How do they do it? Movement strategies in sprinting

Dr Helen Bayne

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My Influences

COACHING

CLINICAL

RESEARCH

APPLIED BIOMECH

Current role(s):

Helen Bayne
Sports performance practitioner, researcher, educator

Picture: Reg Caldecott

2014 – TuksSport and South African sprinting boom


adidas

Role of the biomechanist?

Support the coach's eye and their experiential knowledge with objective measurements, application of biomechanical principles and scientific evidence

Measurement framework

WHY
Mechanical determinants, "drivers"

WHAT
Performance

HOW
Movement strategies to produce those determinants

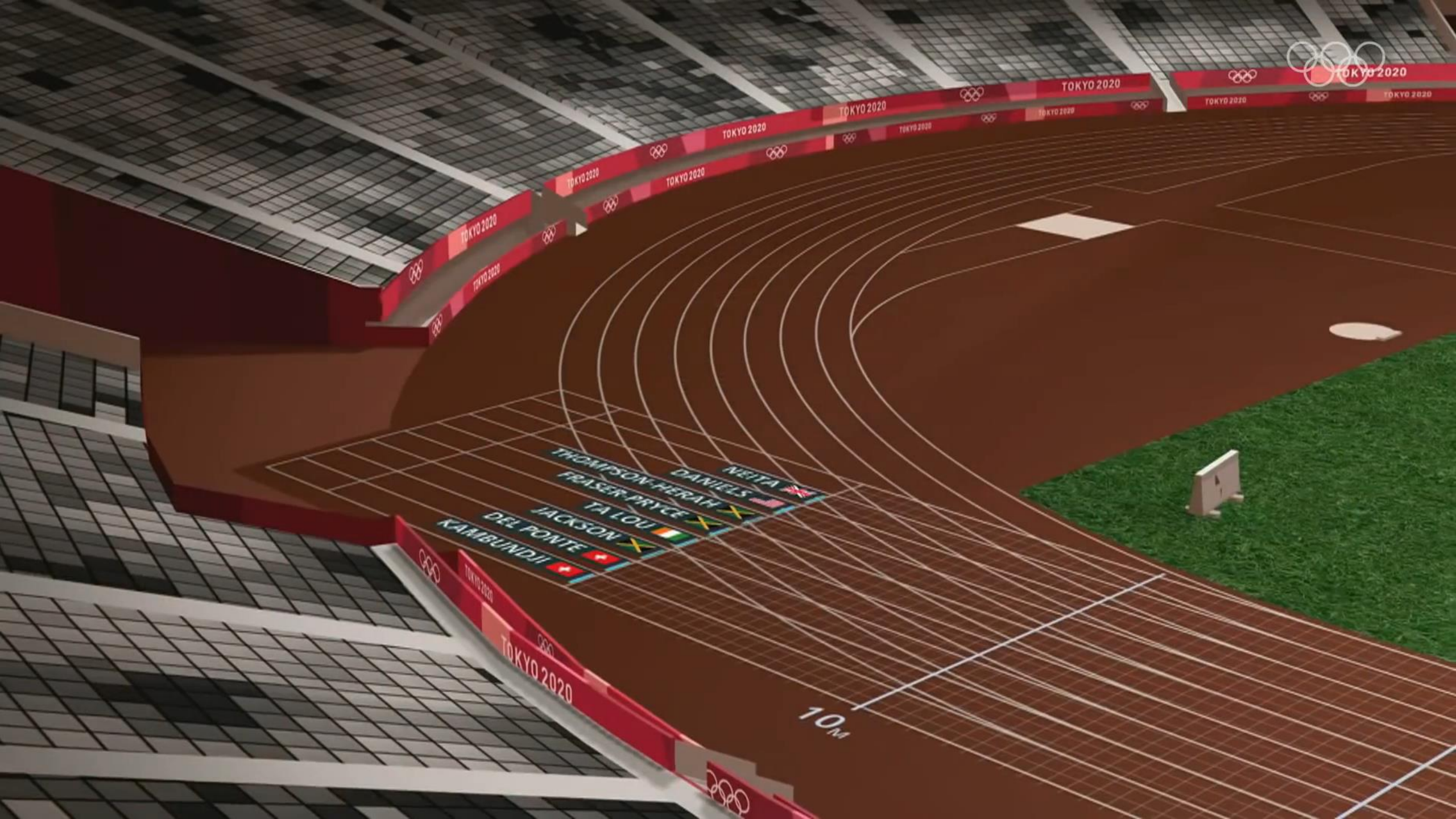
WHAT:
Performance

ATHLETICS

Women's 100m

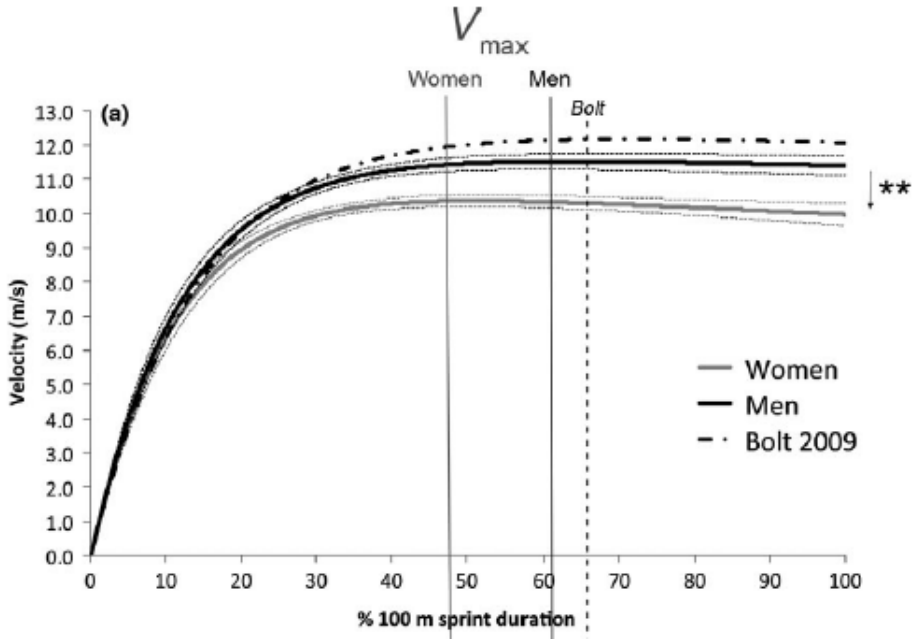
RESULT - FINAL — Wind -0.6m/s

1	JAM	Elaine THOMPSON-HERAH	OR	10.61
2	JAM	Shelly-Ann FRASER-PRYCE		10.74
3	JAM	Shericka JACKSON	PB	10.76
4	CIV	Marie-Josee TA LOU		10.91
5	SUI	Ajla del PONTE		10.97
6	SUI	Mujinga KAMBUNDJI		10.99
7	USA	Teahna DANIELS		11.02
8	GBR	Daryll NEITA		11.12


TOKYO 2020
NEITA
DANIELS
THOMPSON-HERAH
FRASER-PRYCE
TA LOU
JACKSON
DEL PONTE
KAMBUNDJI
10M

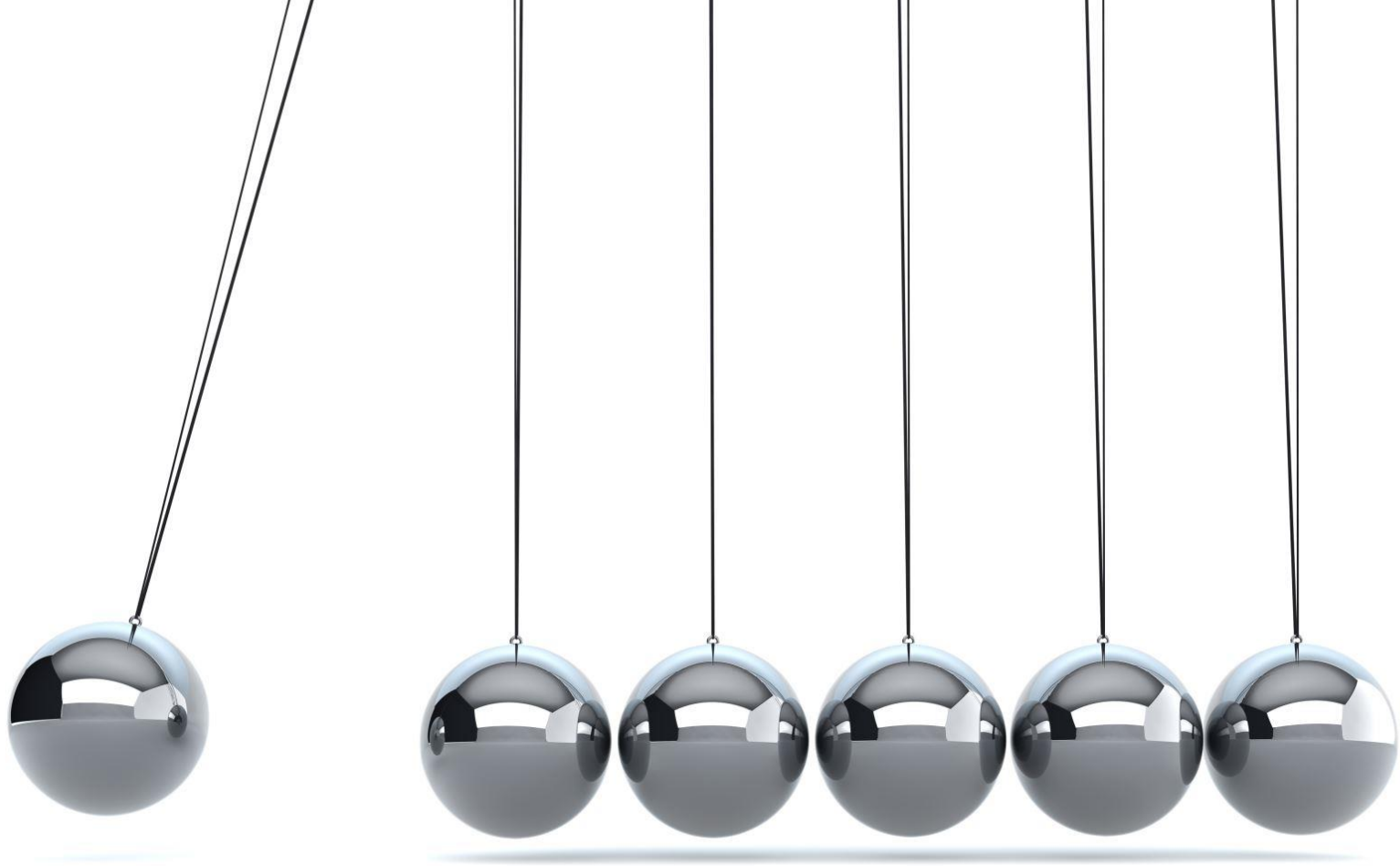
WHAT: Performance

Time to complete race distance



- ✓ Accelerate from a stationary start
- ✓ Reach maximum velocity late in the race (accelerate for as long as possible)

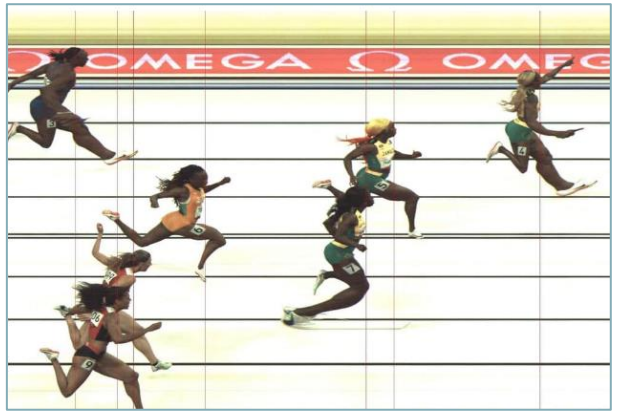
Slawinski, J., et al (2015) Scan J Med Sci Sport.



WHY:
Mechanical determinants

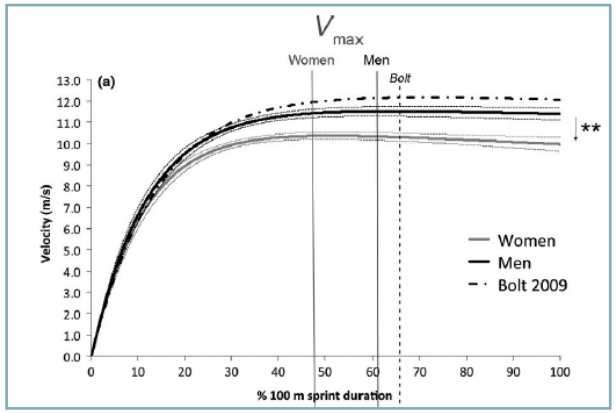
WHY: Determinants

Sprint time



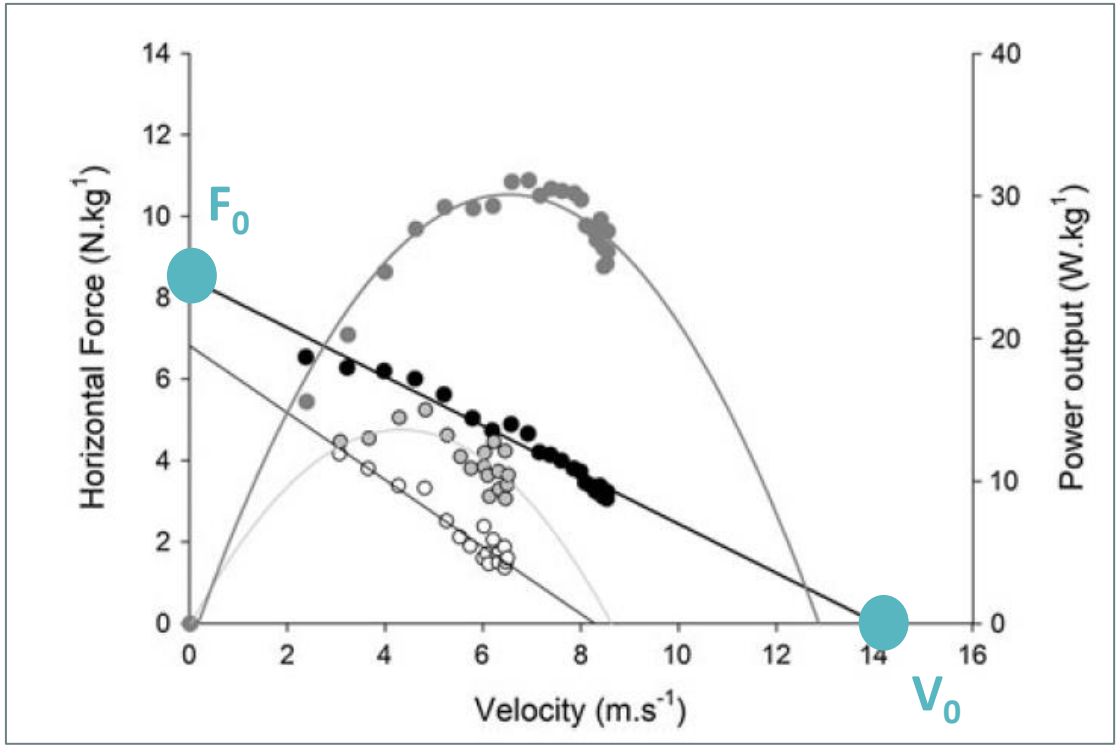
WHY: Determinants

- Acceleration ability → velocity profile
- F = m.a



High F_0 ->

early acceleration performance



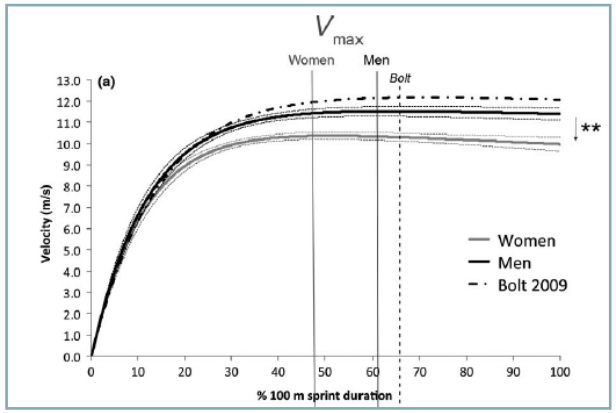
High V_0 ->

continue accelerating for longer

Morin, J-B., et al (2011) Med Sci Sport Exerc.
Morin, J-B., et al (2012) Eur J Appl Physiol.
Rabita, G., et al (2015) Scan J Med Sci Sports.

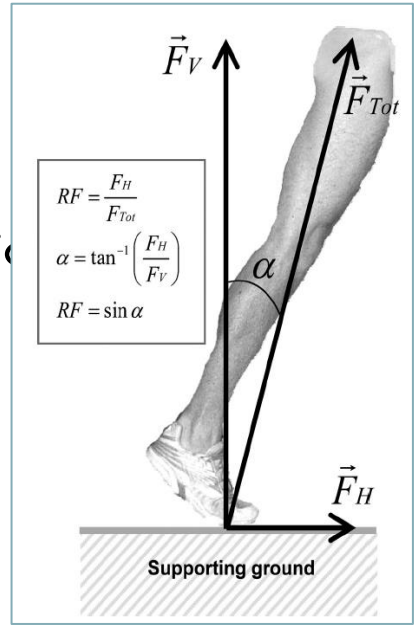
WHY: Determinants

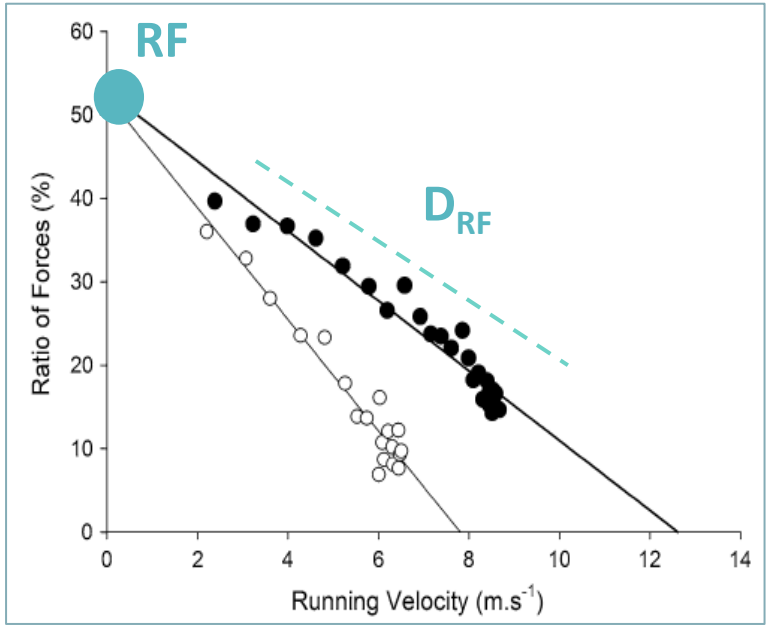
- Direction of force application



Ratio of force (RF) -> more horizontally orientated force application

D_{RF} -> more gradual shift to vertical force orientati





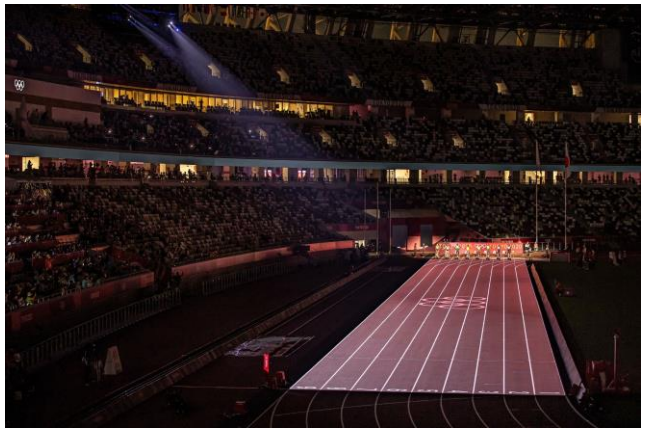
Morin, J-B., et al (2011) Med Sci Sport Exerc.
Morin, J-B., et al (2012) Eur J Appl Physiol.
Rabita, G., et al (2015) Scan J Med Sci Sports.

HOW:

Movement strategies

HOW: Strategy

- "…complex adaptive system with multiple interacting components"
- Movement patterns develop through interaction with constraints



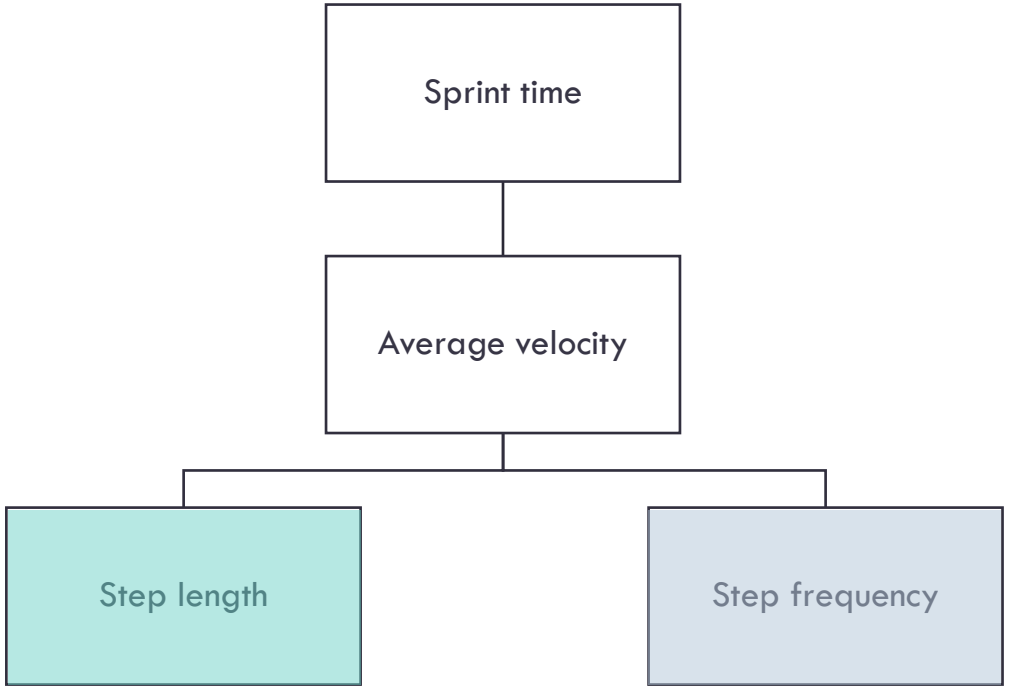
Davids, K., et al (2014) Complex Systems in Sport
Newell, K., et al (1986) Am Psych Assoc.

HOW: Strategy

Elite Sprinting: Are Athletes Individually Step-Frequency or Step-Length Reliant?

AKI I.T. SALO[1], IAN N. BEZODIS[2], ALAN M. BATTERHAM[3], and DAVID G. KERWIN[2]

[1]Sport and Exercise Science, University of Bath, Bath, UNITED KINGDOM; [2]Cardiff School of Sport, University of Wales Institute Cardiff, Cardiff, UNITED KINGDOM; and [3]Health and Social Care Institute, Teesside University, Middlesbrough, UNITED KINGDOM



DOES INCREASING SL OR SF HAVE A GREATER IMPACT ON 100 M PERFORMANCE?

HOW: Strategy

Elite Sprinting: Are Athletes Individually Step-Frequency or Step-Length Reliant?

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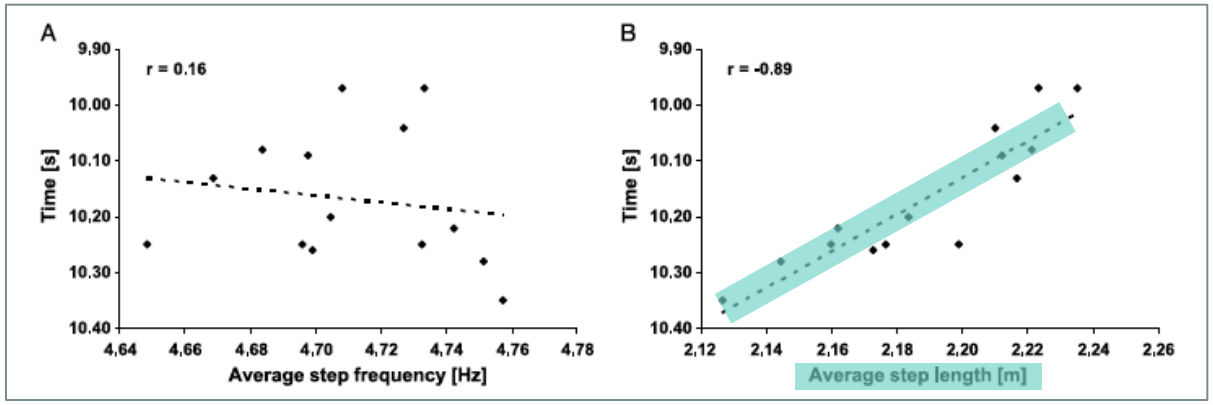
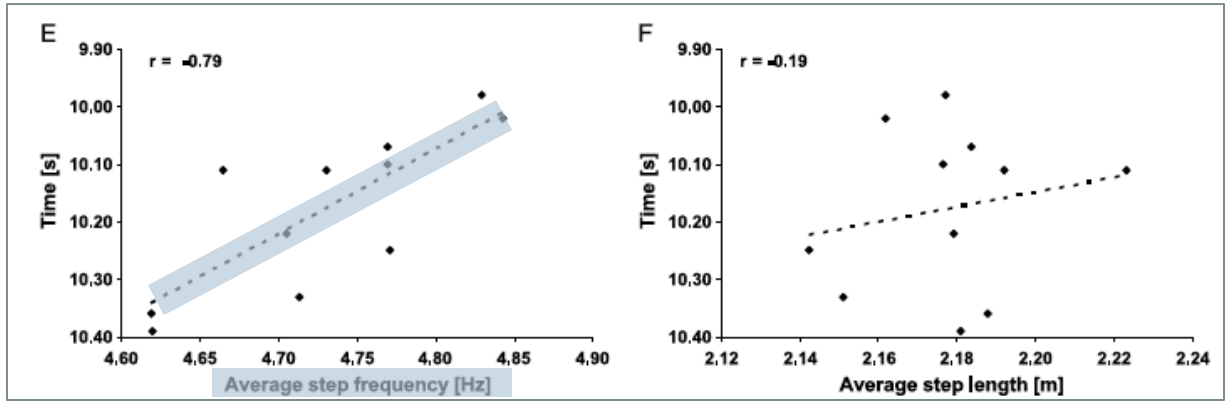
SF SL



SF SL



"step length reliant" Vs. "step frequency reliant"

greater force production capability

greater rate of force production and leg turnover

INDIVIDUAL ATHLETES VARY IN THEIR RELIANCE ON SF OR SL TO IMPROVE PERFORMANCE

HOW: Strategy

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Routledge Taylor & Francis Group
SPORTS MEDICINE AND BIOMECHANICS
OPEN ACCESS Check for updates

Characterising initial sprint acceleration strategies using a whole-body kinematics approach

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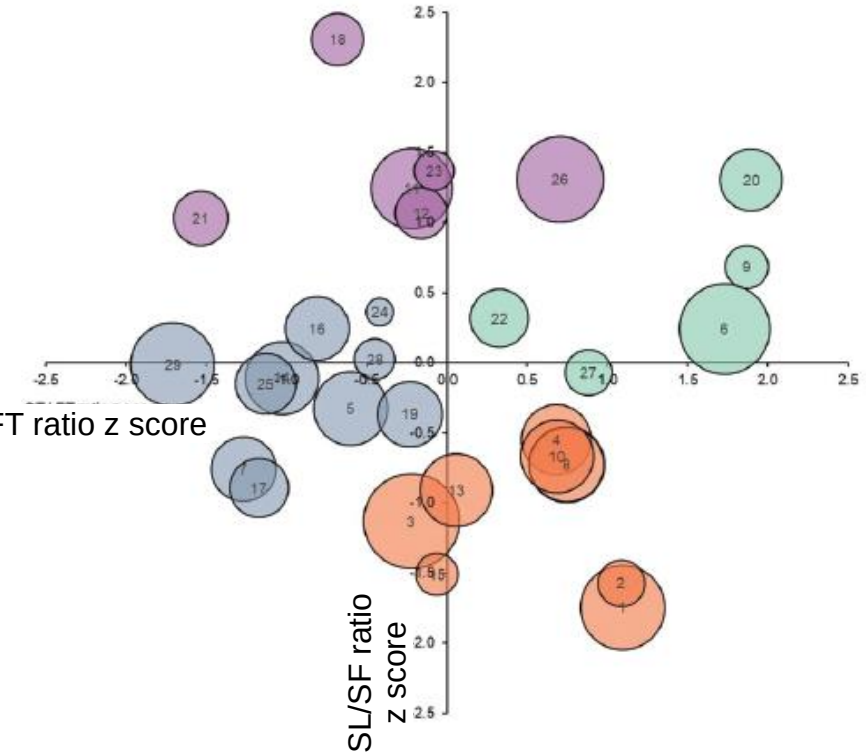
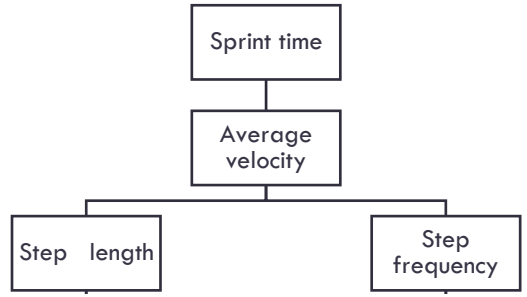
Greater step length
Lower step frequency



Higher flight time
Lower contact time

Higher contact time
Lower flight time

Higher step frequency
Shorter step length



NO DIFFERENCE IN ACCELERATION PERFORMANCE BETWEEN GROUPS!

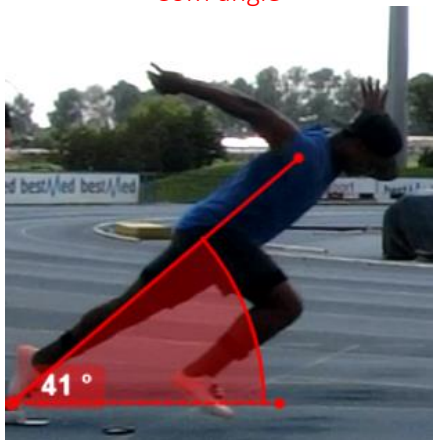
HOW: Strategy

↓ CoM angle

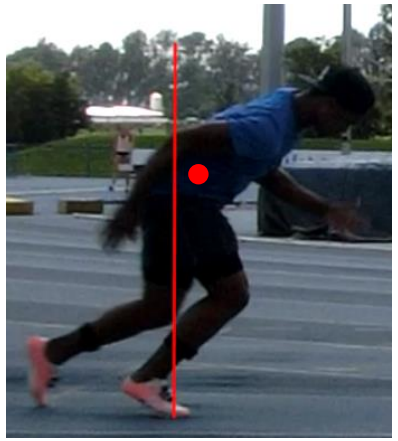
More → horizontal force vector

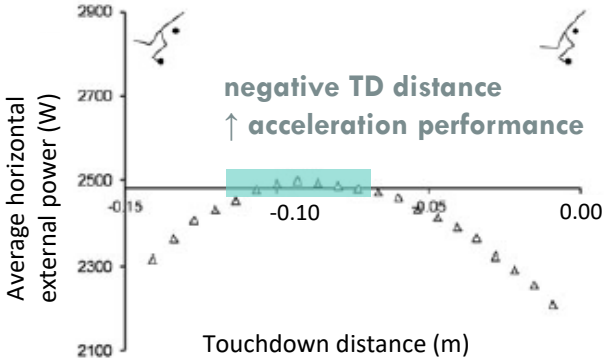
Faster athletes

CoM angle



Touchdown distance



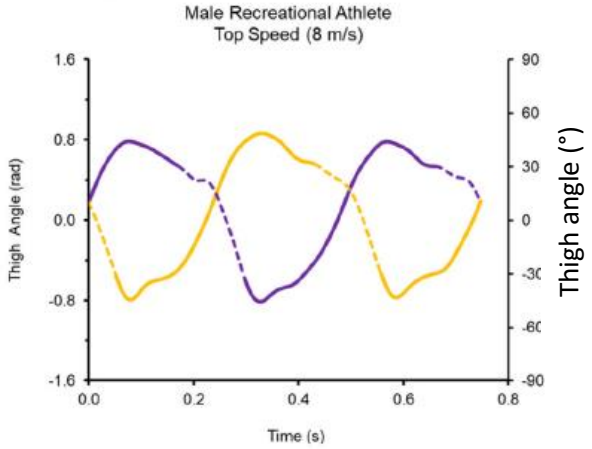


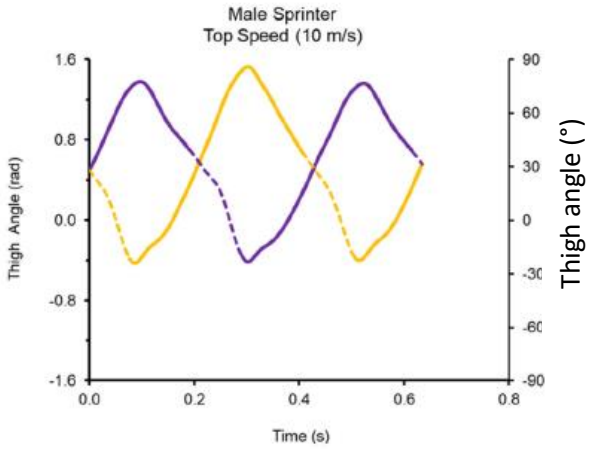
Kugler, F. & Janshen, L. (2015) J Biomech.
Bezodis, N., et al (2015) Sports Biomech.

HOW: Strategy

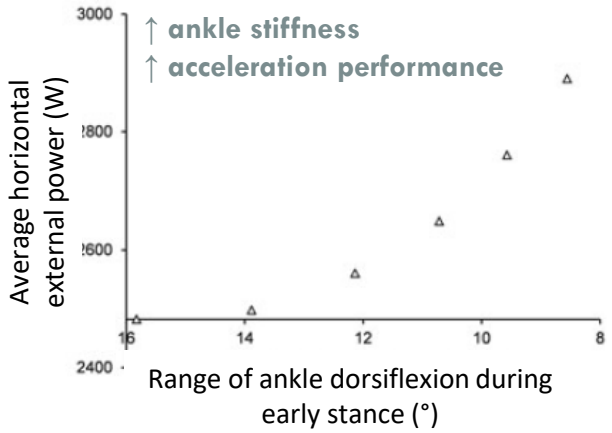
HOW: Strategy

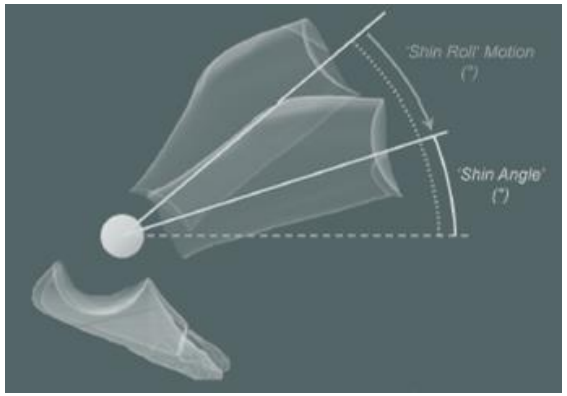
Thigh-Thigh





Shank-Foot





Clark, K., et al. (2020) Biol Open.
Bezodis, N., et al. (2015) Sports Biomech.
Alt, T., et al. (2022) Sports Biomech.

HOW: Strategy

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RESEARCH ARTICLE

Inter- and intra-limb coordination during initial sprint acceleration

Byron J. Donaldson[1], Neil E. Bezodis[2] and Helen Bayne[1,*]

@byrondon_

Thigh-Thigh

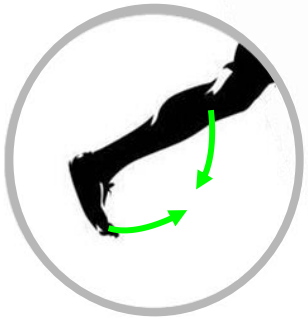
ANTI-PHASE

ANTI-PHASE

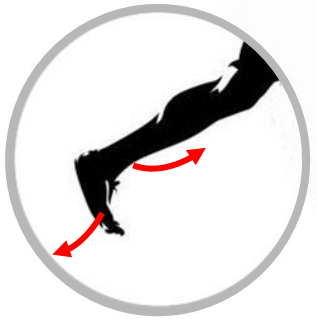
IN-PHASE

IN-PHASE

Shank-Foot

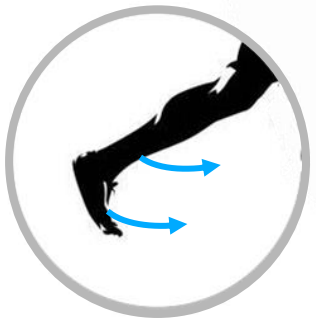


ANTI-PHASE



ANTI-PHASE

IN-PHASE



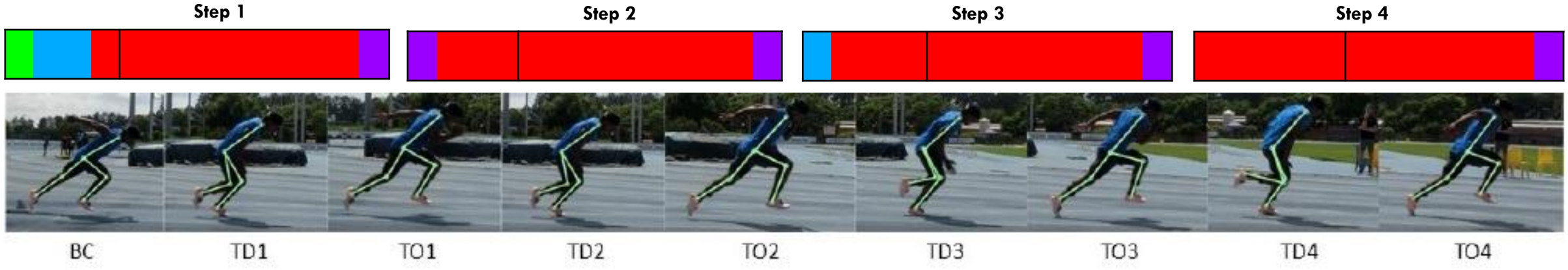
IN-PHASE

HOW: Strategy

21 sprinters

- 15 M [9.89 - 11.15 s]
- 6 F [11.46 - 12.14 s]

3 x max effort blocks starts during training session

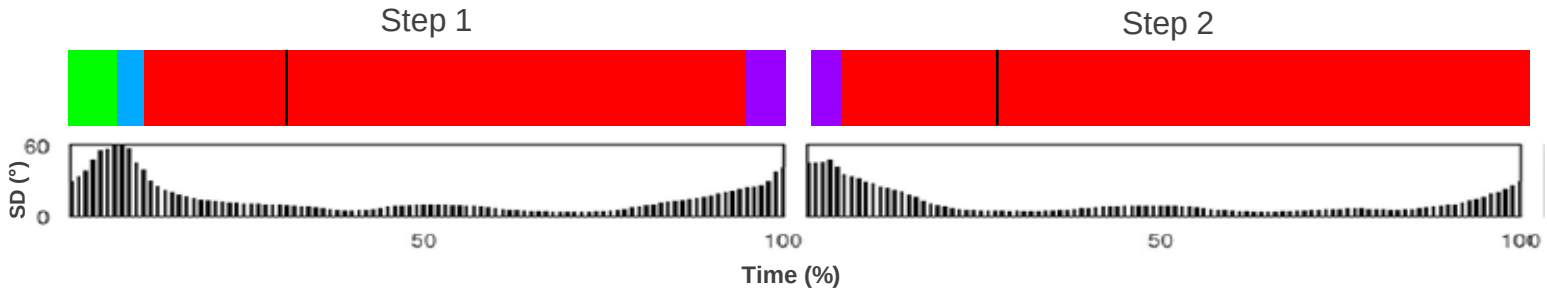


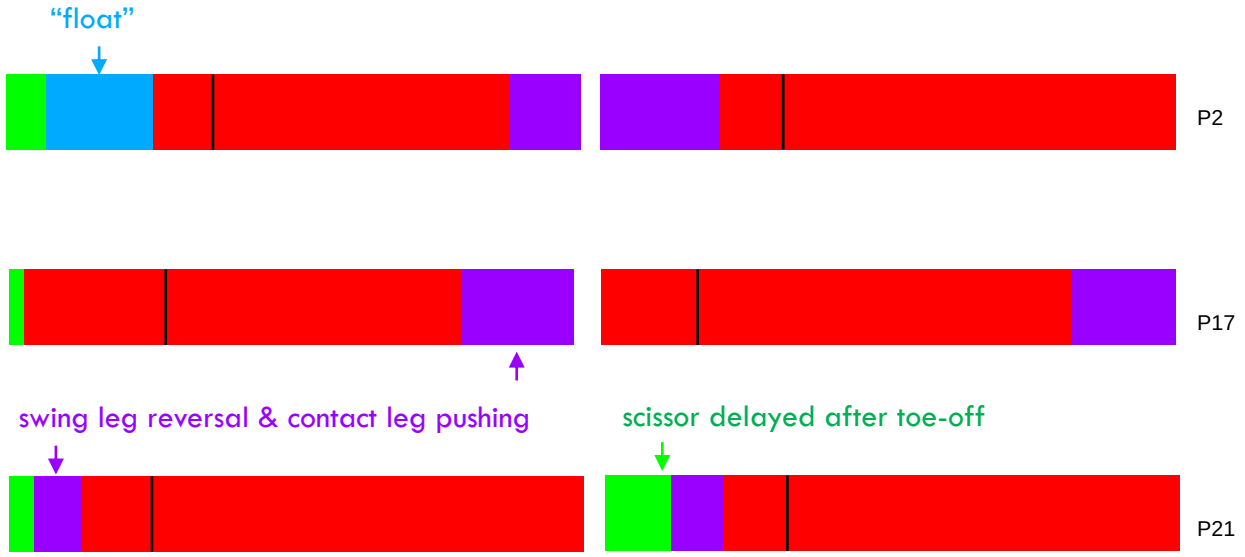
HOW: Strategy

Thigh-Thigh Coordination

Group mean:

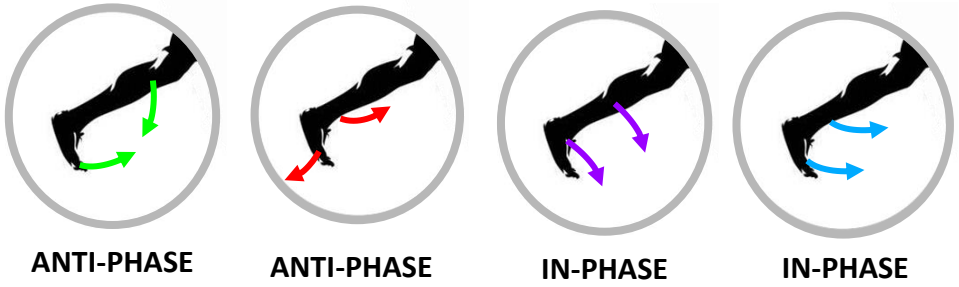
Between-athlete variation:





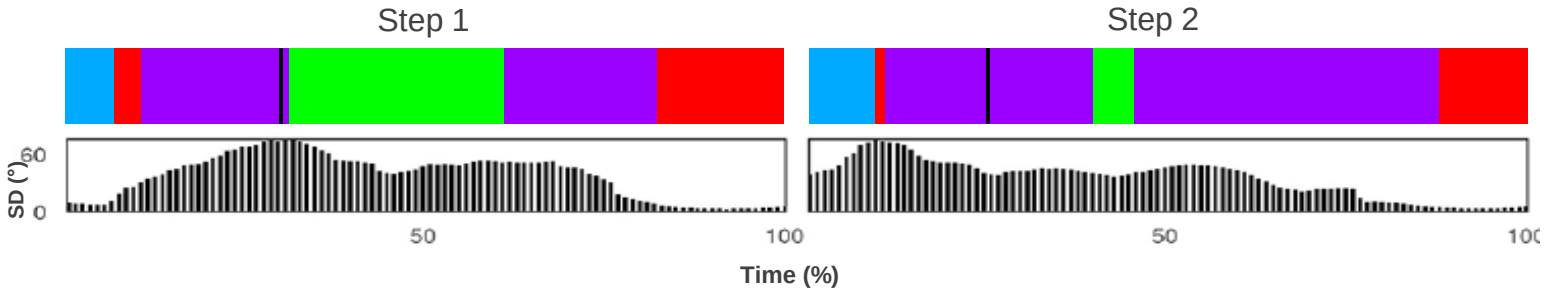
HOW: Strategy

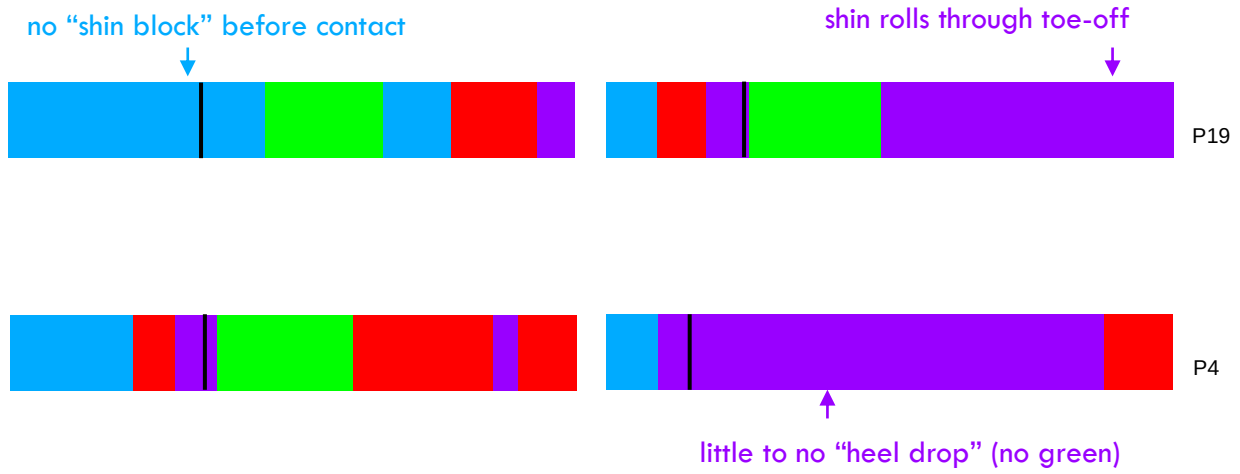
Shank-Foot Coordination



Group mean:

Between-athlete variation:





HOW: Strategy

Coordination analysis reveals subtle details about segment motion that is not apparent from traditional joint angle analysis

Primarily anti-phase with variation between athletes in the timing of thigh reversal around toe-off

Foot motion dominates late stance, but wide variation in how athletes prepare for and handle early stance period

Conclusion

Comprehensive set of measurements → objective support to coaching knowledge

WHAT: Clear performance indicator

WHY: Rules that govern the mechanical basis of performance

HOW: Numerous strategies exist - develop tailored interventions

Picture: Getty Images

Thank you for listening

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