THE UNIVERSITY OF QUEENSLAND
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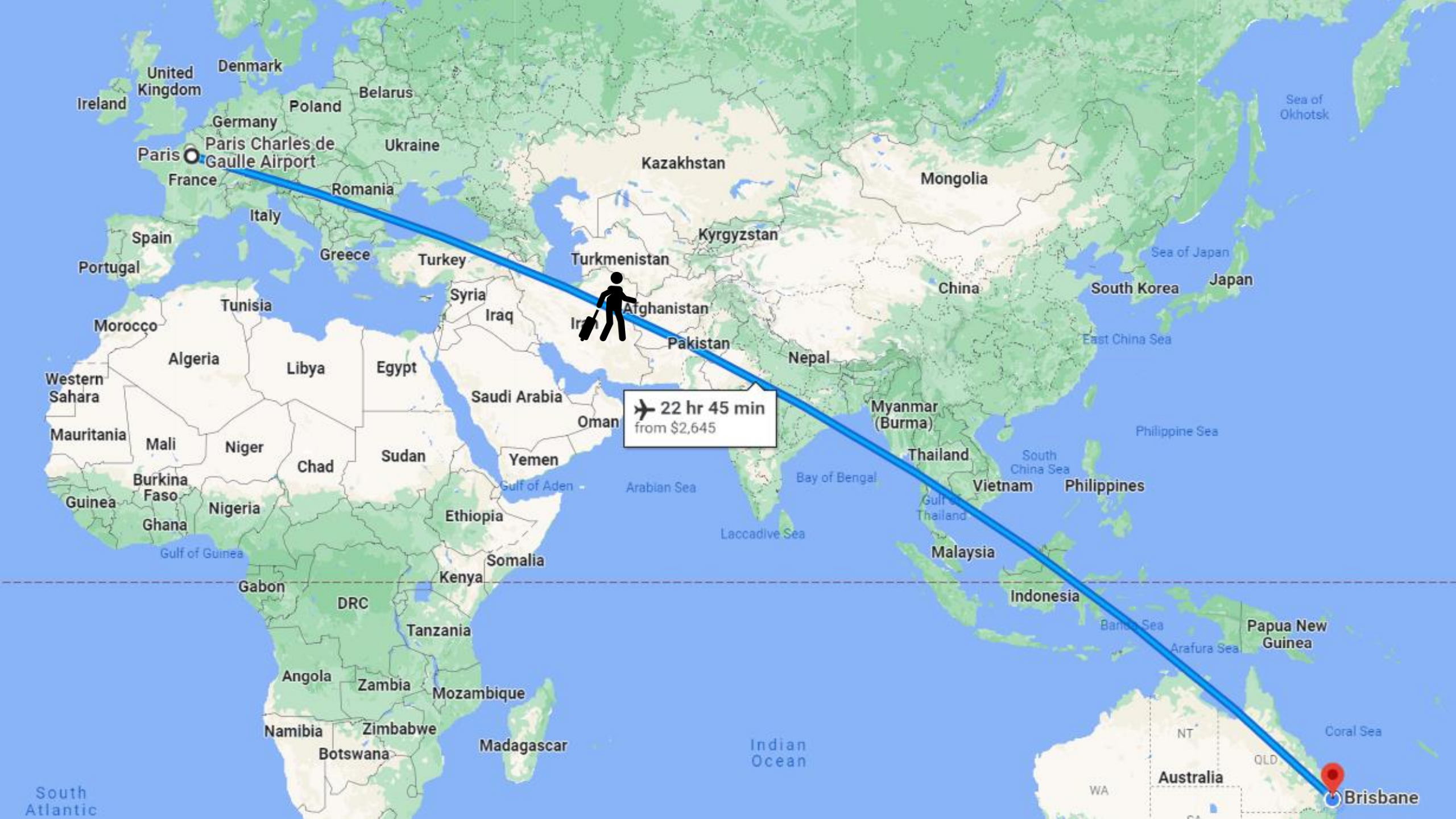
CREATE CHANGE

Eccentric Deceleration

Is this the Golden Ticket for ACL RTS battery?

Jacinta Carroll
PG Masters Sports Physiotherapy
jacinta.carroll@uqconnect.edu.au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Philippines
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Algeria
Libya
Egypt
Western Sahara
Saudi Arabia
Oman
Yemen
Mauritania
Mali
Niger
Chad
Sudan
Burkina Faso
Guinea
Nigeria
Ghana
Gulf of Aden
Arabian Sea
Bay of Bengal
Laccadive Sea
Gulf of Guinea
Ethiopia
Somalia
Kenya
Gabon
DRC
Tanzania
Angola
Zambia
Mozambique
Namibia
Zimbabwe
Botswana
Madagascar
Malaysia
Indonesia
Papua New Guinea
Arafura Sea
Coral Sea
Australia
NT
QLD
WA
Indian Ocean
South Atlantic

Current state of play

- 65% athletes return to pre-injury level sport
  (Adern et al 2014)
- 55% return to competitive level
  (Adern et al 2014)
- 20-30% experience secondary ACL within 2yrs
  (Grindem et al 2016, Risberg et al 2016 & Wiggens et al 2016)

(www-image 1, 01/10/2022)

Change of Direction (COD)

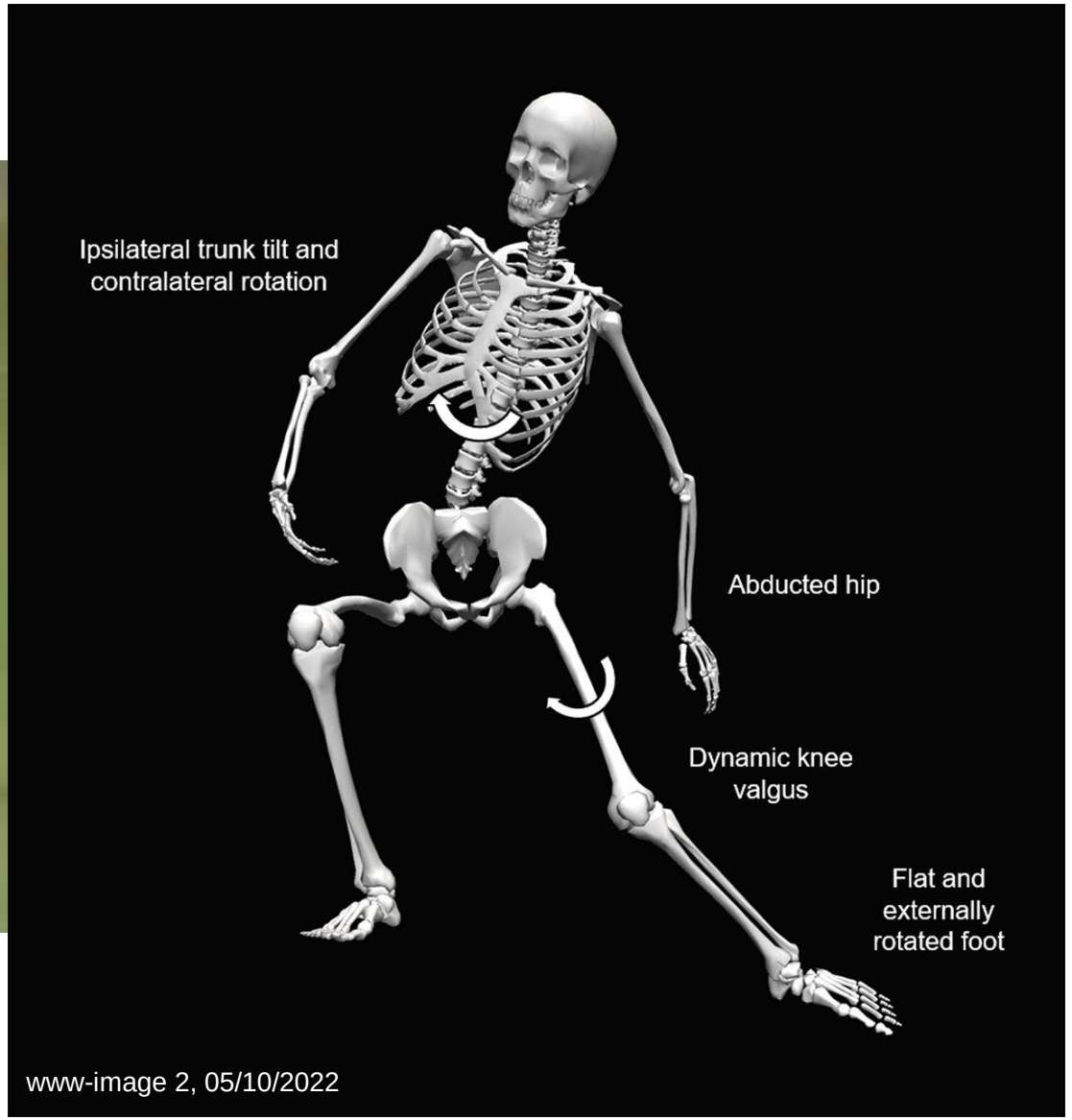
characterized as the

“skills and abilities needed to change movement direction, velocity, or modes”

(Brophy et al 2015)

Current state of play

Video 1



www-image 2, 05/10/2022

Key Components of COD

Image 3a

Acceleration in

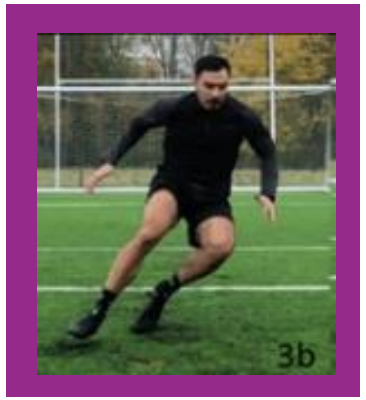


Image 3b

Deceleration

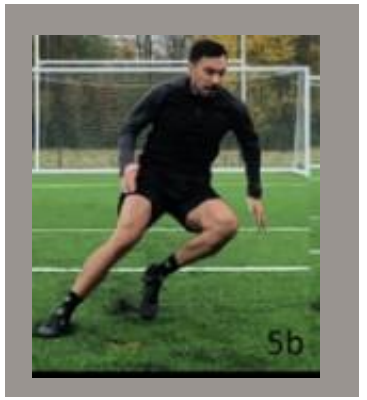


Image 3c

Turn

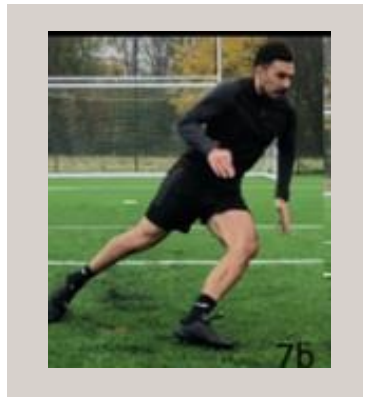


Image 3d

Acceleration out

(Grahanm-Smith et al 2018 & McBurnie et al 2022)

(www-Image 4, 19/10/2022)

Antepenultimate foot contact	Antepenultimate foot contact	Antepenultimate foot toe off	Penultimate foot contact	Penultimate contact	Final foot contact
Horizontal breaking force applied		Muscle Pre-activation	Horizontal breaking force applied	Foot in line with thigh	Reduces GRF through turning leg

(McBurnie et al 2022)

(www-Image 4, 19/10/2022)

What about if I don't decelerate

(McBurnie et al 2022)

(www-Image 4, 19/10/2022)

Penultimate foot contact

Penultimate foot contact

Final foot contact

Lack of deceleration

Lack of muscle pre-activation

Large amounts of breaking forces required with foot not aligned to the thigh

(McBurnie et al 2022, King et al 2019)

Video 2

Passing RTS criteria & re-rupture risk

Editorial

Keep calm and carry on testing: a substantive reanalysis and critique of 'what is the evidence for and validity of return-to-sport testing after anterior cruciate ligament reconstruction surgery? A systematic review and meta-analysis' FREE

Jacob John Capin [1], Lynn Snyder-Mackler [2], May Arna Risberg [3, 4], Hege Grindem [3, 5, 6]
Correspondence to Dr Lynn Snyder-Mackler; smack@udel.edu

Passing RTS criteria =
↓ Graft re-rupture odds by 78%
No conclusion on contralateral risk

SYSTEMATIC REVIEW

What is the Evidence for and Validity of Return-to-Sport Testing after Anterior Cruciate Ligament Reconstruction Surgery? A Systematic Review and Meta-Analysis

Kate E. Webster[1] · Timothy E. Hewett[2,3,4,5]

Passing RTS criteria =
↓ graft re-rupture by 60%
↑ Contralateral rupture risk by 235%

RTS criteria

Practitioners knowledge of the health of the athletes body part → Health of the athletes knee

The stress the injured tissue needs to be able to withstand → COD mechanics

Context of sports participation → Amount of COD required

Review

Which criteria are used to clear patients to return to sport after primary ACL reconstruction? A scoping review

Ciara R Burgi,[1] Scott Peters,[2] Clare L Ardern,[3,4] John R Magill,[1] Christina D Gomez,[5] Jonathan Sylvain,[6] Michael P Reiman[7]

Field based assessments

- Shuttle runs, carioca, 505 test & T-tests
- ✓ Easy to administer
- Time based
- ✗ Do not reflect relevant sporting demands
- ✗ Unable to effectively assess knee function

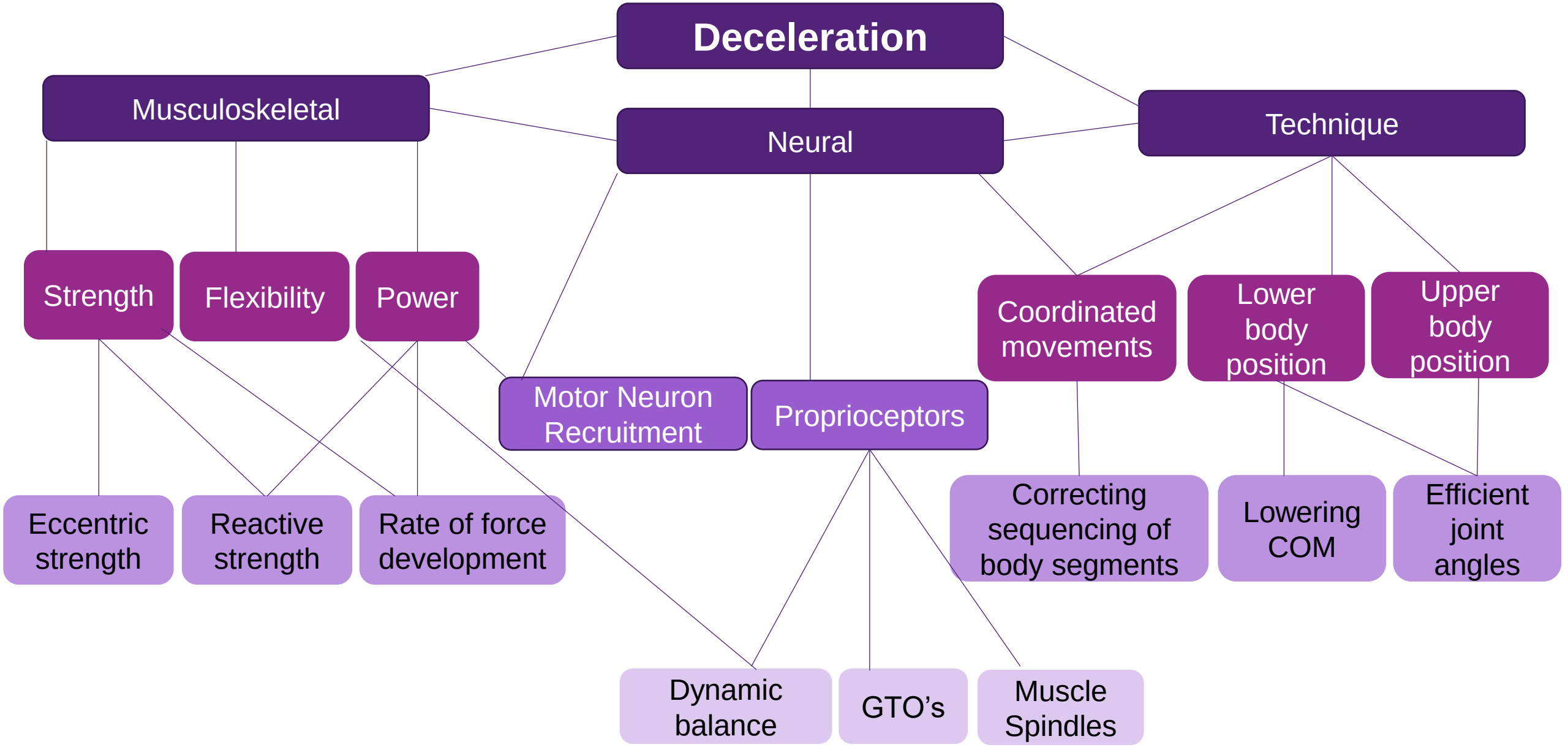
Lab based assessments

- 3D motion capture or Tri-axial force plates
- ✓ Have the ability to identify residual deficits in knee function & altered movement strategies
- ✗ Often not practically viable to monitor progress during rehab

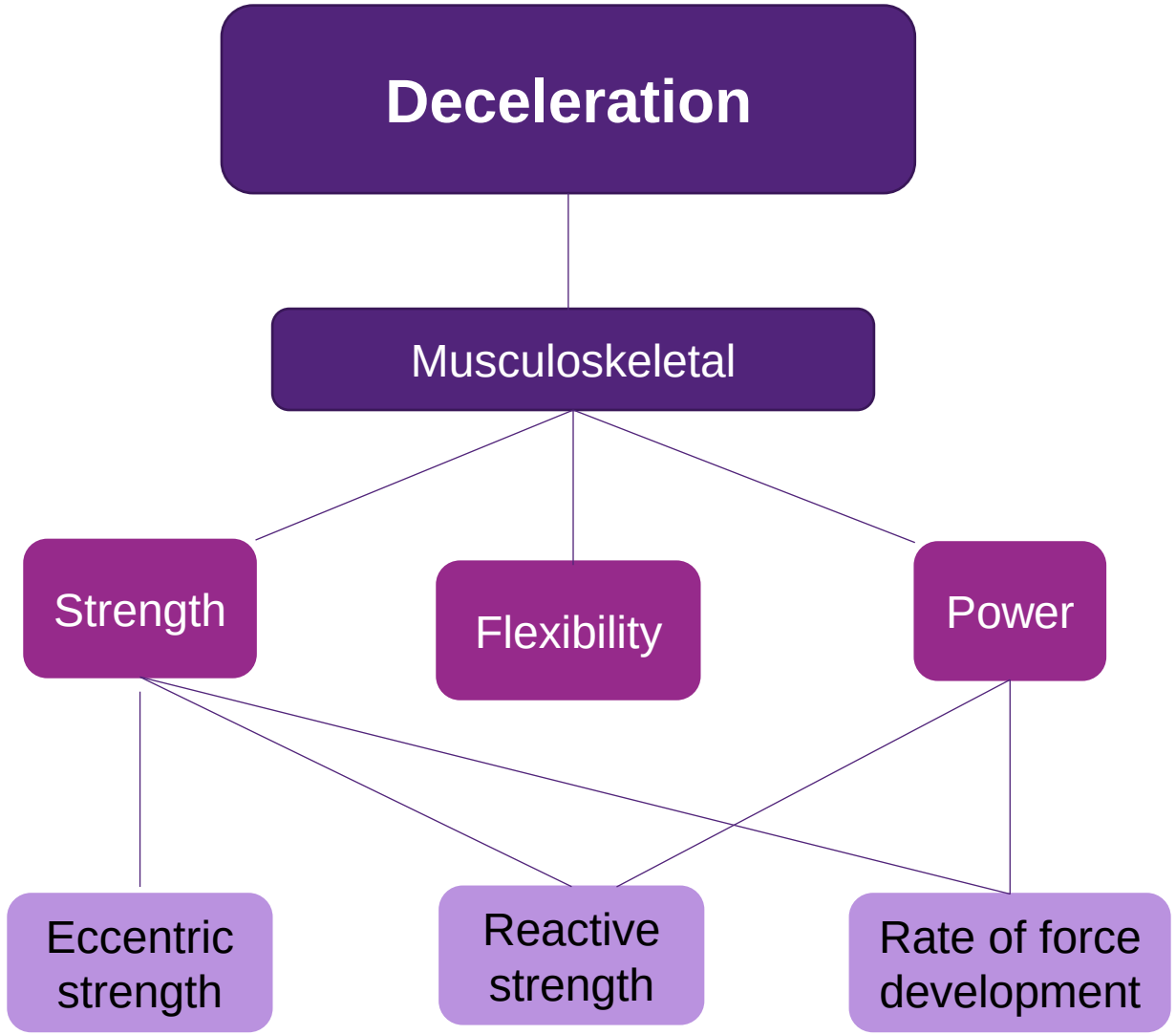
(Marques et al 2020)

What are the components of eccentric deceleration that contribute to effective COD ability

Can we measure them effectively?



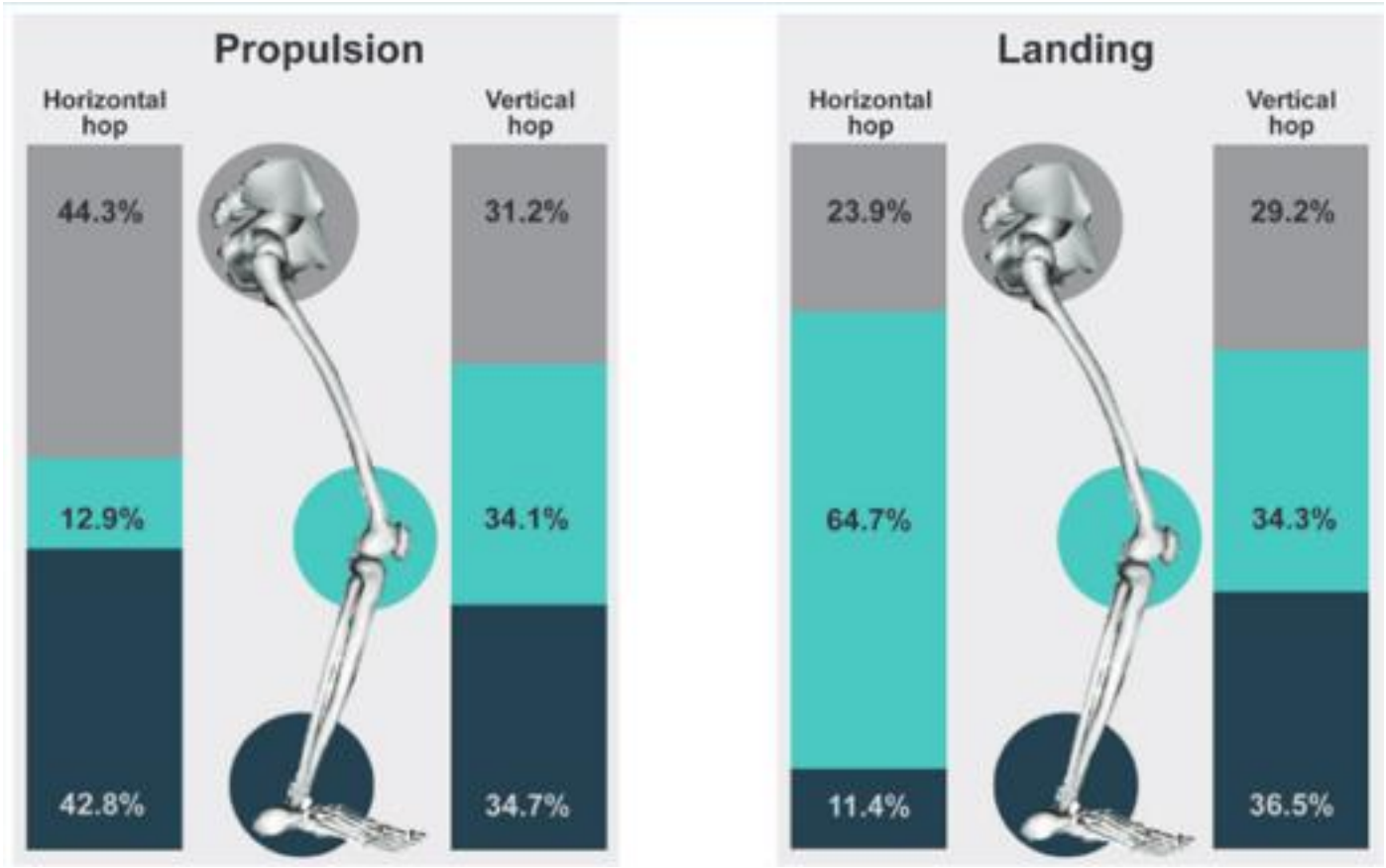
(Adapted from Kovacs et al 2008)

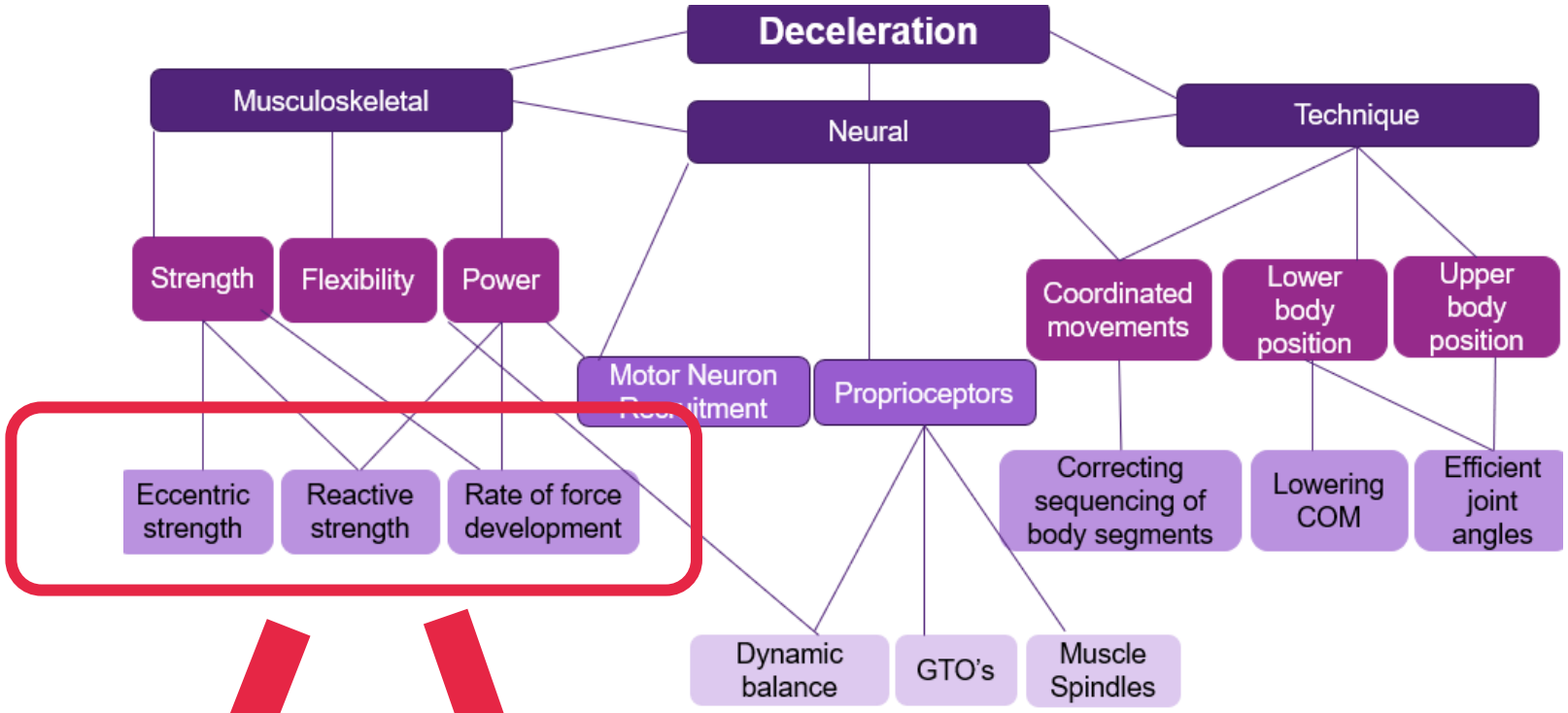


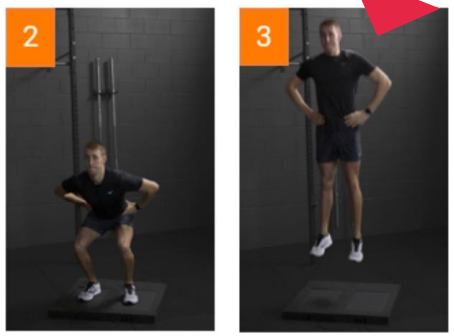
(Adapted from Kovacs et al 2008)

Vertical and Horizontal Hop Performance: Contributions of the Hip, Knee, and Ankle

Argyro Kotsifaki, PT, MSc,*† Vasileios Korakakis, PT, PhD,† Philip Graham-Smith, PhD,‡ Vasileios Sideris, MSc,† and Rod Whiteley, PT, PhD†







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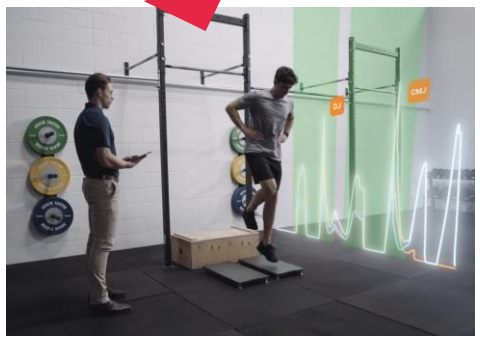


(www-Image 6, 20/10/2022)

(Adapted from Kovacs et al 2008)

Article - Knee

Lower Limb Kinetic Asymmetries in Professional Soccer Players With and Without Anterior Cruciate Ligament Reconstruction: Nine Months Is Not Enough Time to Restore "Functional" Symmetry or Return to Performance

Paul J. Read, PhD[†,‡,*], Sean Michael Auliffe, PhD[§], Mathew G. Wilson, PhD[‖,¶], and Philip Graham-Smith, PhD[#]

- CMJ protocol
- Residual deficits in eccentric loading capacity of involved limb > 9months
- Greatest asymmetry in eccentric deceleration RFD*
- "Our data suggest the presence of residual deficits in the eccentric loading capacity of the involved ACL limb"

Eccentric deceleration Impulse asymmetry	Q1	Q2	Q3	Q4
<6 months	<4.8	4.9-10.3	10.4-13.2	>13.3
6-9months	<5.6	5.7-9.5	9.6-12.9	>13.0
>9 months	<3.5	3.6-8.6	8.7 – 12.2	>12.4
Healthy Controls	<2.6	2.7-4.8	4.9-8.4	>8.5
Eccentric deceleration RFD asymmetry				
< 6months	<8.7	8.8-12.7	12.8-28.1	>28.2
6-9 months	<6	6.1-13.2	13.3-21.4	>21.5
> 9 months	<5.9	6.012.8	12.9-21.0	>21.1
Healthy Controls	<3.0	3.1-7.2	7.3-11.8	>11.9

ORIGINAL ARTICLE

WILEY

Previous injury is associated with heightened countermovement jump force-time asymmetries in professional soccer players

Luke M. Hart[1,2] | Daniel D Cohen[3] | Stephen D. Patterson[1] | Matt Springham[1] | James Reynolds[4] | Paul Read[5,6,7]

- Previous “severe” lower limb injury in previous 12months
- CMJ analysis
- Despite no difference in bilateral PERFORMANCE variables (jump height and peak power), significant interlimb differences were present
- Eccentric Deceleration RFD 20.52% between limb asymmetry.

Eccentric deceleration RFD	Previously injured	20.52 ± 10.64[a]	15.06-25.99	1.05
	Uninjured	10.52 ± 8.24	6.28-12.87	
Eccentric deceleration impulse	Previously injured	12.60 ± 8.59	8.18-17.01	0.33
	Uninjured	9.66 ± 6.24	6.45-12.87	
Eccentric peak force	Previously injured	11.98 ± 7.51[a]	8.11-15.84	0.73
	Uninjured	7.38 ± 4.81	4.91-9.85	
Force at zero velocity	Previously injured	11.93 ± 7.45[a]	8.10-15.76	0.73
	Uninjured	7.34 ± 4.89	4.82-9.86	

*Significant difference ($p < 0.05$)

sports

MDPI

Article

Can Countermovement Jump Neuromuscular Performance Qualities Differentiate Maximal Horizontal Deceleration Ability in Team Sport Athletes?

Damian J. Harper [1,*], Daniel D. Cohen [2,3], Christopher Carling [4] and John Kiely [1]

- CMJ
- Split participants into low and high deceleration ability groups
- Concentric and eccentric peak force were the variables with the largest difference between groups
- The high deceleration ability group showed a moderate effect size difference in eccentric-deceleration RFD .

Table 3. Countermovement jump (CMJ) neuromuscular performance qualities that differentiate between athletes with a high and low horizontal deceleration (HDEC).

Variable	High HDEC (n = 13)	Low HDEC (n = 14)	ES (90% CI)	CL-ES	Descriptor	*p*-Value
Concentric						
Peak Force (N·kg^{-1})	25.87 ± 2.42	23.53 ± 2.50	0.95 (0.71, 1.20)	75%	Large	0.02 *
Mean Force (N·kg^{-1})	20.87 ± 1.27	19.86 ± 1.39	0.91 (0.67, 1.14)	74%	Large	0.03 *
Peak Power (W·kg^{-1})	51.81 ± 7.17	46.98 ± 5.68	0.75 (0.54, 0.95)	70%	Moderate	0.06
Mean Power (W·kg^{-1})	28.72 ± 2.84	25.92 ± 3.66	0.85 (0.62, 1.08)	73%	Large	0.04 *
Impulse (N·s·kg^{-1})	2.57 ± 0.27	2.44 ± 0.24	0.51 (0.34, 0.68)	64%	Moderate	0.20
Peak Velocity (m·s^{-1})	2.71 ± 0.25	2.58 ± 0.21	0.57 (0.39, 0.75)	65%	Moderate	0.15
Duration (ms)	249 ± 39	271 ± 39	−0.56 (−0.39, −0.73)	66%	Moderate	0.16
Eccentric						
Peak Force (N·kg^{-1})	24.66 ± 2.42	22.89 ± 2.47	0.72 (0.52, 0.92)	70%	Moderate	0.07
Peak Power (W·kg^{-1})	17.47 ± 3.82	16.38 ± 4.86	0.25 (0.12, 0.38)	57%	Small	0.53
Mean Power (W·kg^{-1})	6.35 ± 1.10	6.17 ± 1.16	0.16 (0.03, 0.29)	54%	Trivial	0.68
Peak Velocity (m·s^{-1})	−1.22 ± −0.21	−1.18 ± 0.24	−0.18 (−0.31, −0.05)	55%	Trivial	0.65
Duration (ms)	485 ± 58	514 ± 88	−0.39 (−0.24, −0.54)	61%	Small	0.33
Eccentric Deceleration						
Mean Force (N·kg^{-1})	18.10 ± 1.41	17.30 ± 2.10	0.44 (0.28, 0.60)	62%	Small	0.26
Impulse (N·s·kg^{-1})	2.88 ± 0.48	2.90 ± 0.44	−0.04 (−0.16, 0.08)	51%	Trivial	0.91
RFD (N·s^{-1}·kg^{-1})	98.7 ± 34.4	81.3 ± 25.4	0.58 (0.40 to 0.76)	66%	Moderate	0.15
Duration (ms)	160 ± 30	170 ± 30	−0.33 (−0.19, −0.47)	59%	Small	0.40
Other						
CMJ Height (cm)	35.7 ± 7.8	31.5 ± 6.3	0.59 (0.41, 0.77)	66%	Moderate	0.14
CMJ Depth (cm)	31.7 ± 7.9	32.4 ± 6.7	0.11 (−0.02, 0.23)	53%	Trivial	0.94
RSI-Mod (m·s^{-1})	0.45 ± 0.11	0.42 ± 0.09	0.27 (0.13, 0.40)	58%	Small	0.44

ES—Effect Size (Cohen's d_s); CL—Common Language; CI—Confidence Interval; RFD—Rate of Force Development; RSI-Mod—Reactive Strength Index Modified. * $p < 0.05$.

Drop jump neuromuscular performance qualities associated with maximal horizontal deceleration ability in team sport athletes

Damian J. Harper, Daniel D. Cohen, David Rhodes, Christopher Carling & John Kiely

(www-Image 7, 20/10/2022)

Concentric mean force demonstrated the largest effect size differences between the high and low ability groups

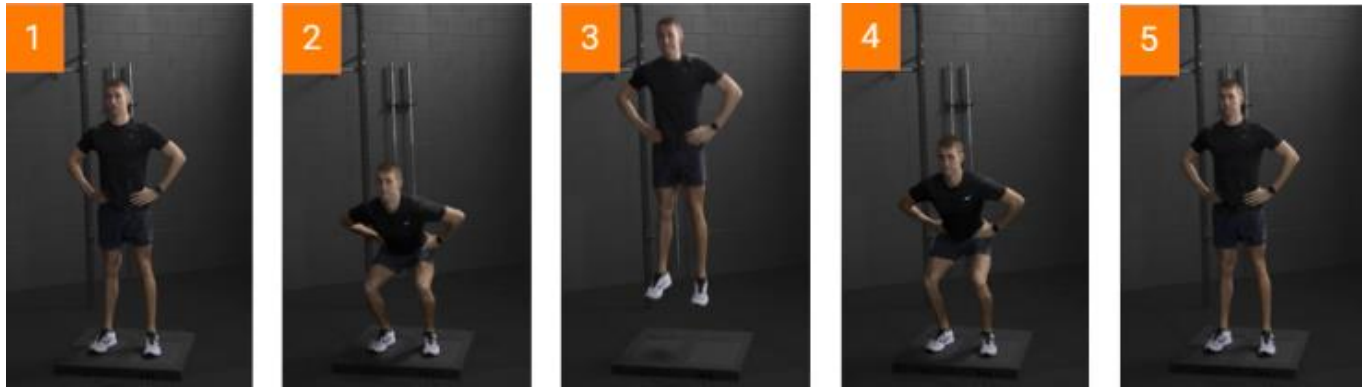
DJ eccentric mean force had larger differences between the high versus low ability groups at 40cm compared to 20cm drop heights

- Players with > drop jump RSI demonstrated superior horizontal deceleration ability

Higher box heights → generate higher eccentric braking forces

Types of Assessment

CMJ



(www-Image 8, 24/10/2022)

Drop jump

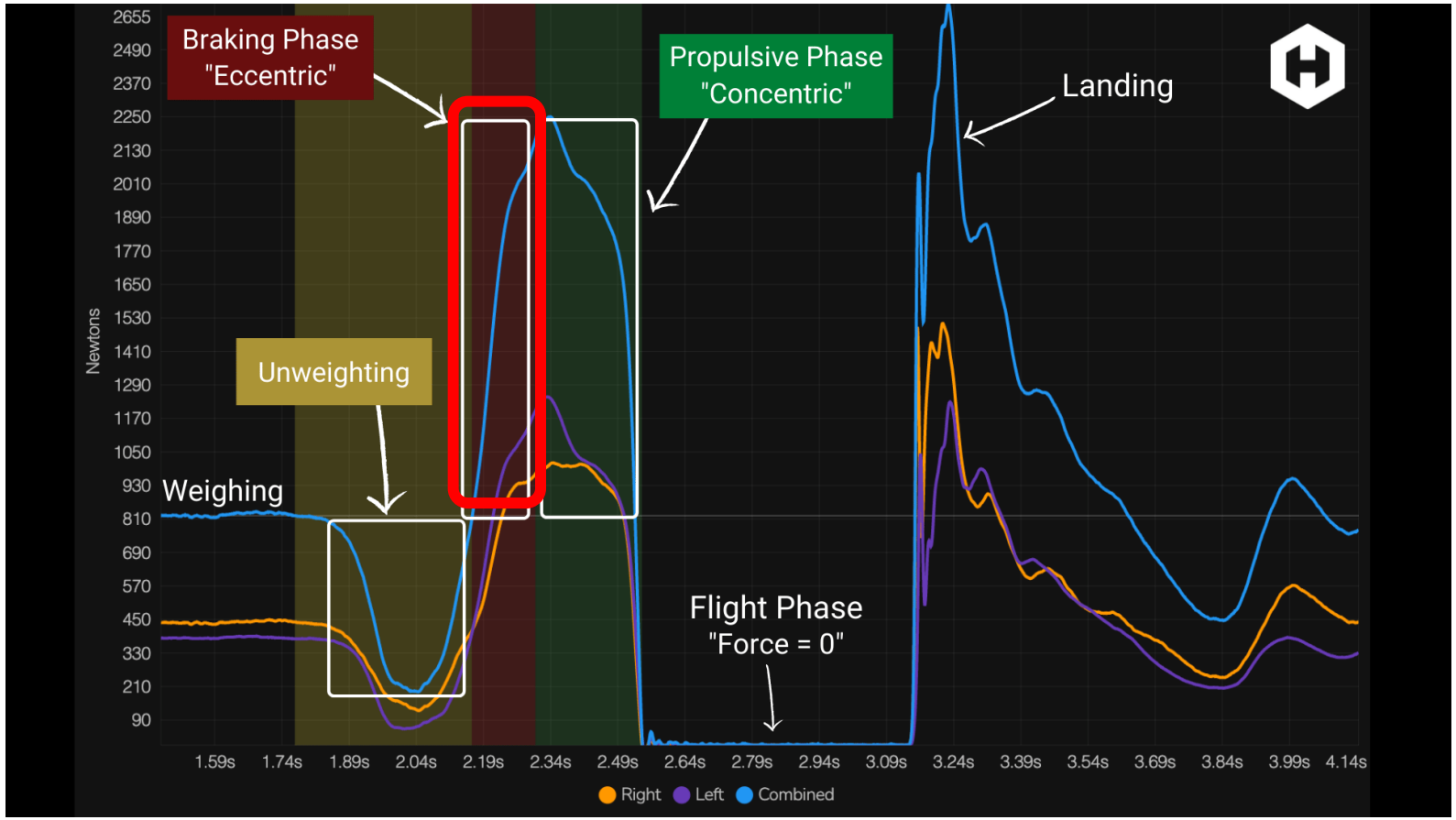
(www-Image 7, 20/10/2022)

CMJ - Metrics to look at

- Eccentric deceleration impulse >9months post ACLR
  (Read et al 2020)

- Eccentric deceleration RFD
  (Hart et al 2019, Read et al 2021, Harper et al 2020)

- Eccentric and Concentric peak force
  (Harper et al 2020)



(www-Image 9, 25/10/2022)

Drop Jump - Metrics to look at

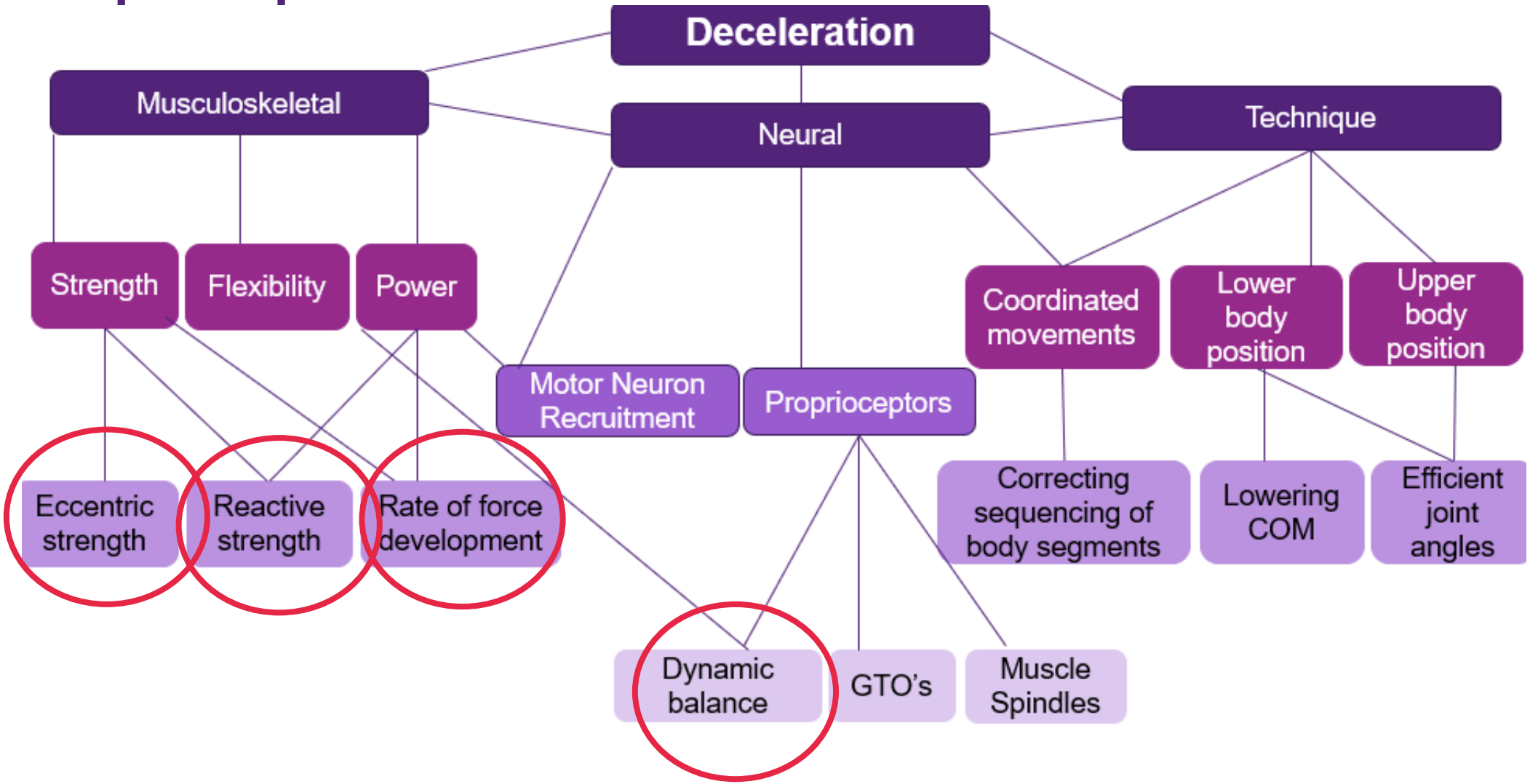
(Harper et al 2022)

Concentric mean force

Eccentric mean force

RSI

Drop Jump - Metrics to look at



Limitations

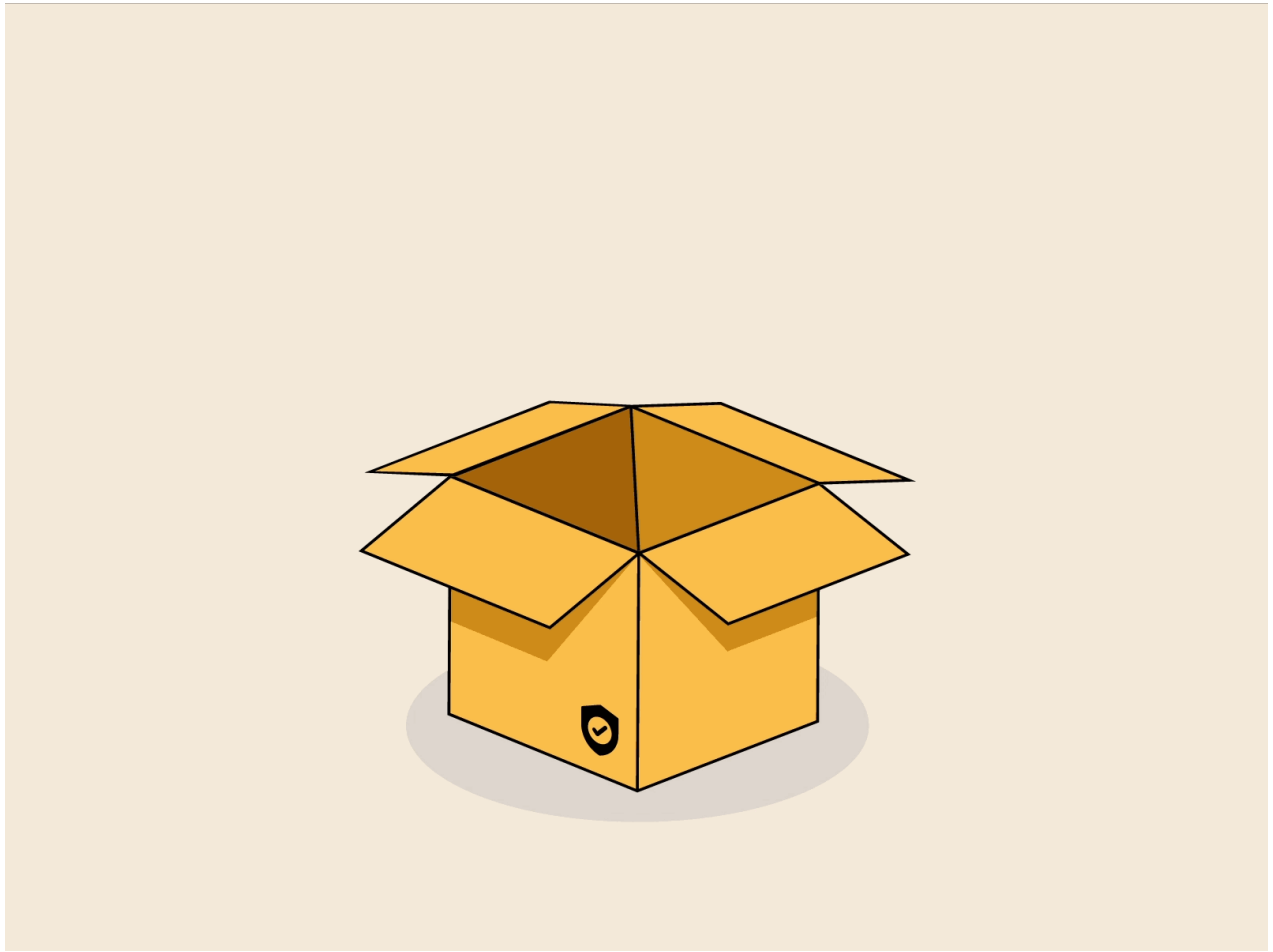
(www-Image 10, 27/10/2022)

- **Cross sectional studies**
- **Commercially available force plates only measure vertical GRF.**
- **Using vertical GRFs as a surrogate**
- **Uni-dimensional index to characterise a multi-dimensional task**

Take homes:

- Our current RTS testing in the literature is yet to successfully reduce the risk of subsequent ACL injuries
- COD is a mechanism of non-contact ACL rupture yet is often no included in RTS criteria
- Vertical jump testing measures neuromuscular characteristics that are associated with deceleration ability.
- Deceleration is more important in the penultimate foot placement

Questions?



Video 3

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References images:

Image 1 Image: AFL player lying on field, Adapted from Mental Toughness Mental Fortitude, by D. Menzel, retrieved from https://www.mtmf.com.au/bio

Image 2: Della Villa, F., Buckthorpe, M., Grassi, A., Nabiuzzi, A., Tosarelli, F., Zaffagnini, S., & Della Villa, S. (2020). Systematic video analysis of ACL injuries in professional male football (soccer): injury mechanisms, situational patterns and biomechanics study on 134 consecutive cases. *Br J Sports Med, 54*(23), 1423-1432. doi:10.1136/bjsports-2019-101247

Image 3a-d: Change of direction phases, Adapted from "Multidirectional speed in team sports by science of multi-directional speed 2020. Retrieved from: https://sciofmultispeed.com/mds-team-sports/

Image 4: Change of direction phases, Adapted from "Multidirectional speed in team sports by science of multi-directional speed 2020. Retrieved from: https://sciofmultispeed.com/mds-team-sports/

Image 5: Counter movement jump adapted from Vald Support by Vald performance 2021. Retrieved from, https://support.vald.com/hc/en-au/articles/4999781545881-ForceDecks-Test-Countermovement-Jump-Overview

Image 6: Single leg vertical jump. Adapted from, The biggest innovation in force plate technology since the launch of ForceDecks by Allied Magazine 2021. Retrieved from: https://alliedmagazine.com/the-biggest-innovation-in-force-plate-technology-since-the-launch-of-forcedecks/

Image 7: Drop Jump adapted from Vald Support by Vald performance 2021. Retrieved from: https://support.vald.com/hc/en-au/articles/4999765154713-ForceDecks-Test-Drop-Jump-Overview

Image 8: Counter movement jump adapted from Vald Support by Vald performance 2021. Retrieved from, https://support.vald.com/hc/en-au/articles/4999781545881-ForceDecks-Test-Countermovement-Jump-Overview

Image 9: Force trace adapted from "difference between countermovement jump and squat jump" by Drake Berberet 2019. Retrieved from: https://www.hawkindynamics.com/blog/countermovement-jump-or-squat-jump

Image 10: Person and question mark adapted from "How to be Stoic" by Massimo Pigliucci 2018. Retrieved from: https://howtobeastoic.wordpress.com/

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