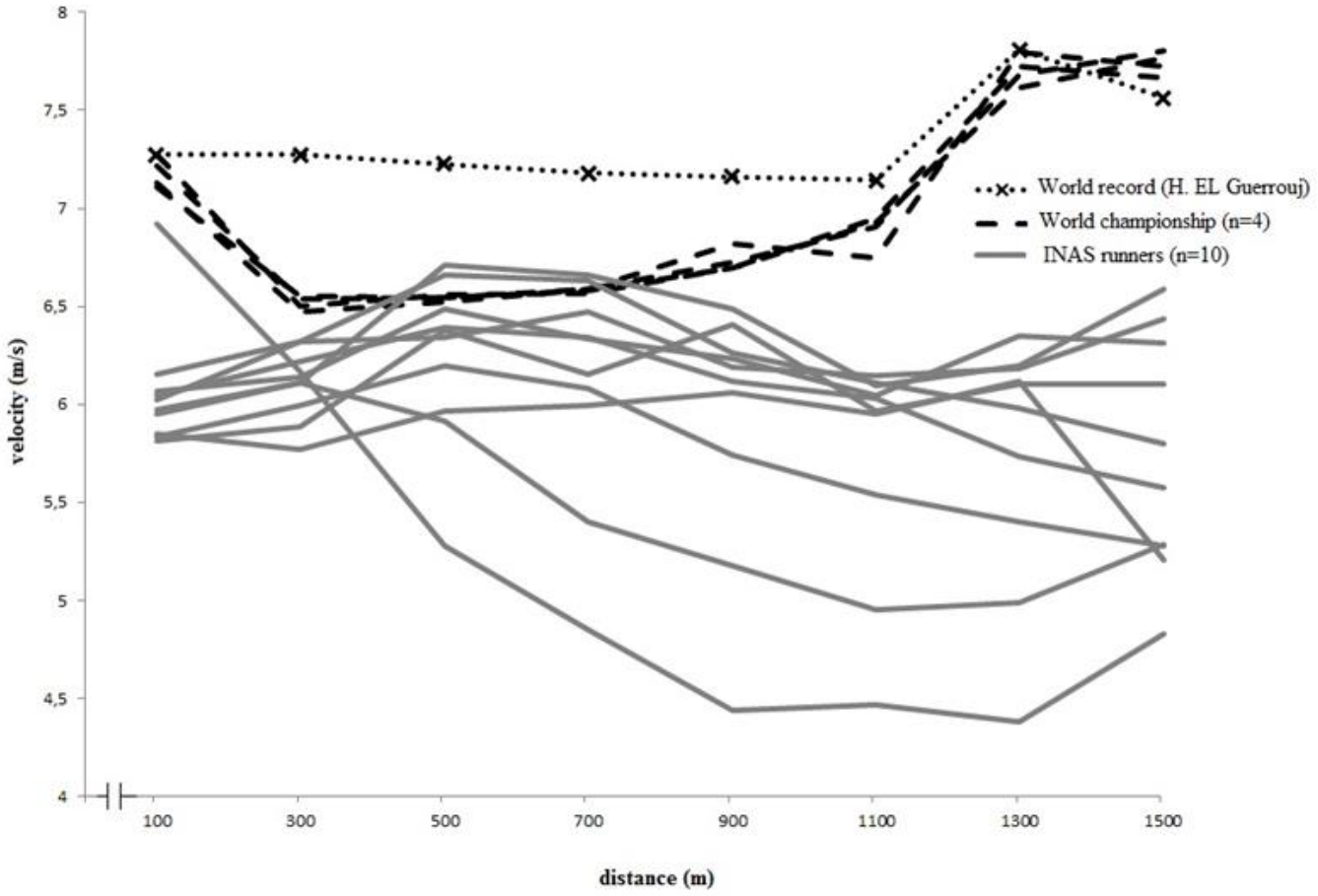
  - **Studies on learning how to pace: youth athletes**

R. Wiersma, I.K. Stoter, C. Visscher, F.J. Hettinga, M.T. Elferink-Gemser. Development of 1500m pacing behavior in junior speed skaters: a longitudinal study. *Int. J. Sports Physiol. Perform.* (in press). doi: 10.1123/ijspp.2016-0517

M. Elferink-Gemser, F.J. Hettinga. Invited Commentary: Pacing and self-regulation: Important for talent development in endurance sport. *Int. J. Sports Phys. and Perf.* (in press).

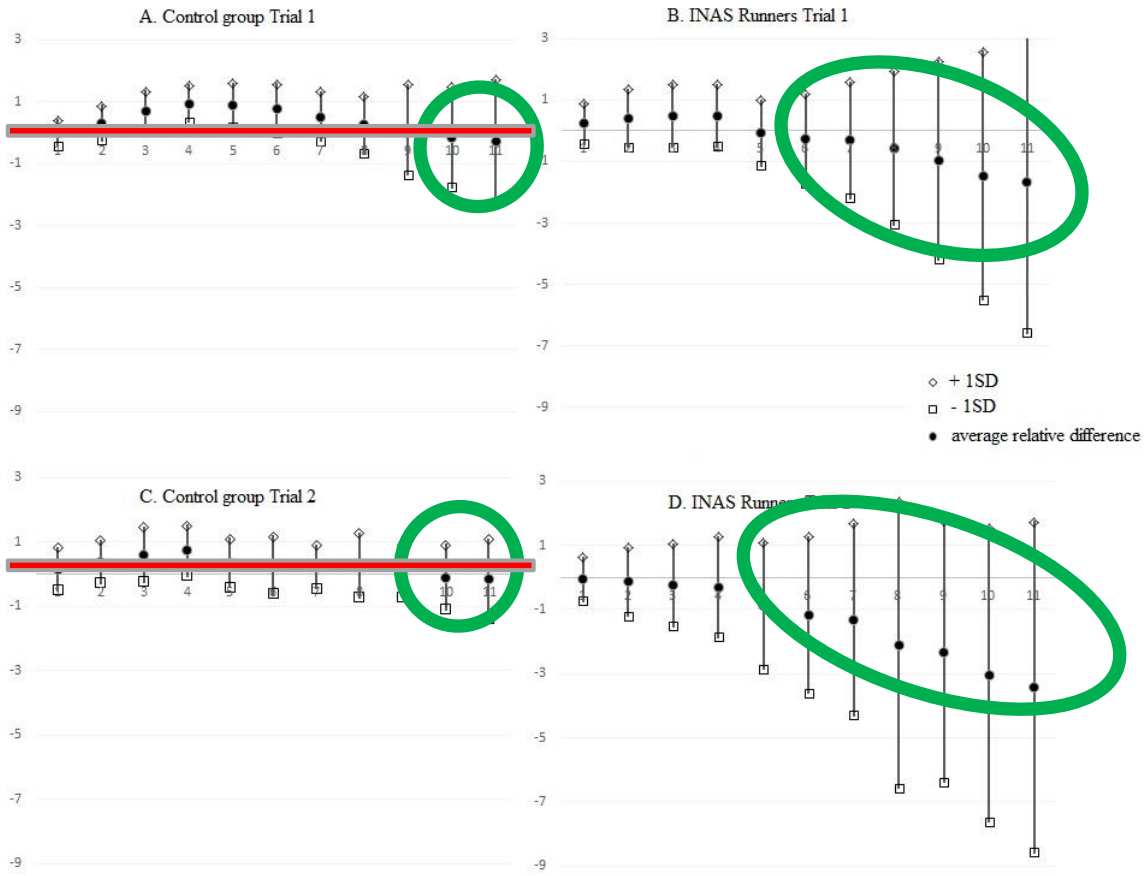
Menting S, Konings M, Elferink-Gemser M, Hettinga FJ. Pacing Behaviour of Elite Youth Athletes: Analysing 1500-m Short-Track Speed Skating. *IJSPP* (in press).

Different pace: Individual pacing strategies of elite men's 1500m finalists (II and non-II) versus World Record



D. Van Biesen, F. Hettinga, K. McCulloch, Y.C. Vanlandewijck. Pacing strategy in competitive track races: is the regulation of exercise intensity linked to cognitive ability? *Front. Physiol.* 7 (2016) 624.

Why do runners with II pace differently? The ability to perform at a pre-planned submaximal pace was assessed.



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Field test study outcomes:

- Intellectual capacity is involved in pacing.
- II-runners have difficulties maintaining a pre-planned submaximal velocity

- Impact of II on pacing and performance can now be assessed: fair Paralympic classification-procedure
  - Time trial sports: Swimming, cycling, X-country skiing…..

D. Van Biesen, F. Hettinga, K. McCulloch, Y.C. Vanlandewijck. Pacing Ability in Elite Runners with Intellectual Disability. *Med. Sci. Sport Exerc.* 49(3) (2017) 588-594.

Can we learn how to pace? Youth athletes

- Pacing and self-regulation crucial skills in talent development
  - Only 1 longitudinal study (skating) and few cross-sectional (swimming, short track skating) conducted

M.T.Elferink-Gemser & F.J. Hettinga. Pacing and self-regulation: Important skills for talent development in endurance sports. *IJSPP.* (in press).

- Younger athletes had less stable pacing patterns, also found in young school children (Micklewright et al, 2012)
  - Pacing and ability to anticipate exercise demand differed with age (5-14yrs) and cognitive development

Forming a performance template

- Information from prior races is used as input for the next race, to anticipate on the exercise demand and divide the available energy optimally.

- Based on increasing experience with the task, athletes build a 'performance template'.

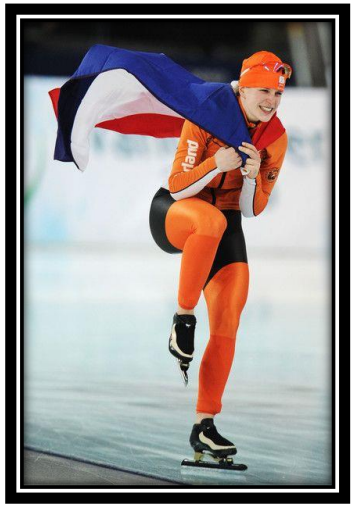
C. Foster, K.J. Hendrickson, K. Peyer, B. Reiner, J.J. de Koning, A. Lucia, R.A. Battista, F.J. Hettinga, J.P. Porcari , G. Wright. Pattern of developing the performance template. *Br. J. Sports Med.* 43 (2009) 765-769.

Cognitive elements in pacing

- Self-reflection
- Ability to anticipate exercise demands: Planning skills
- Interpretation of bodily signals
- Learn from previous experiences
- Time and distance perception & visualization
  - Distance monitoring (Pinhiero et al 2016).
    - Elongated distance perception in the dark
  - Time perception (Edwards & McCormick, 2017)
    - Higher intensity is perceived shorter

What so we know from youth athletes and their development of pacing?

- Longitudinal study in 1500m speed skating:
  - Maintaining high speed after 70^% of the race appears crucial for high performance
  - Generally, juniors develop towards senior profile, particularly from >16yrs for elite juniors.
  - The results of the present study indicate the relevance of pacing behavior for talent development.



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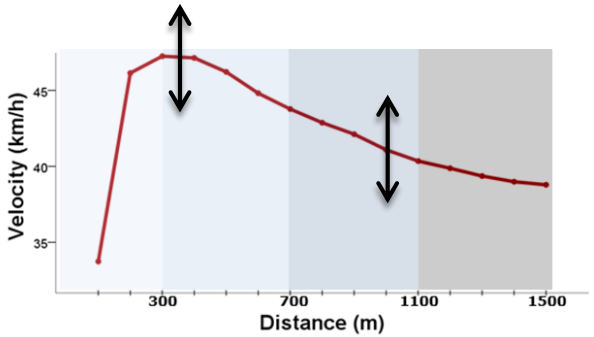
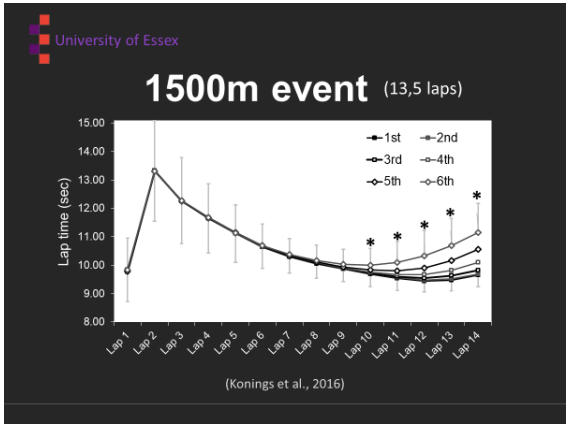
Adults: Differences long-track time trial and short track head to head



Pacing and tactics differ between time trial and head to head competition



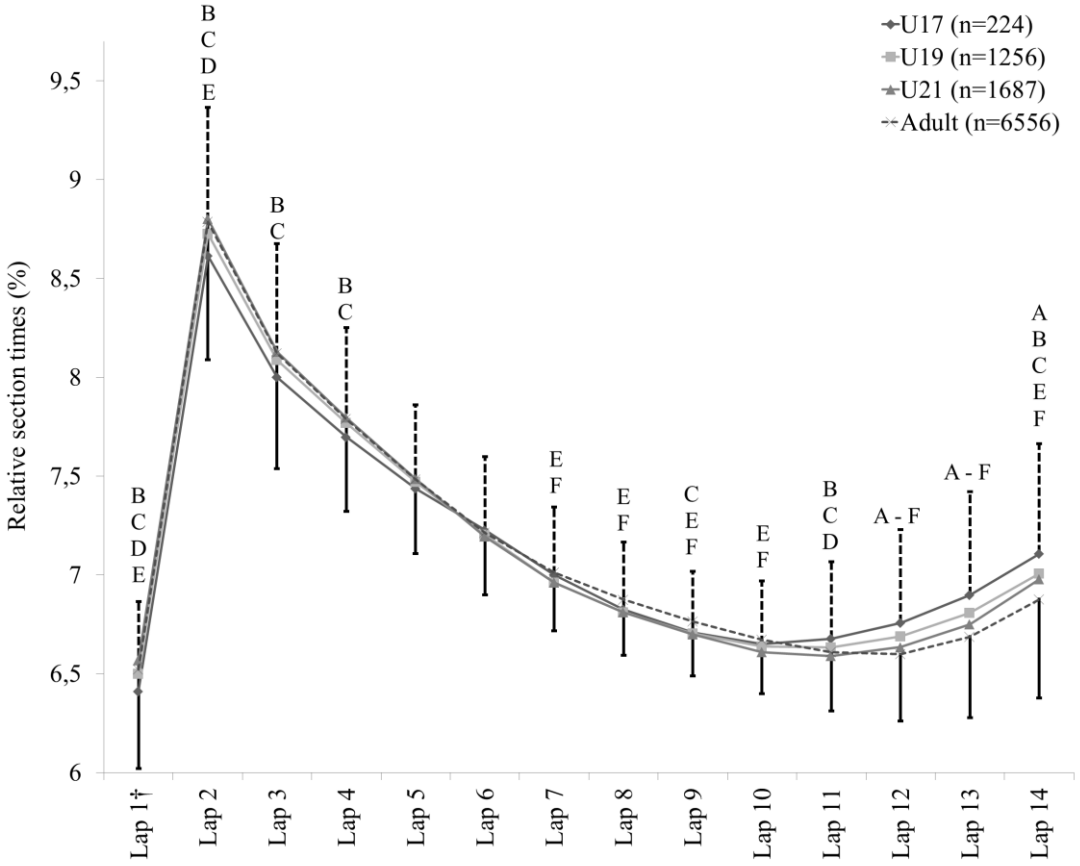
青年 Youth short track skating athletes

- Youth skaters (n=9715) displayed less conservative pacing behaviour compared to seniors in head to head competition.
- The pacing behaviour of youths also changed throughout adolescence and came to resemble that of seniors.
- Pacing behaviour and adequately responding to environmental cues in competition could therefore be seen as a self-regulatory skill that is under development throughout adolescence.

Menting S, Konings M, Elferink-Gemser M, Hettinga FJ. Pacing Behaviour of Elite Youth Athletes: Analysing 1500-m Short-Track Speed Skating. *IJSPP* (in press).

Elferink-Gemser M, Hettinga FJ. Pacing and Self-regulation: Important Skills for Talent Development in Endurance Sports. *IJSPP* (2017), 12(6), 831-835.

Youth athletes



† = Lap 1 accounts for only the first ½ lap
A significant difference ($p<0.05$) in RST between: [A] U17 and U19, [B] U17 and U21, [C] U17 and Adult, [D] U19 and U21, [E] U19 and Adult, [F] U21 and Adult.

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Literature: youth swimming

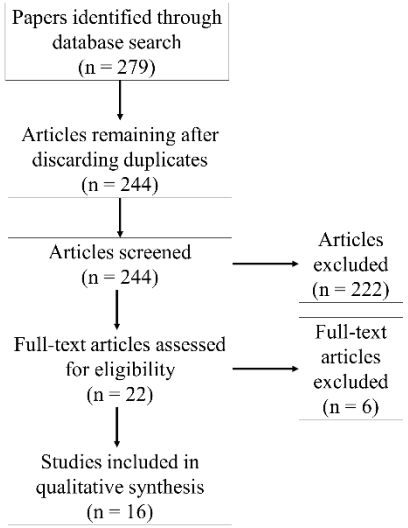
- Three studies focused on the pacing behaviour of youth swimmers (Dormehl & Osborough, 2015; Skorski et al., 2014; Veiga and Roig, 2016).
- Youth swimmers demonstrate a more variable pacing profile and have more difficulty with choosing the most beneficial energy distribution.

Menting S, Elferink-Gemser M, B. C. Huijgen, Hettinga FJ. Pacing in track based head-to-head competitions: a systematic review on swimming. *JSS* (minor revisions).

Pacing in Swimming: Literature review

- Pacing behaviour in swimming head to head shares an abundance of characteristics with pacing behaviour in time-trial sports. This can most likely be attributed to the lane racing set-up.

- The low efficiency in swimming, caused by the propulsion through water, results in a fast onset of fatigue, which impacts on swimming biomechanics.



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Can pacing be learned?

- Development of the complex skill of pacing throughout adolescence can be:
  - Related to physical and psychological maturation
  - Or: several aspects can be trained and learned
- Similar dilemma relevant to ll sports: Can we train or learn the complex skill of pacing?
- More research needed

In the lab

- Performance of novice youth exercisers improved after one visit, parallel with the ability to anticipate the future workload (expected finishtime estimates).

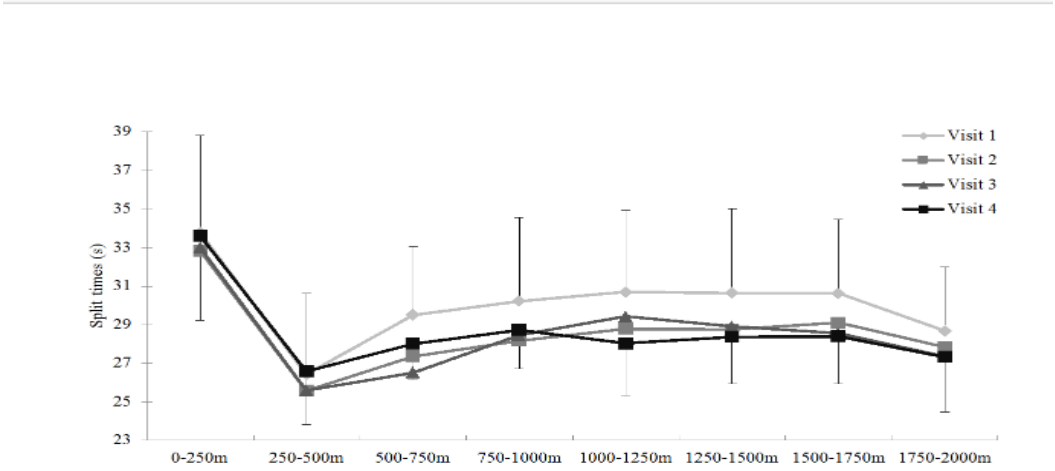

Figure 1. Split times of 250m segments for each visit. A significant difference in split time ($p < 0.05$) between: A: visit 1 and visit 2 , B: visit 1 and visit 3, C: visit 1 and visit 4, D: visit 2 and visit 3, E: visit 2 and visit 4, F: visit 3 and visit 4.

Menting S, Edwards A, Elferink-Gemser M, Hettinga FJ. Pacing behaviour and performance of novice youth exercisers: analysing the influence of previous experience and opponents in a 2-km cycling trial. *PES* (submitted).

Classification

- More research needed to explore separate cognitive elements relevant in pacing
  - Field test developed testing ability to run at preplanned velocity for a certain time
  - How about self-reflection? Anticipation of exercise demands? Planning skills? Time/Distance perception? Visualization? Interpretation of bodily signals? Learning from previous experiences? To what extent do they play a role in pacing and ar they affected by II? Can they be developed into field tests?
  - What can we learn from youth athletes development?

- More research needed!

To start off: tortoise and hare

- link

THANK YOU

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