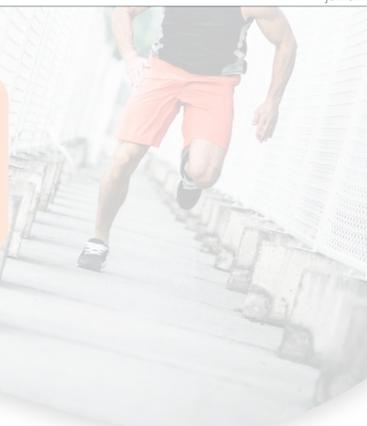


SOCCERDOC jb morin



**SOCCERDOC**

**HAMSTRING  
& SPRINTING  
MASTERCLASS**

**SPRINT ACCELERATION MECHANICS**  
Individual kinetic & kinematic profiling, methods and applications

Pr J-B Morin







1

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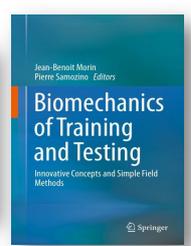


**KEEP  
CALM  
AND  
GO BACK  
TO BASICS**

- ✓ Every player can get faster
- ✓ Practicing your sport is not enough
- ✓ « Just sprinting » is very often not enough

*International Journal of Sports Physiology and Performance*, 2016, 11, 267-272  
<http://dx.doi.org/10.1123/ijsp.2015-0028>  
 © 2016 Human Kinetics, Inc.

Human Kinetics  
INVITED COMMENTARY



**Interpreting Power-Force-Velocity Profiles  
for Individualized and Specific Training**

Jean-Benoît Morin and Pierre Samozino

2



3

SPORTSCIENCE DOI 10.1007/s40279-016-0653-3

SPORTS MED  
DOI 10.1007/s40279-016-0653-3

CrossMark

REVIEW ARTICLE

**Methods of Power-Force-Velocity Profiling During Sprint Running: A Narrative Review**

Matt R. Cross<sup>1</sup> · Matt Brughelli<sup>1</sup> · Pierre Samozino<sup>2</sup> · Jean-Benoit Morin<sup>1,3</sup>

Matt Cross  
(AUT, Auckland)  
@MattCrossNZ

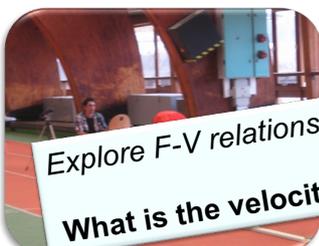


**1 second....10 to 12-m**  
0 to 50% Vmax in ~1 sec  
4-5 steps per second  
Contact time ~0.1 sec  
Very close in 🏀🏈🏉

4

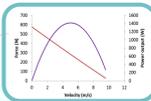
CCERDOC jb morin

Elite Sprinter 



Explore F-V relationships...

**What is the velocity at which force will be produced?**



HZT Force

**BLOCKS**  
10m step

800 N ( $\approx 80$  kg eq. mass)  
400 N

CoM Speed

3.5 m/s ( $\approx 1/3$  of top speed)  
7 m/s ( $\approx 2/3$  of top speed)



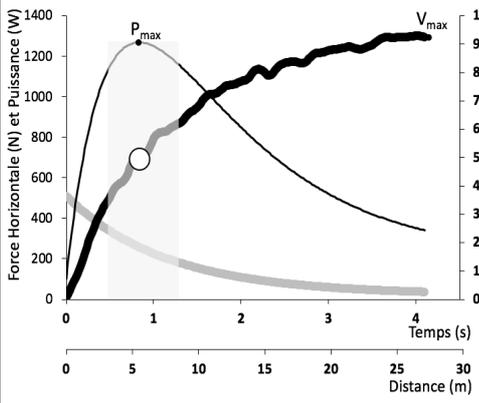
**FORCE @ HIGH SPEED**

Rabita et al. Scand J Med Sci Sport 2015

5

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DATA = REFERENCE FRAMEWORK



Force Horizontale (N) et Puissance (W)

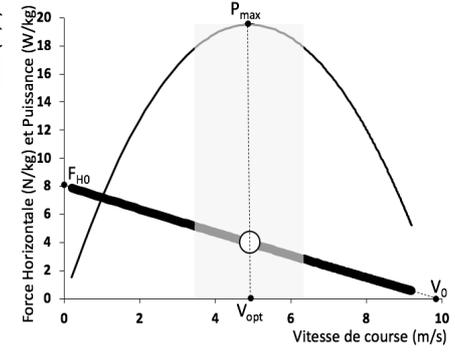
Temps (s)

Distance (m)

$P_{max}$

$V_{max}$

Elite 



Force Horizontale (N/kg) et Puissance (W/kg)

Vitesse (m/s)

Vitesse de course (m/s)

$F_{H0}$

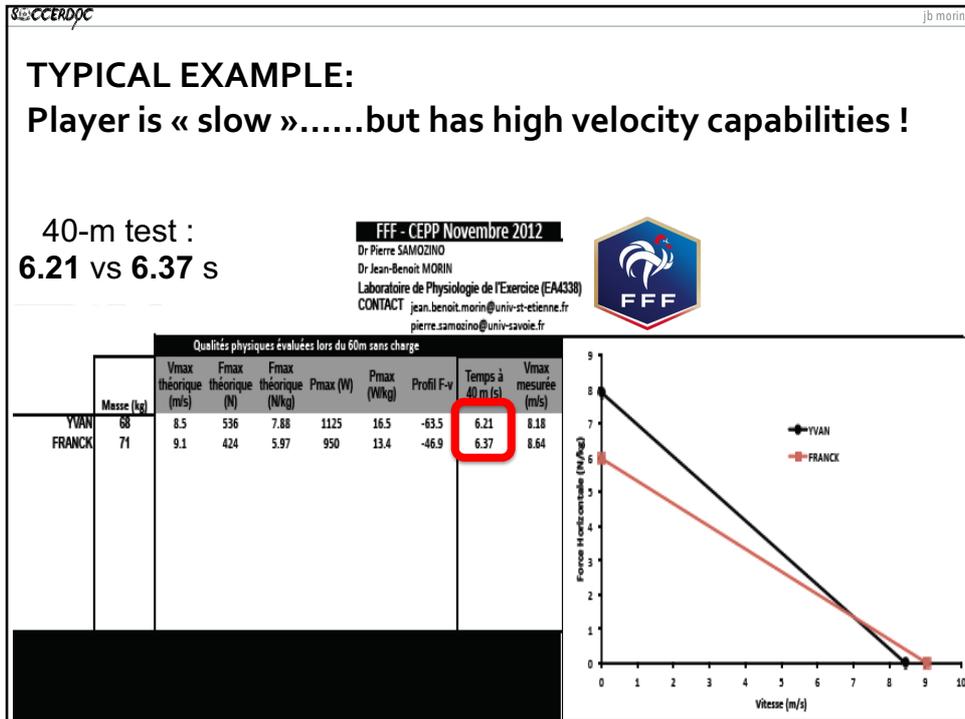
$P_{max}$

$V_{opt}$

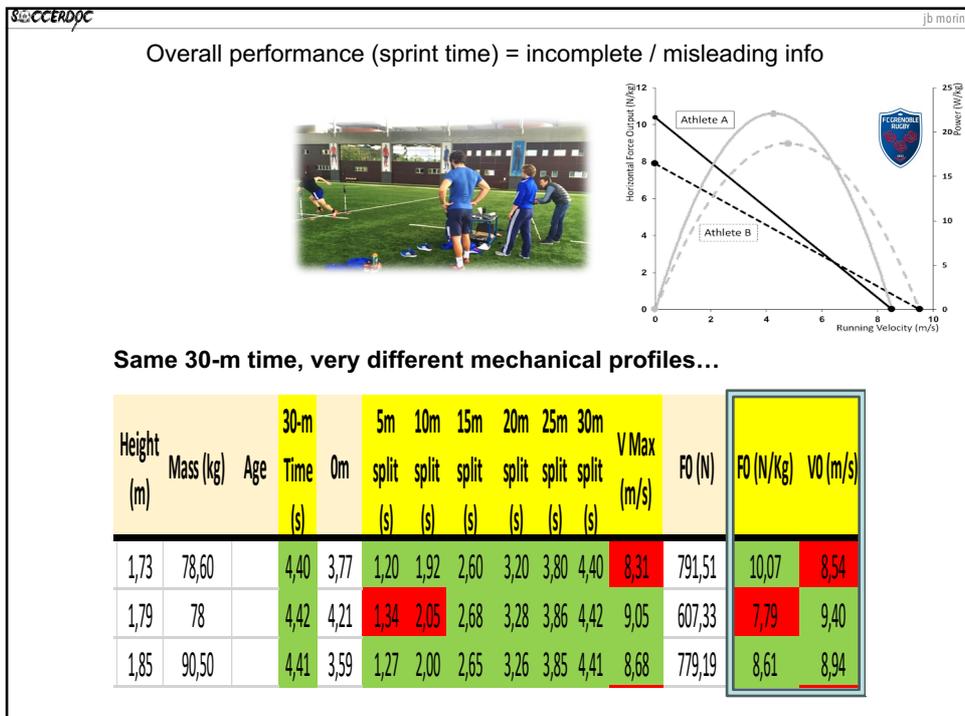
$V_0$

« Velocity-based training »

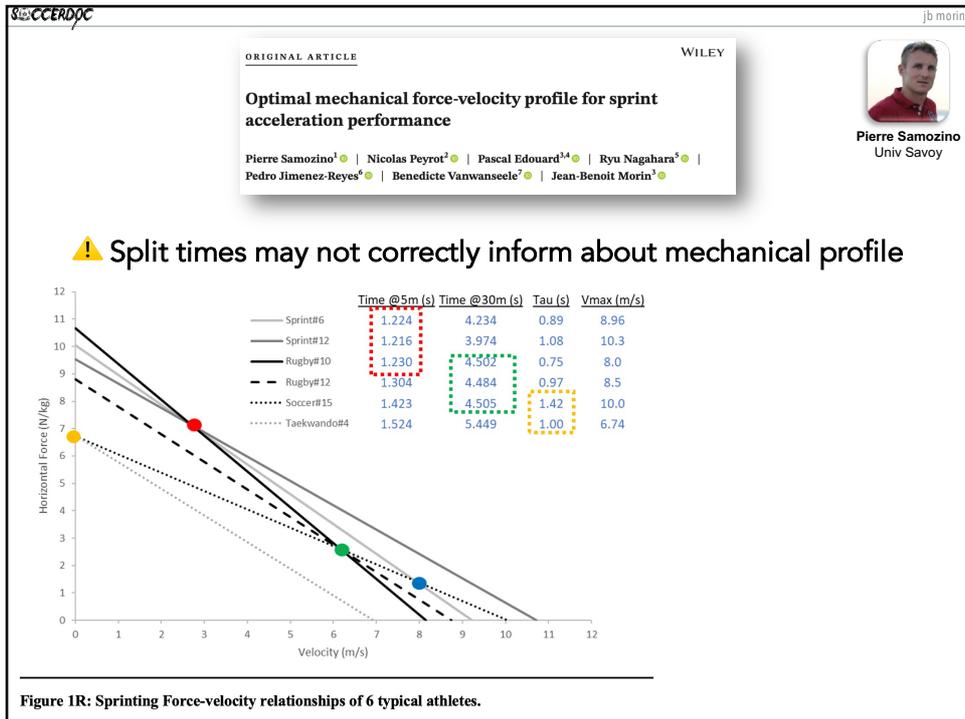
6



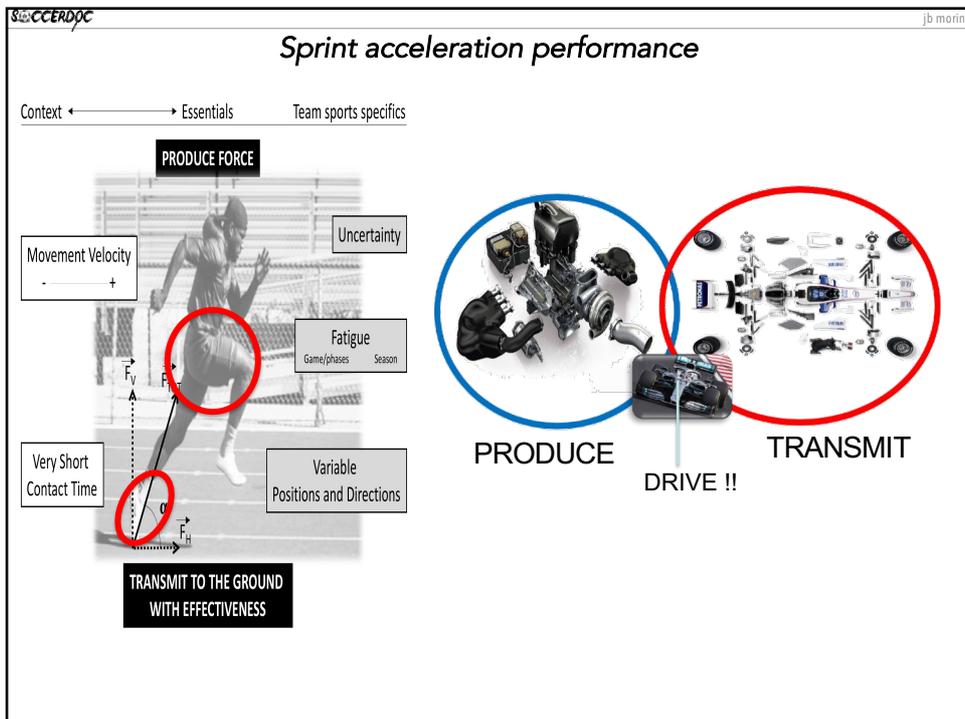
7



8



9



10

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## Beyond split times: from Brain-Muscles to Sport Speed

**KINETICS - DYNAMICS (CoM)**



**Ground Reaction Force**

**KINEMATICS (Segments)**

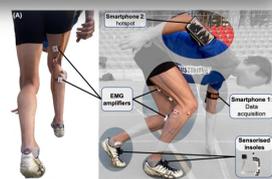


**Sprint pattern / form**

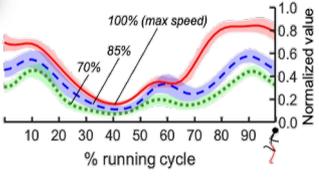
**ORIGINAL ARTICLE** Cerone 2023 WILEY

**Running speed changes the distribution of excitation within the biceps femoris muscle in 80 m sprints**

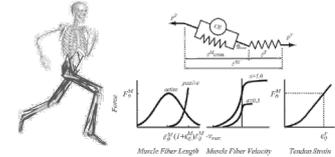
Giacinto L. Cerone<sup>1,2</sup> | Ricardo Nicola<sup>1</sup> | Marco Caruso<sup>3</sup> | Rachele Rossanigo<sup>3</sup> | Andrea Cerretti<sup>2</sup> | Talan Martins Vieira<sup>1,2</sup>



**Surface EMG**



**Modeling**



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## Methods: only 2 (im)possibilities



**INSTRUMENTED SPRINT TREADMILL**  
St-Etienne, France  
Doha, Qatar

**FORCE PLATES**  
INSEP, Paris, France (7m)  
Kanoya, Japan (50m+)



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## GROUND REACTION FORCE ...first steps

*J. Physiol.* (1971), **217**, pp. 709-721 709  
 With 5 text-figures  
 Printed in Great Britain

**THE MECHANICS OF SPRINT RUNNING**  
 BY GIOVANNI A. CAVAGNA, L. KOMAREK AND  
 STEFANIA MAZZOLENI  
 From the Istituto di Fisiologia Umana dell'Università di  
 Milano e Centro di Studio per la Fisiologia del Lavoro  
 Muscolare del C.N.R., Milano, Italy

**METHODS**

*Procedure and apparatus.* The experiments were made on three male subjects 19-22 yr old, the body weight being 66-70 kg and the height 1.72-1.76 m. The subjects were trained sprinters; they ran in an indoor track 56 m long. A strain-gauge platform (4 × 0.5 m), sensitive to the forward and the vertical component of the push exerted by the foot was inserted, with its surface at the level of the floor, 30 m from the beginning of the corridor. The subjects did several runs on different days starting at various distances from the platform; they always exerted their maximum effort. Care was taken to avoid fatigue. Two photocell sights were placed 3 m apart at the platform level to measure the speed of the trunk. To prevent skidding the subjects wore gym shoes.

The force exerted by the foot on the platform in the direction of the run is:

$$F = m \cdot a + \text{Forces of friction} \quad (1)$$

Cavagna et al. 1971

Fig. 1. For legend see opposite page.

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## OK, How can we do with field devices??

*Scand J Med Sci Sports* 2015; ... doi: 10.1111/sms.12490

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 Published by John Wiley & Sons Ltd

**SCANDINAVIAN JOURNAL OF  
 MEDICINE & SCIENCE  
 IN SPORTS**

2016

**A simple method for measuring power, force, velocity properties, and mechanical effectiveness in sprint running**

P. Samozino<sup>1</sup>, G. Rabita<sup>2</sup>, S. Dore<sup>3</sup>, J. Slawinski<sup>4</sup>, N. Peyrot<sup>5</sup>, E. Saez de Villarreal<sup>6</sup>, J.-B. Morin<sup>7</sup>

**Pierre Samozino**  
Univ Savoy

$v(t) = V_{max} \cdot (1 - e^{-t/\tau})$

**Newtonian dynamics**  
Position/Speed -> GRF

di Prampero et al., 2015

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## « Velocity-Time curves »

- 1927, Archibald HILL, pioneer
- Furusawa et al. 1927

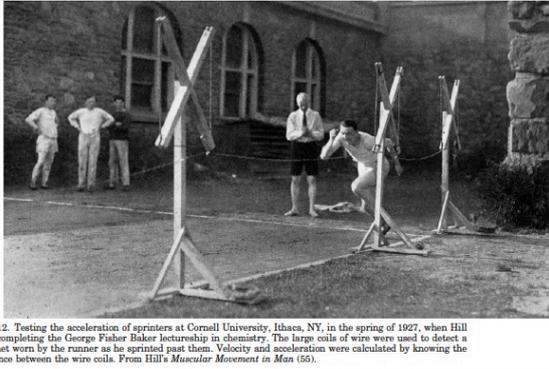






Fig. 12. Testing the acceleration of sprinters at Cornell University, Ithaca, NY, in the spring of 1927, when Hill was completing the George Fisher Baker lectureship in chemistry. The large coils of wire were used to detect a magnet worn by the runner as he sprinted past them. Velocity and acceleration were calculated by knowing the distance between the wire coils. From Hill's *Muscular Movement in Man* (55).

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## 2019 REPLICATION DURING SINGLE SPRINT

### 60m force plate system !



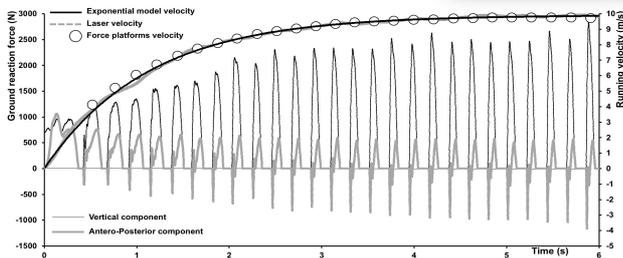
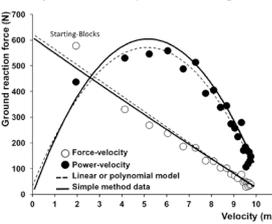
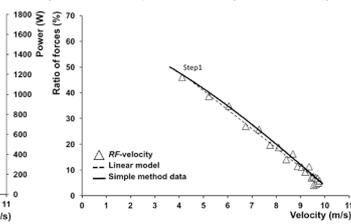
Journal of Biomechanics 94 (2019) 82-87  
Contents lists available at ScienceDirect  
**Journal of Biomechanics**  
journal homepage: www.elsevier.com/locate/jbiomech  
www.JBiomech.com

A simple method for computing sprint acceleration kinetics from running velocity data: Replication study with improved design  
Jean-Benoit Morin<sup>a,d,\*</sup>, Pierre Samozino<sup>b</sup>, Munenori Murata<sup>c</sup>, Matt R Cross<sup>b,d</sup>, Ryu Nagahara<sup>c</sup>




✔

Exact same results

16

OK WITH FIELD DEVICES...

2016: P. Jiménez-Reyes

**My Jump Lab**

**iPhone / iPad:**  
**240 frames/s**

**MySprintApp**

**MySprint**

EJ Marey, 1885,  
24 fps

17

Different systems = different outputs for early acceleration

All systems have similar very good inter-trial reliability

**Laser Muscle Lab**  
1000 Hz

**Radar Stalker**  
48 Hz

**GPS Catapult Vector**  
10 Hz

**Cellules photoélectriques**  
0-5-10-15-20-25-30-40 m

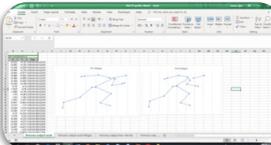
**1080 Sprint**  
333 Hz

**Reliable speed/position inputs and computations = Reliable outputs**

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## 2D Basics: field conditions

**Slow Motion**  
240 frames/s



**Reference Framework**




### The Sprint Mechanics Assessment Score

**A Qualitative Screening Tool for the In-field Assessment of Sprint Running Mechanics**

Christopher Bramah,<sup>\*,††</sup> PhD, Jonas Tawiah-Dodoo,<sup>§</sup> BSc, MSc, Samantha Rhodes,<sup>†††</sup> BSc, MSc, Joshua D. Elliott,<sup>†††</sup> BSc, MSc, and Thomas Dos'Santos,<sup>\*\*\*</sup> PhD  
Investigation performed at School of Health & Society, University of Salford, Salford, Manchester, UK



AI-powered solutions






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**Dr Chris Bramah**  
@chrisbramah

HQ Biomechanics | Consultant Physiotherapist & Sports Health Lecturer & Researcher | Specialist in running injuries, lover of track & field

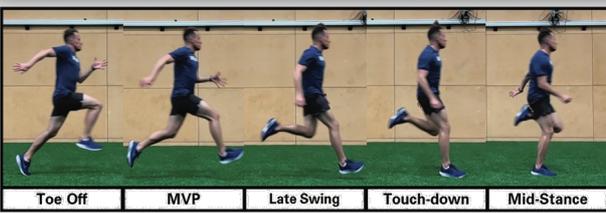
### The Sprint Mechanics Assessment Score

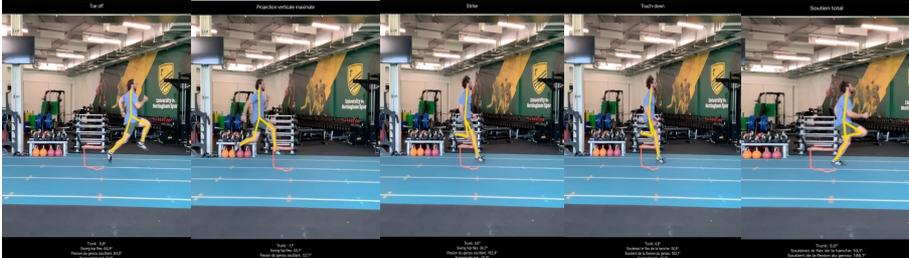
**A Qualitative Screening Tool for the In-field Assessment of Sprint Running Mechanics**

Christopher Bramah,<sup>\*,††</sup> PhD, Jonas Tawiah-Dodoo,<sup>§</sup> BSc, MSc, Samantha Rhodes,<sup>†††</sup> BSc, MSc, Joshua D. Elliott,<sup>†††</sup> BSc, MSc, and Thomas Dos'Santos,<sup>\*\*\*</sup> PhD  
Investigation performed at School of Health & Society, University of Salford, Salford, Manchester, UK

Description	S-MAS	T-Score
Excellent	0	33.8
Excellent	1	37.7
Good	2	41.5
Average	3	45.4
Average	4	49.2
Average	5	53.1
Poor	6	57.0
Very Poor	7	60.8
Very Poor	8	64.7
Very Poor	9	68.6
Very Poor	10	72.4
Very Poor	11	76.3
Extremely Poor	12	80.1







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2D, 3D KINEMATICS AND APPLICATIONS PhD Simon Crespeau

MOTION ANALYSIS **THEIA** Markerless

**SPRINT MECHANICS ASSESSMENT SCORE (SMAS)**

SMAS versus Reference 3-D MOCAP?  
 Field simple → 2D versus 2-D Lab MOCAP?  
 3D Marker-based versus 3D Markerless

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**“Produce and Transmit FORCE” ...**  
**hip extensors and foot-ankle**

22

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## Ground Reaction Force Magnitude & Orientation

2011

APPLIED SCIENCES

### Technical Ability of Force Application as a Determinant Factor of Sprint Performance

JEAN-BENOÎT MORIN, PASCAL EDOUARD, and PIERRE SAMOZINO  
*Université de Lyon; and Laboratory of Exercise Physiology, Saint-Etienne, FRANCE*

European Athletics  
Innovation Awards 2012

*Category: Coaching*

23

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## Mechanical Effectiveness: « Ratio of Force »

For each step, averaged values of  
**Horizontal, Vertical and Total Force**

$$RF = \frac{F_H}{F_{Tot}}$$

$$\alpha = \tan^{-1} \left( \frac{F_H}{F_V} \right)$$

$$RF = \sin \alpha$$

24

2010 - 2020  
**Sprint acceleration: importance of Horizontal Force Production**

APPLIED SCIENCES

**Technical Ability of Force Application as a Determinant Factor of Sprint Performance**

JEAN-BENOÎT MORIN, PASCAL EDOUARD, and PIERRE SAMOZINO  
*Université de Lyon, and Laboratory of Exercise Physiology, Saint-Etienne, FRANCE*

ORIGINAL ARTICLE

**Mechanical determinants of 100-m sprint running performance**

Jean-Benoît Morin · Muriel Bourdin · Pascal Edouard · Nicolas Peyrot · Pierre Samozino · Jean-René Lacour

*Stand J Med Sci Sports 2015; 45: 1289-1294*  
 doi: 10.1111/sms.12389

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 Published by John Wiley & Sons Ltd

WILEY-BLANKETTING JOURNAL OF MEDICINE & SCIENCE IN SPORTS

**Sprint mechanics in world-class athletes: a new insight into the limits of human locomotion**

G. Rabita<sup>1</sup>, S. Dorel<sup>2</sup>, J. Slawinski<sup>3</sup>, E. Sáez-de-Villarreal<sup>4</sup>, A. Couturier<sup>5</sup>, P. Samozino<sup>6</sup>, J.-B. Morin<sup>6</sup>

Contents lists available at ScienceDirect

Journal of Biomechanics  
 journal homepage: www.elsevier.com/locate/jbiomech  
 www.elsevier.com

Acceleration capability in elite sprinters and ground impulse: Push more, brake less?

Jean-Benoît Morin<sup>1,2\*</sup>, Jean Slawinski<sup>3</sup>, Sylvain Dorel<sup>4</sup>, Eduardo Saez de villareal<sup>4</sup>, Antoine Couturier<sup>5</sup>, Pierre Samozino<sup>6</sup>, Matt Brughelli<sup>7</sup>, Giuseppe Rabita<sup>8</sup>

Sprint Instrumented treadmill  
 Track-Embedded Force Plates  
 Elite Athletes  
 (Sub-10s)

Horizontal GRF / impulse is paramount

Vertical / resultant GRF is not

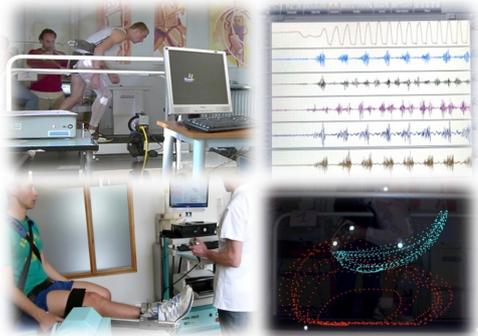
Hzt Force **at high speed** & RF greater in top athletes



25

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**HIP EXTENSORS HYPOTHESIS**



frontiers in Physiology

ORIGINAL RESEARCH  
 published: 24 December 2015  
 doi: 10.3389/fphys.2015.00404

CrossMark

**Sprint Acceleration Mechanics: The Major Role of Hamstrings in Horizontal Force Production**

Jean-Benoît Morin<sup>1\*</sup>, Philippe Gimenez<sup>2</sup>, Pascal Edouard<sup>3,4</sup>, Pierrick Arnal<sup>5</sup>, Pedro Jiménez-Reyes<sup>6</sup>, Pierre Samozino<sup>6</sup>, Matt Brughelli<sup>7</sup> and Jurdan Mendiguchia<sup>8</sup>

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Journal of Experimental Biology

Home Articles About us For authors Journal info Contacts

RESEARCH ARTICLE

**Lower-limb joint mechanics during maximum acceleration sprinting**

Anthony G. Schache, Adrian K. M. Lai, Nicholas A. T. Brown, Kay M. Crossley, Marcus G. Pandy  
Journal of Experimental Biology 2019 222: jeb.209460 doi: 10.1242/jeb.209460 Published 25 November 2019

	High acceleration (5.30 (±0.64) m/s <sup>2</sup> )	Medium acceleration (2.93 (±0.14) m/s <sup>2</sup> )	Low acceleration (1.32 (±0.11) m/s <sup>2</sup> )
Positive work	50.0% (Ankle), 29.1% (Hip), 20.9% (Knee)	58.7%* (Ankle), 24.9% (Hip), 16.4% (Knee)	60.8%* (Ankle), 22.7% (Hip), 16.5% (Knee)
Negative work	38.6% (Ankle), 50.6% (Hip), 10.8% (Knee)	48.9% (Ankle), 40.6% (Hip), 10.5% (Knee)	44.4% (Ankle), 40.1% (Hip), 15.5% (Knee)

Legend: Hip (black), Knee (grey), Ankle (white)

>75% of mechanical work = HIP + ANKLE

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SPORTSMITH

FOOT & ANKLE

Sportsmith

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ARTICLE

**Training the foot to improve performance in sprinting, jumping and change of direction**

JOURNAL OF SPORTS SCIENCES  
https://doi.org/10.1080/02640414.2024.2367365

Routledge  
Taylor & Francis Group

SPORTS PERFORMANCE

Human foot muscle strength and its association with sprint acceleration, cutting and jumping performance, and kinetics in high-level athletes

Romain Tourillon<sup>a,b</sup>, Antoine Michel<sup>a</sup>, François Fourchet<sup>b,c</sup>, Pascal Edouard<sup>b,d</sup> and Jean-Benoit Morin<sup>b,a,e</sup>

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## ROLE OF "FOOT STRENGTH" IN HIGH-INTENSITY SPORT ACTIONS SPRINT, JUMP, CUT




**MTP flexion strength?**

The Foot 59 (2024) 102095

Contents lists available at ScienceDirect




journal homepage: [www.elsevier.com/locate/foot](http://www.elsevier.com/locate/foot)

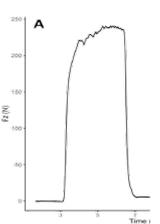
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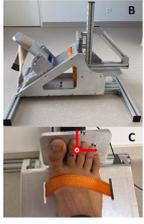
**Reliability and measurement error of a maximal voluntary toe plantarflexion measurement process**

Enrico Roma <sup>a,\*</sup>, Antoine Michel <sup>a</sup>, Romain Tourillon <sup>a,c</sup>, Guillaume Y. Millet <sup>b,d</sup>, Jean-Benoit Morin <sup>a</sup>

<sup>a</sup> Université Aix-Marseille Université, Ecole 2, Université Savoie Mont Blanc, Laboratoire Interuniversitaire de Biologie de la Motricité, F-42023 Saint-etienne, France  
<sup>b</sup> Institut Universitaire de France (IUF), France  
<sup>c</sup> Physiologie Department and Motion Analysis Lab, Swiss Olympic Medical Center, Za Tsur Hahqhal, 2117 Meyrin, Switzerland







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JOURNAL OF SPORTS SCIENCES  
<https://doi.org/10.1080/02640414.2024.2367365>

SPORTS PERFORMANCE

**Human foot muscle strength and its association with sprint acceleration, cutting and jumping performance, and kinetics in high-level athletes**

Romain Tourillon <sup>a,b</sup>, Antoine Michel <sup>a</sup>, François Fourchet <sup>a,c</sup>, Pascal Edouard <sup>a,d</sup> and Jean-Benoit Morin <sup>a,e</sup>

**Broad Jump Peak Power** ✓

Routledge  
Taylor & Francis Group

Check for updates

Model 3	Adj. R <sup>2</sup>	RMSE	p-value
Low-acceleration condition: Relative effective vertical impulse	0.28	0.013	0.008
Independent variables	Coefficient	t	p-value
Relative MTP maximal isometric total torque	0.069	1.885	0.072
Foot mobility magnitude	-0.024	-2.380	0.026
Constant	0.110	7.603	<0.001

Model 4	Adj. R <sup>2</sup>	RMSE	p-value
Low-acceleration condition: Contact time	0.35	0.010	0.003
Independent variables	Coefficient	t	p-value
Relative MTP maximal isometric pushing torque	-0.057	-1.966	0.062
Foot-ankle reactive strength index	-0.027	-3.037	0.006
Constant	0.149	16.599	<0.001

MTPJ: Metatarsophalangeal Joint; RMSE: Root Mean Square Error; Adj.: adjusted

**Top speed Contact time and Vertical Impulse** ✓

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## What training input(s) for what part of the spectrum?

Individual puzzle

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« Toothpaste Tube Theory »...

**ANYTHING** might work (more or less)  
Young, untrained, beginners

**Not anymore...**  
Trained, elite, older athletes

« SPORT ONLY » or « SPRINT ONLY » not efficient beyond a certain level

2020

Sports Medicine  
<https://doi.org/10.1007/s40279-020-01372-z>

SYSTEMATIC REVIEW

**The Training of Short Distance Sprint Performance in Football Code Athletes: A Systematic Review and Meta-Analysis**

Ben Nicholson<sup>1,2,3</sup> · Alex Dinsdale<sup>1</sup> · Ben Jones<sup>1,3,4,5,6</sup> · Kevin Till<sup>1,3</sup>

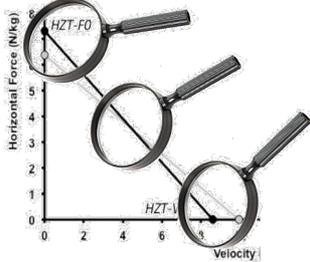
Quest for improvement margins

Individual puzzle

32

jb morin

Towards more Individualized Sprint Training...








Cahill, Cross, Jimenez-Reyes, Lahti & others

+MANY unpublished staff works

Sports Med  
DOI 10.1007/s40279-015-0422-8

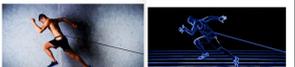
 CrossMark

**SYSTEMATIC REVIEW**

**Resisted Sled Sprint Training to Improve Sprint Performance: A Systematic Review**

George Petrakos<sup>1</sup> · Jean-Benoit Morin<sup>2</sup> · Brendan Egan<sup>1</sup>

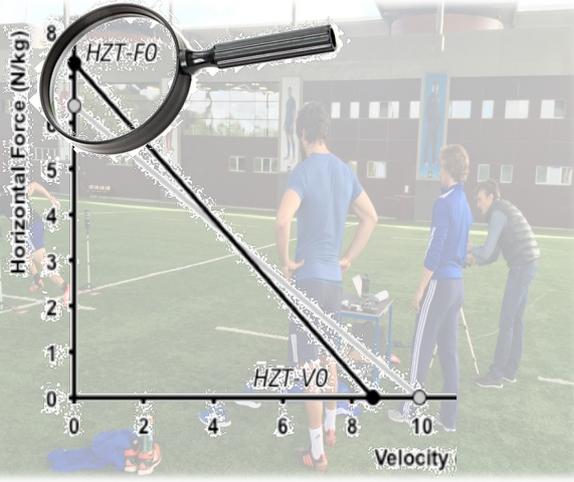




33

jb morin

Towards a more Individualized Sprint Training...



**Maximal FORCE - EFFECTIVENESS**

**Improving Mechanical Effectiveness During Sprint Acceleration: Practical Recommendations and Guidelines**

Dylan Shaun Hicks, MSc<sup>1</sup>, Jake George Schuster, MSc<sup>1</sup>, Pierre Benoit Morin, PhD<sup>2</sup> and Jean-Benoit Morin, PhD<sup>2</sup>  
<sup>1</sup>Exercise Science Department, Flinders University, Australia, <sup>2</sup>Team Performance and Force Health Laboratory, Institute of Sports Science and Sports Medicine, Université Claude-Bernard, Laboratoire Neurosciences de Biologie de la Motricité, Chambéry, France, <sup>3</sup>Université Côte d'Azur, UMR5175, Nice, France

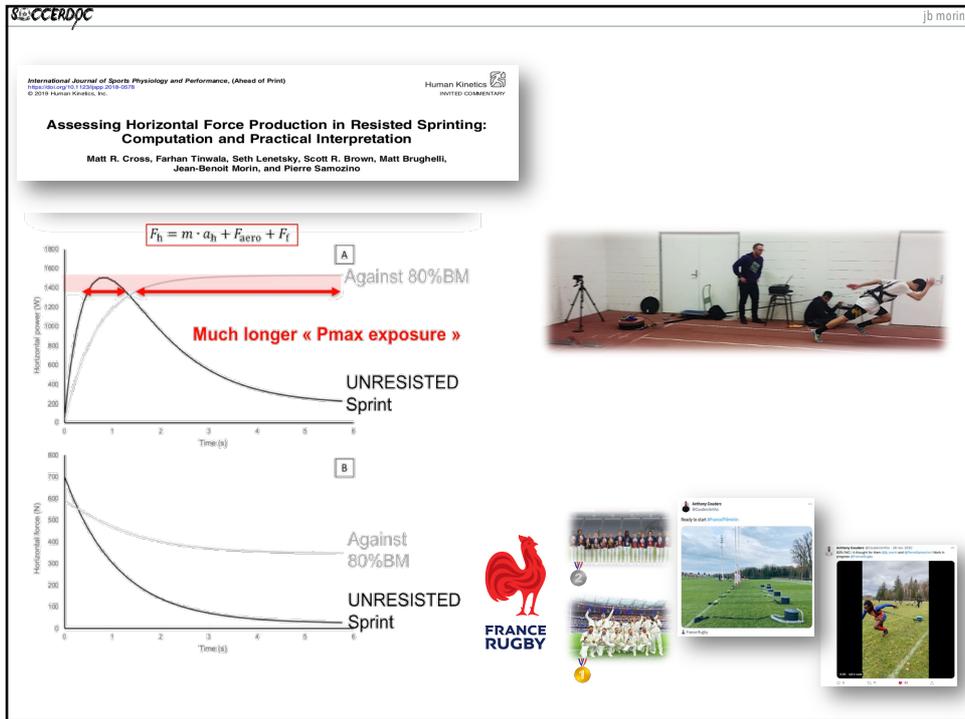
2019 SCJ



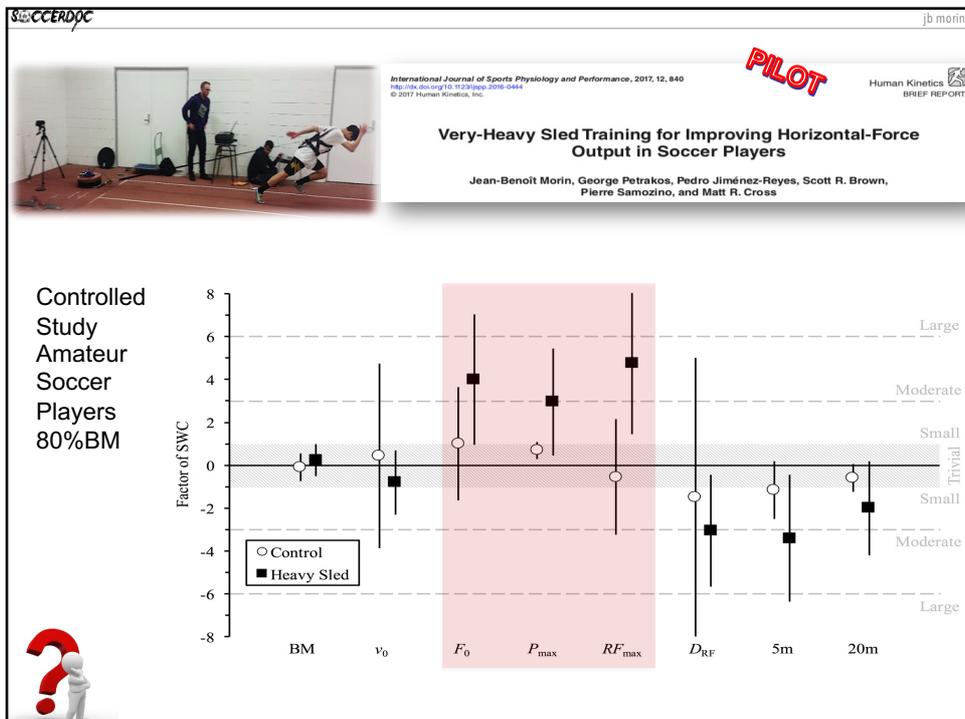
**Dylan Shaun Hicks** is a PhD candidate and teaching faculty member in Exercise Science at Flinders University, South Australia.

**Dylan Hicks**  
[@DylHicks](#)

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**METHODS: kg, %BM or %Vdec ?**

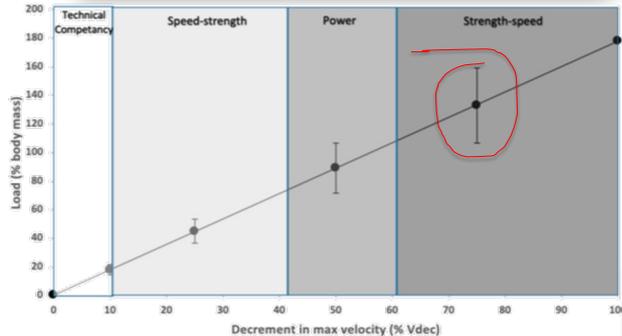
**sports** 2019

Article  
**Sled-Pull Load-Velocity Profiling and Implications for Sprint Training Prescription in Young Male Athletes**

Michael J. Cahill <sup>1,2,\*</sup>, Jon L. Oliver <sup>2,3</sup>, John B. Cronin <sup>2</sup>, Kenneth P. Clark <sup>4</sup>, Matt R. Cross <sup>2,5</sup> and Rhodri S. Lloyd <sup>2,3,6</sup>



**Micheal Cahill**



Load (% body mass)

Decrement in max velocity (% Vdec)

Technical Competency | Speed-strength | Power | Strength-speed

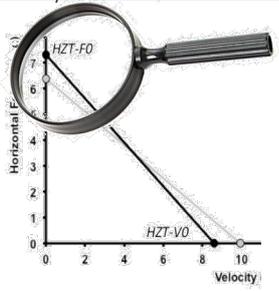
⚠️ %BM = high variability in stimulus

Load prescription ???!



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Horizontal Force

Velocity

HZT-FO

HZT-VO

Work in progress

**« NON-SPECIFIC » Linear test....**  
**but sprint force capability related to game skills** ✓

International Journal of Sports Physiology and Performance, (Ahead of Print)  
<https://doi.org/10.1123/ijsp.2022-0294>  
 © 2023 Human Kinetics, Inc.  
 First Published Online: Mar. 16, 2023

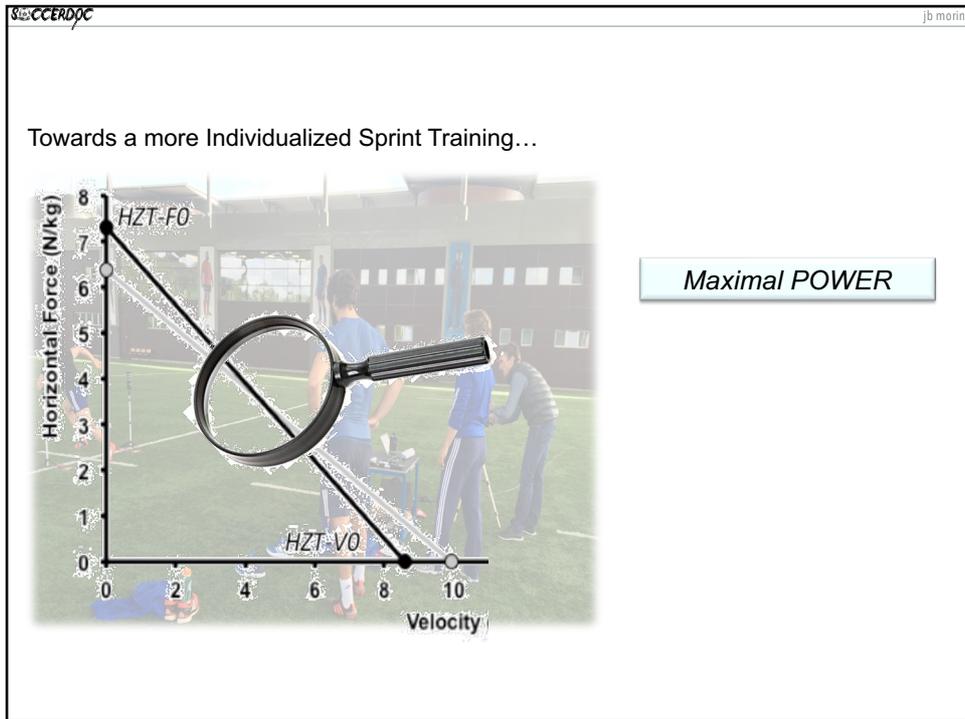
**Human Kinetics ORIGINAL INVESTIGATION**

**Opposition Skill Efficiency During Professional Rugby Union Official Games Is Related to Horizontal Force-Production Capacities in Sprinting**

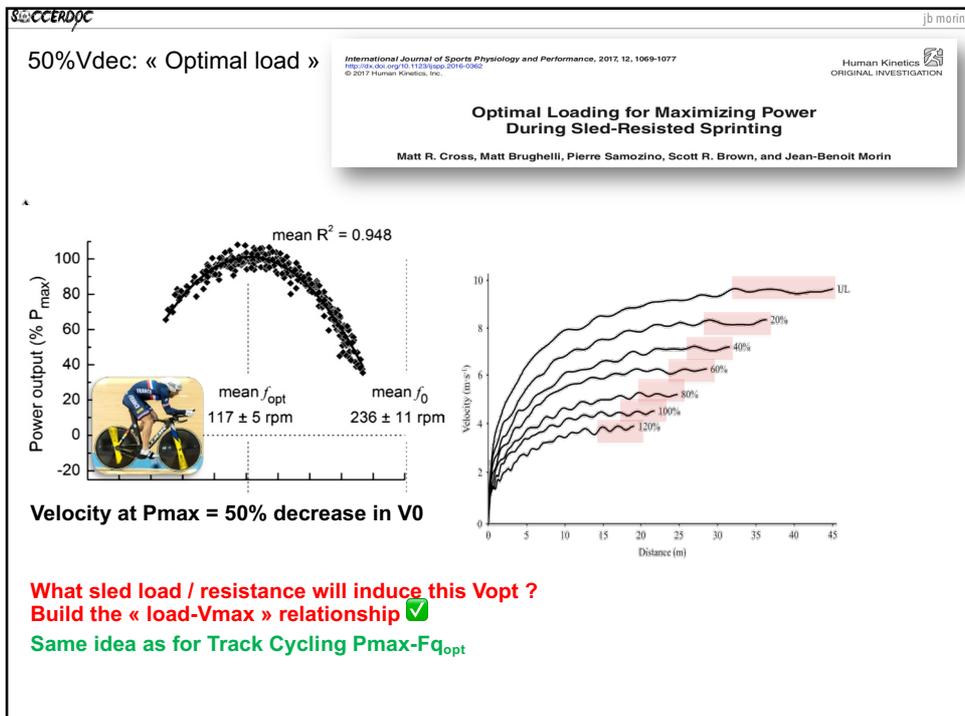
Paul Glaise,<sup>1,2</sup> Isabelle Rogowski,<sup>1</sup> Pierre Samozino,<sup>3</sup> Jean-Benoit Morin,<sup>4</sup> Baptiste Morel,<sup>3</sup> and Cyril Martin<sup>1</sup>




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### 4. Sprints: increasing resistances

### 5. Individual linear load-Vmax relationship

Body Mass	70			
V0 (m/s)	7.5			
Vopt (m/s)	3.75		Obtained with MySprint: FV profile of a free sprint (30m)	

Load (%BM)	Load (kg)	Vmax (m/s)	Slope of Load-Vmax	Y-intercept
0% (sprint 1)	0	7.5	-0.066	7.5
25%	18	6.3		
50%	35	5.1		
75%	53	3.9		
100%	70	2.9		

Note: Average Speed over 5m = 5/time to run 5m  
No need to run 30m with heavy loads if athlete already decelerates before...

**Fill the Yellow cells and Click "SAVE" to update computations**

### 6. Calculate the individual Optimal load

- ✓ Load at which Vmax = Vopt = 0.5V0
- ✓ Example: Vopt = 3.75m/s => Lopt= 56kg
- ✓ Load at which Pmax is produced

Cross et al. Int J Sport Physiol Perf, 2016

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## Complete study in Professional soccer players

2017– 2021 Series of Studies

**Increase in F0, RFmax and Pmax ✓**

**No change in V0**

PeerJ 2020  
Johan Lahti, Toni Huuhka, Valentin Romero, Ian Bezodis, Jean-Benoit Morin and Keijo Häkkinen

Johan Lahti (Univ Nice) @lahti\_johan

**HEAVY: 50% Drop in Vmax (90% BM on average here)**

**VERY HEAVY: 60% Drop in Vmax (120% BM on average here)**

Pre-tests and familiarization (Week -1 to Week 0) | Intervention (Week 1-9) | Post-tests (Week 11)

Week(s)	Sled sprints		Sled sprint distance		Free sprints (20 m)	
	Day 1	Day 2	HS60 %	HS50 %	Day 1	Day 2
1	4	4			2	2
2-4	2	4			2	2
5-6	3	5			1	1
7	5	Camp #	15 m, RECO: 2-3 min	20 m, RECO: 2-3 min	1	1
8	2				2	2
9	3	5			1	1
Taper: 10-11	2					2

Familiarization to Sled sprints: 80% of BM x 3 → 20 meters

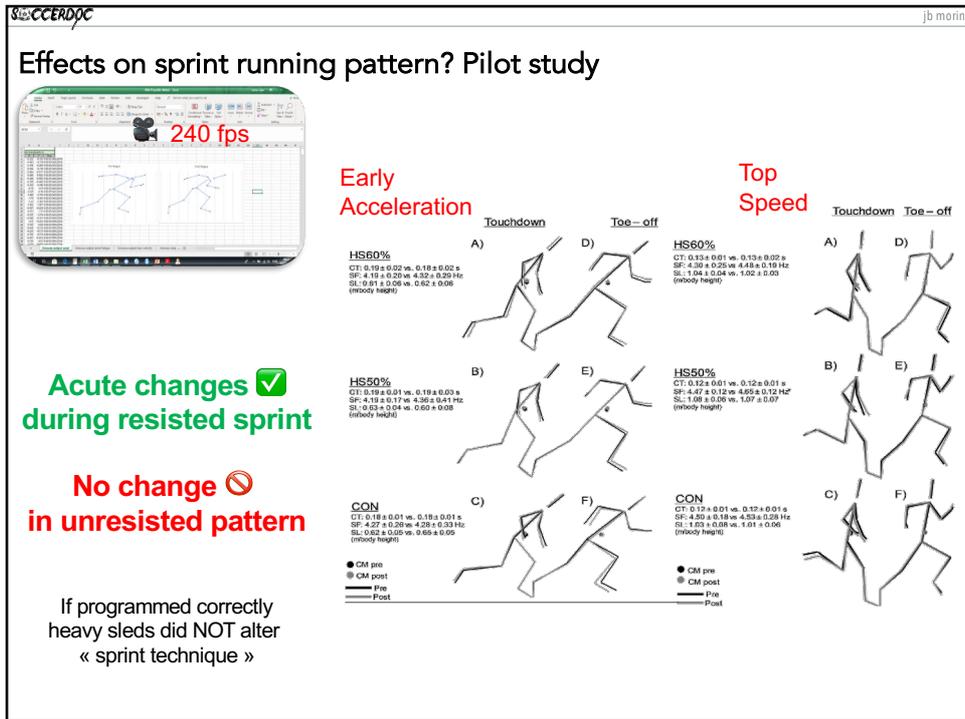
Load-velocity profiles: 1 x 25, 50, 75, 100% of BM → 15-25 m

Sprint FV-profiles: 2x30 m sprints

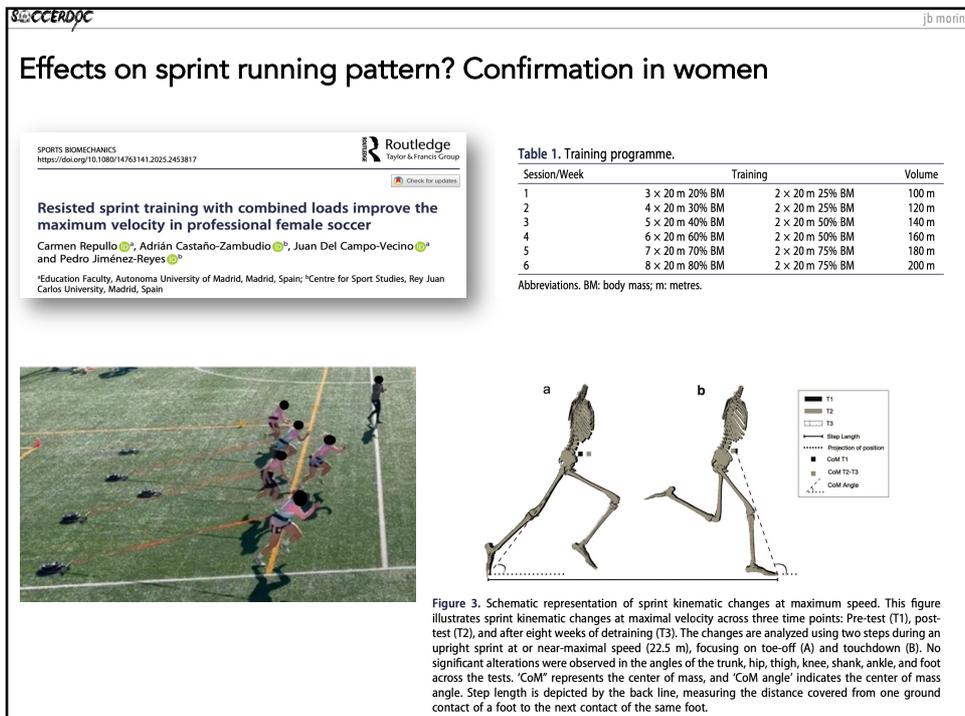
Sprint FV-profiles: 2x30 m sprints

Sprint FV-profiles: 2x30 m sprints

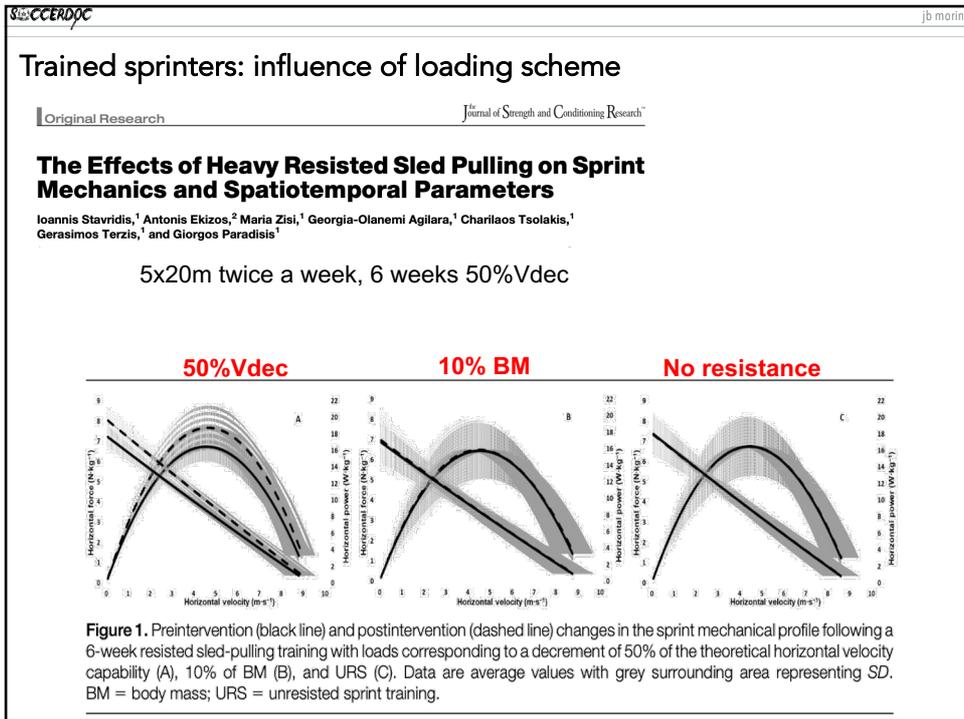
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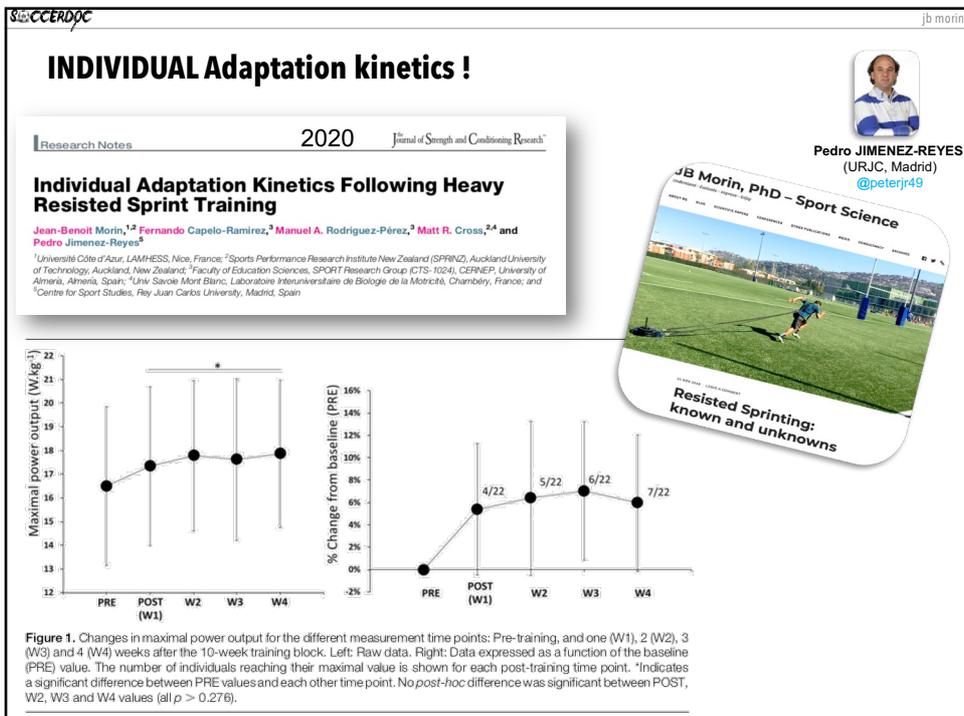
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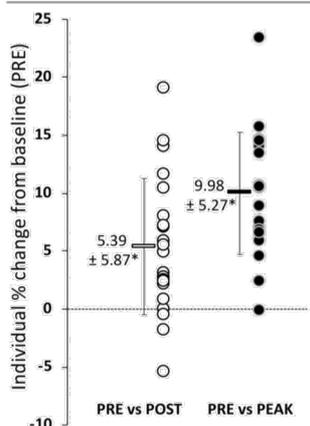
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## INDIVIDUAL Adaptation kinetics !



**Pedro JIMENEZ-REYES**  
(URJC, Madrid)  
[@peterjr49](#)



**Figure 2.** Comparison between individual changes in maximal power output analyzed with a PRE-POST vs. PRE-PEAK approach. Data indicate the group average change and standard deviation. \*Indicates significant ( $p < 0.01$ ) difference with PRE values.

### Practical Applications

A window of ~2-4 weeks seems effective for most athletes to reach their peak adaptation to a HRST block. This window should help coaches better control their training program and ensure that athletes' physical capabilities are properly monitored, and/or are allowed to reach their peak at a targeted time. We suggest researchers avoid single post-tests where able, and instead adopt a repeated-measurements follow-up period design to better describe and understand the individual adaptations to any type of overload training, especially HRST.

**Stuart McMillan** @StuartMcMillan1 · 1h  
On 'averagearianism' from @JB\_morin - very often overlooked/ ignored:

"Coaches seek to improve individual performance, not only group average, so research should focus on individual performances, not group average adaptations."

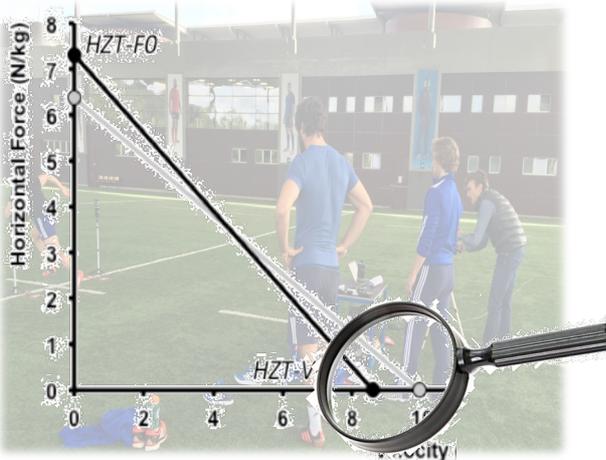


Resisted Sprinting: known and unknowns  
[jbmorin.net](#)

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## Towards a more Individualized Sprint Training...



*Maximal VELOCITY*

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**Overspeed: the other dish you avoid, but have never tasted**

LITERATURE REVIEW

**Resisted and Assisted Sprint Training: Determining the Transfer to Maximal Sprinting**

by Dylan Hicks

© by IAAF  
32:12; xx-xx 2017







**YES NO MAYBE**

Several « **acute** » studies

**1 training study ! Group effect but unclear individual changes**



My current thoughts...

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**sports**

Article

**Individual Sprint Force-Velocity Profile Adaptations to In-Season Assisted and Resisted Velocity-Based Training in Professional Rugby**

Johan Lahti <sup>1\*</sup>, Pedro Jiménez-Reyes <sup>2</sup>, Matt R Cross <sup>1,3</sup>, Pierre Samozino <sup>3</sup>, Patrick Chassaing <sup>1,5</sup>, Benjamin Simond-Cote <sup>3</sup>, Juha Ahtianen <sup>4</sup> and Jean-Benoit Morin <sup>1,4</sup>





**Johan LAHTI**  
(Univ Nice)  
@lahti\_jchp075%

**A) RESISTED**  
1-2 x week  
Week 1-4: 7 x sled, 1,2 x 20 m free sprints  
Week 5-8: 4 x sled, 1 x 20 m free sprint



Heavy sled: 10 meters

Set recovery: 3 minutes

**B) ASSISTED**  
1-2 x week  
Week 1-4: 3 x assist, 3-2 x 20 m free sprints  
Week 5-8: 4 x assist, 1 x 20 m free sprint



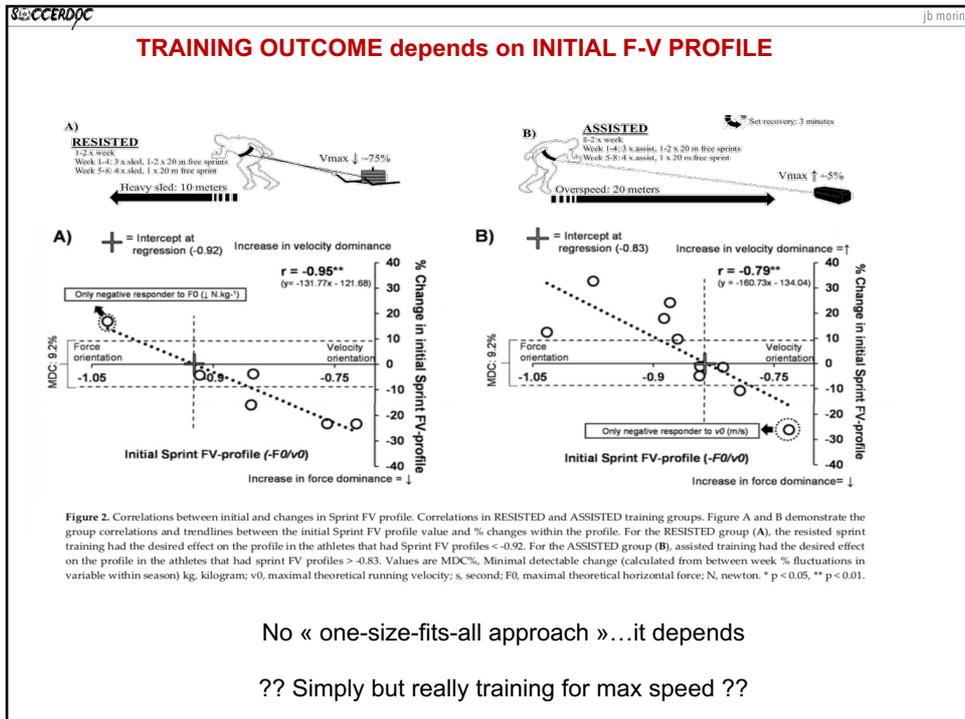
Overspeed: 20 meters

Vmax ↑ ~5%

Table 2. Inferential statistics for within- and between-group comparisons.

Variable	Group	Homogeneity of variance (Levene's test)	RESISTED AND ASSISTED Within-Group Inferential Statistics				Between-Group Differences (ANCOVA)		
			Pre x ± SD	Post x ± SD	%Δ ± SD	Post-Pre ES; ±95% CL	p value	ES; ±95% CL	p value
v0 (m/s)	RESISTED	F(1, 19) = 0.2692 p = 0.59	8.75 ± 0.47	9.08 ± 0.48	3.21 ± 2.37	0.70 (-0.34-1.74)	0.02	0.06 (-0.95-1.07), p = 0.81 †	
	ASSISTED		8.71 ± 0.50	8.94 ± 0.46	3.40 ± 4.15	0.47 (-0.38-1.32)	0.03		
F0 (N.kg-)	RESISTED	F(1, 19) = 1.669 p = 0.21	7.46 ± 0.73	8.08 ± 0.26	8.95 ± 13.2	1.13 (0.02-2.24)	0.22	-0.74 (-1.78-0.31), p = 0.02	
	ASSISTED		7.46 ± 0.41	7.32 ± 0.78	-1.27 ± -14.4	-0.23 (-1.10-0.66)	0.69		
Pmax (W.kg)	RESISTED	F(1, 19) = 0.041 p = 0.84	16.1 ± 1.15	17.7 ± 0.78	9.21 ± 12.0	1.58 (0.40-2.76)	0.17	-0.55 (-1.58-0.48), p = 0.16	
	ASSISTED		16.1 ± 1.50	16.4 ± 1.82	2.75 ± 11.3	0.15 (-0.69-0.99)	0.51		
Sprint FV Profile (F0/v0)	RESISTED	F(1, 19) = 0.474 p = 0.49	-0.85 ± 0.08	-0.92 ± 0.05	-9.00 ± 15.3	-1.01 (-2.11-0.08)	0.29	0.86 (-0.20-1.91), p = 0.02	
	ASSISTED		-0.86 ± 0.09	-0.81 ± 0.08	5.17 ± 17.6	-0.60 (-1.50-0.29)	0.27		
5-meter time (s)	RESISTED	F(1, 19) = 1.284 p = 0.27	1.38 ± 0.05	1.33 ± 0.02	-3.22 ± 4.62	-1.19 (-2.28-0.10)	0.14	0.74 (-0.30-1.79), p = 0.07	
	ASSISTED		1.38 ± 0.03	1.40 ± 0.07	0.68 ± 5.80	0.23 (-0.65-1.11)	0.64		
20-meter time (s)	RESISTED	F(1, 19) = 0.780 p = 0.38	3.44 ± 0.11	3.32 ± 0.08	-3.25 ± 1.78	-1.23 (-2.33-0.14)	0.007*	1.16 (0.07-2.25), p = 0.07 †	
	ASSISTED		3.45 ± 0.08	3.45 ± 0.37	0.23 ± 3.86	0.02 (-0.82-0.86)	0.91		

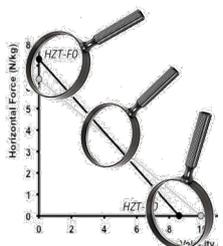
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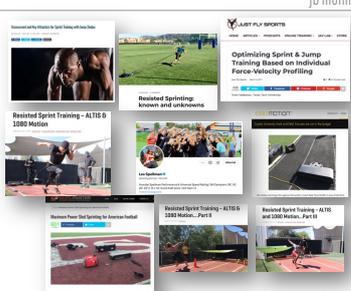
**10+ TRAINING studies since Pilot study in 2017**  
+ consistent anecdotal evidence, young to elite

**TAKE-HOME**



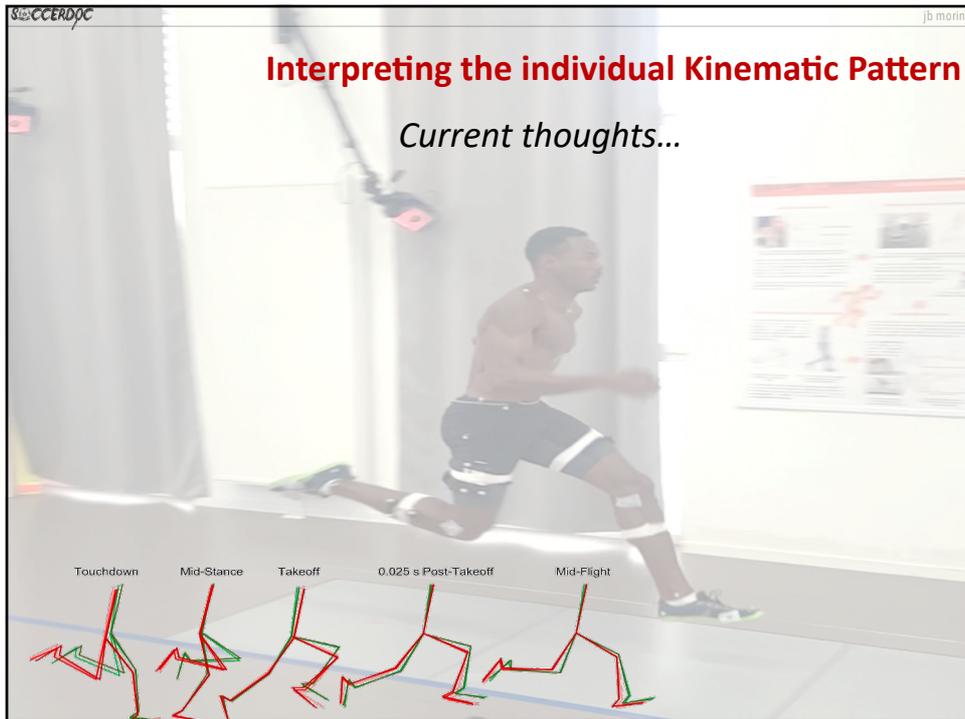
Different loads → different parts of the spectrum (VBT)  
Effect **DEPENDS** on the initial profile of **EACH** athlete  
**IT DEPENDS** on training objectives, context and period  
No « one-size-fits-all » 🎯  
Implement the overload correctly ✅  
Max speed? First do it, but ⚠️ « form before load »

🚩 **JUST** a piece of the training puzzle

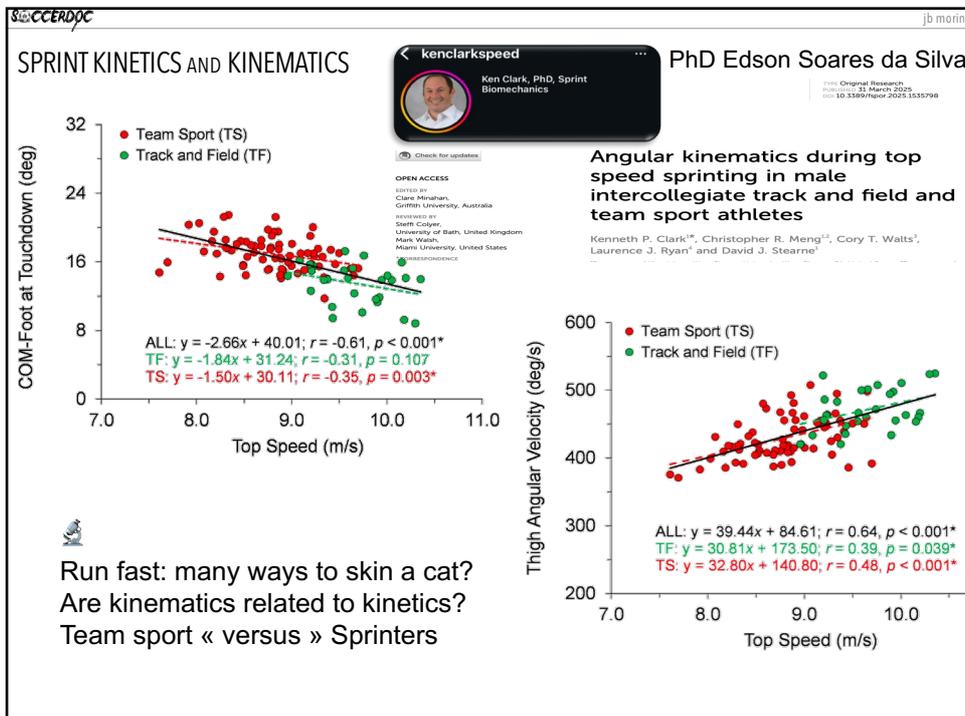




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frontiers | Frontiers in Sports and Active Living

TYPE Original Research  
PUBLISHED 31 March 2025  
DOI 10.3389/fspor.2025.1535798

Check for updates

**Angular kinematics during top speed sprinting in male intercollegiate track and field and team sport athletes**

Kenneth P. Clark<sup>1\*</sup>, Christopher R. Meng<sup>1,2</sup>, Cory T. Walts<sup>3</sup>, Laurence J. Ryan<sup>4</sup> and David J. Stearne<sup>5</sup>

**OPEN ACCESS**  
EDITED BY  
Clare Minahan,  
Griffith University, Australia  
REVIEWED BY  
Steffi Colyer,  
University of Bath, United Kingdom  
Mark Walsh,  
Miami University, United States  
\*CORRESPONDENCE

Legend	Sub-Group	Description	n	Mean Speed (m/s)
—	Fast TF	Fast Track & Field	14	10.00 ± 0.21
—	Slow TF	Slow Track & Field	14	9.34 ± 0.21
—	Fast TS	Fast Team Sport	22	9.31 ± 0.19
—	Int. TS	Intermediate Team Sport	29	8.78 ± 0.14
—	Slow TS	Slow Team Sport	19	8.21 ± 0.25

Are faster athletes faster **because** of their kinematics/kinetics/both?

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FOOT & ANKLE May 30 Ph.D.

Université Jean Monnet  
LBM  
Hôpital de La Tour

Thèse de Doctorat  
Pour l'obtention du grade de docteur  
En sciences de la Motricité Humaine  
Présentée par Romain TOURILLON

**THE ROLE OF METATARSOPHALANGEAL JOINTS FLEXION STRENGTH IN PROPULSION KINETICS AND SPORT PHYSICAL PERFORMANCE**

Devant le jury composé de:  
Pr Luke KELLY, Griffith University (AUS), Rapporteur  
Pr Caroline NICOL, Aix-Marseille Université (FRA), Rapportrice  
Dr Nicola MAFFIOLETTI, Schullthess Clinic (CHE), Examinateur  
Dr Grace SMITH, University of Chester (UK), Examinateur  
Dr Anamária PÉTER, Hungarian University (HUN), Examinateur  
Pr Jean-Benoît MORIN, Université Jean Monnet (FRA), Directeur  
Pr Dr Pascal EDOUARD, Université Jean Monnet (FRA), Co-directeur  
Dr François FOURCHET, Hôpital La Tour (CHE), Co-encadrant

Sportsmith  
ARTICLE  
Training the foot to improve performance in sprinting, jumping and change of direction  
By Romain Tourillon

« A chain is only as strong as its weakest link... »  
« You can't fire a cannon from a row boat »

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## TRAINING STUDY IN HIGHLY TRAINED ATHLETES



INTERVENTIONAL PERIOD (8 WEEKS)

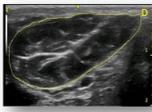
TRAINING GROUP ⇒ FOREFOOT STRENGTHENING PROTOCOL

**8 WEEKS**  
2 sessions / week

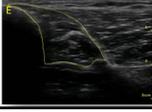


Jump Sprint COD  
Performance Kinetics  
MTPj strength  
PF-KE strength  
posture  
CSA

**CSA of abductor hallucis (AbH)**



**CSA of flexor digitorum longus (FDL)**



1 SUPERVISED SESSION

EXERCISE 1: FOREFOOT ISO-PUSH + NMES

EXERCISE 2: 1<sup>st</sup> RAY DYNAMIC ISO-HOLD

EXERCISE 3: FOREFOOT REBOUND JUMPS

1 UNSUPERVISED SESSION

EXERCISE 1: FOOT BRIDGE ISO-HOLD + NMES

EXERCISE 2: FOREFOOT ISO WALL PUSH



Thesis R. Tourillon

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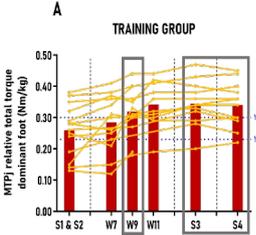
June 2 PLOS One

RESEARCH ARTICLE

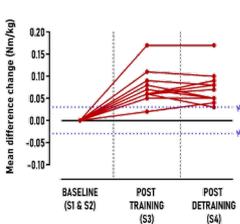
### Effects of a forefoot strengthening protocol on explosive tasks performance and propulsion kinetics in athletes: a single-blind randomized controlled trial

Romain Tourillon<sup>1,2\*</sup>, François Fourchet<sup>1,2</sup>, Pascal Edouard<sup>1,2</sup>, Jean-Benoît Morin<sup>1,2</sup>

**A TRAINING GROUP**

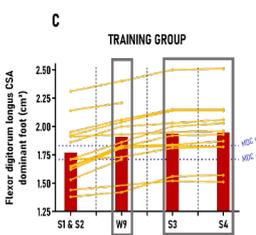


**B**

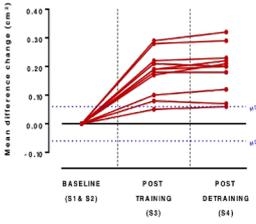


NO change in Plantarflexion or Knee extension torque

**C TRAINING GROUP**



**D**



**+26% strength gains & +9% CSA gains after 8 weeks (p<0.001)**

**S3 = S4 (long-lasting effect)**

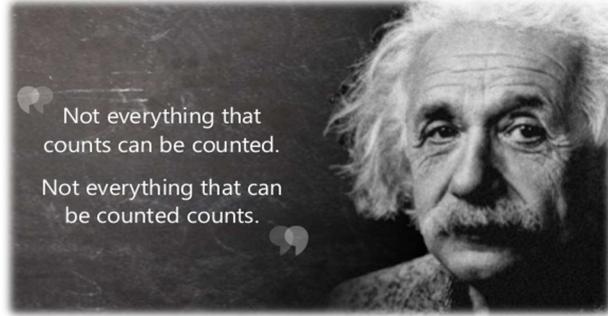
**+17% strength gains & +5% of CSA gains after 5 weeks (p<0.05)**

**92% of « positive responders » (n=11/12)**

Thesis R. Tourillon

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**Merci !**