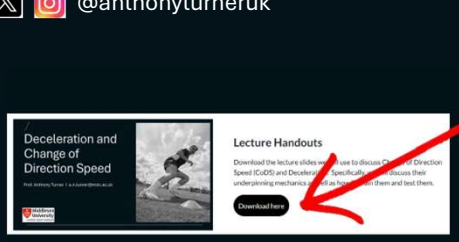
Deceleration and Change of Direction Speed

Prof. Anthony Turner I a.n.turner@mdx.ac.uk

https://thefitnessformula.training/workshop-resources

@anthonyturneruk



THE FITNESS FORMULA

1

Presentation outline

1. Underpinning mechanics
2. How to Train it
3. How to TEST it

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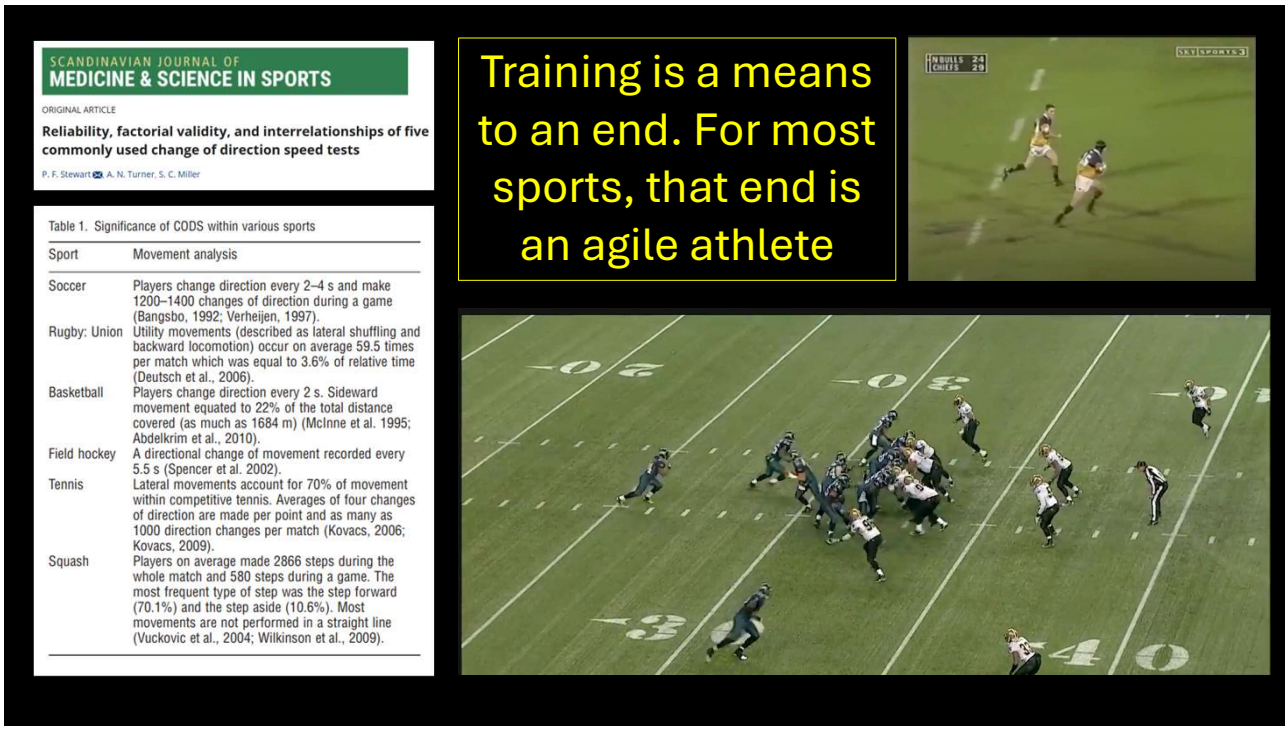
SCANDINAVIAN JOURNAL OF
MEDICINE & SCIENCE IN SPORTS
ORIGINAL ARTICLE
Reliability, factorial validity, and interrelationships of five commonly used change of direction speed tests
P. F. Stewart ✉ A. N. Turner, S. C. Miller
Table 1. Significance of CODS within various sports
Sport | Movement analysis
Soccer | Players change direction every 2–4 s and make 1200–1400 changes of direction during a game (Bangsbo, 1992; Verheijen, 1997).
Rugby: Union | Utility movements (described as lateral shuffling and backward locomotion) occur on average 59.5 times per match which was equal to 3.6% of relative time (Deutsch et al., 2006).
Basketball | Players change direction every 2 s. Sideward movement equated to 22% of the total distance covered (as much as 1684 m) (McInne et al. 1995; Abdelkrim et al., 2010).
Field hockey | A directional change of movement recorded every 5.5 s (Spencer et al. 2002).
Tennis | Lateral movements account for 70% of movement within competitive tennis. Averages of four changes of direction are made per point and as many as 1000 direction changes per match (Kovacs, 2006; Kovacs, 2009).
Squash | Players on average made 2866 steps during the whole match and 580 steps during a game. The most frequent type of step was the step forward (70.1%) and the step aside (10.6%). Most movements are not performed in a straight line (Vuckovic et al., 2004; Wilkinson et al., 2009).
Training is a means to an end. For most sports, that end is an agile athlete

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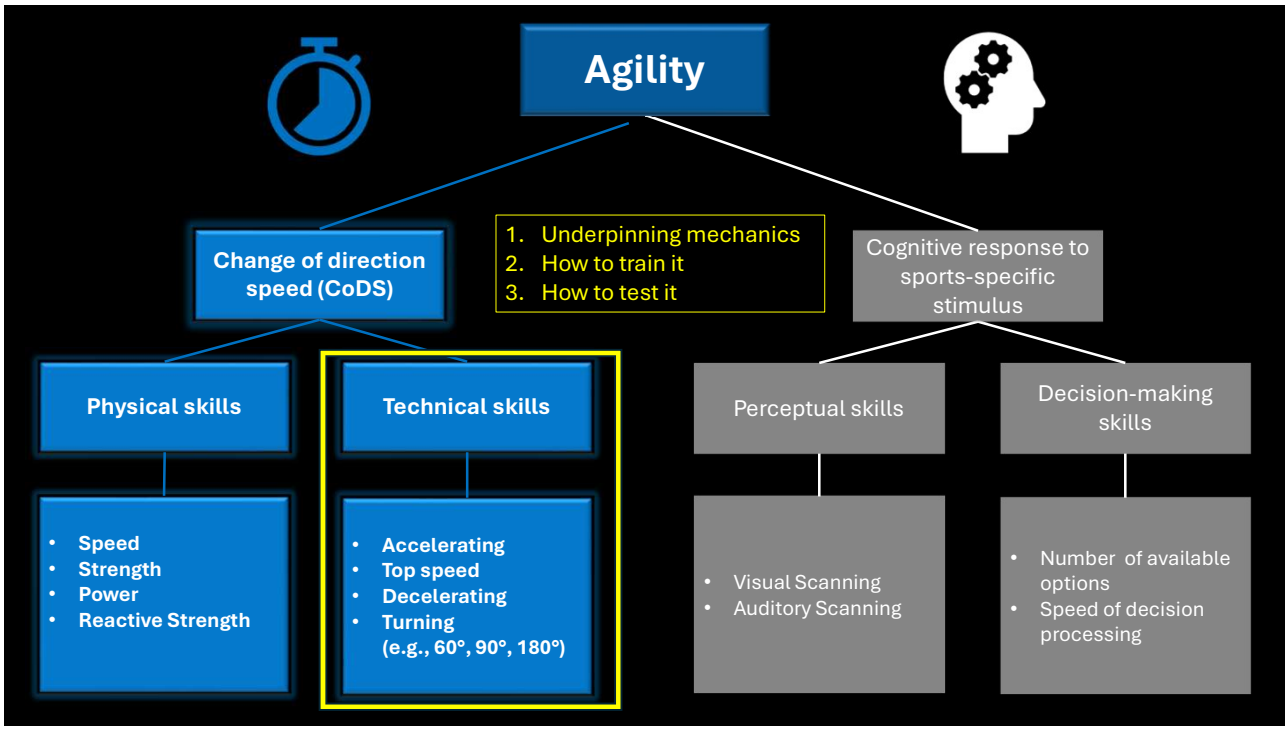
Agility
Change of direction speed (CoDS)
1. Underpinning mechanics
2. How to train it
3. How to test it
Cognitive response to sports-specific stimulus
Physical skills
Technical skills
Perceptual skills
Decision-making skills
• Speed
• Strength
• Power
• Reactive Strength
• Accelerating
• Top speed
• Deceleration
• Turning (e.g., 60°, 90°, 180°)
• Visual Scanning
• Auditory Scanning
• Number of available options
• Speed of decision processing

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Underpinning CoDS is Deceleration and reAcceleration

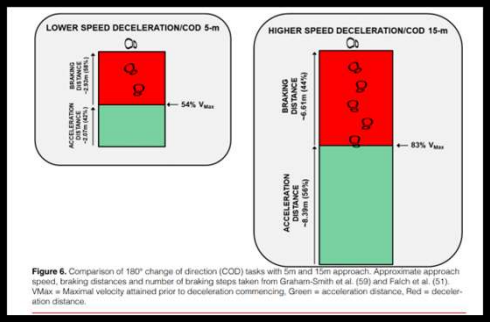


Figure 6. Comparison of 180° change of direction (COD) tasks with 5m and 15m approach. Approximate approach speed, braking distances and number of braking steps taken from Graham-Smith et al. (59) and Falch et al. (51). VMax = Maximal velocity attained prior to deceleration commencing, Green = acceleration distance, Red = deceleration distance.

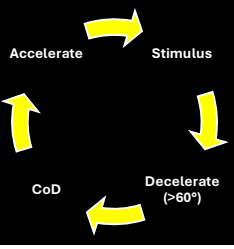
Harper, D. J., Cervantes,C., Van Dyke, M., Evans, M., McBurnie, A. J., Dos Santos, T., Eriksrud, O., Cohen, D. D., Rhodes, D., Carling, C., & Kiely, J. (2024). The Braking Performance Framework: Practical Recommendations and Guidelines to Enhance Horizontal Deceleration Ability in Multi-Directional Sports. International Journal of Strength and Conditioning
https://doi.org/10.47206/ijsc.v4i1.351

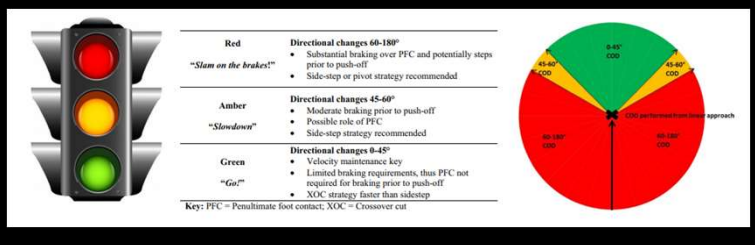
Sports Medicine (2018) 48:2235–2253
https://doi.org/10.1007/s40279-018-0968-3

REVIEW ARTICLE

The Effect of Angle and Velocity on Change of Direction Biomechanics: An Angle-Velocity Trade-Off

Thomas Dos'Santos[1] · Christopher Thomas[1,2] · Paul Comfort[1] · Paul A. Jones[1]





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Li, W, Lin, J, Dos'Santos, T, and Turner, A. Mechanical determinants of superior horizontal deceleration performance in multidirectional sportspersons. *J Strength Cond Res* XX(X): 000–000, 2025

Stats in Football

- ~ 195 and ~ 46 **decel** at ≈ -2 m/s^2 and -3 m/s^2, respectively
- Demand for high-intensity (> -3 m/s^2) **decel** > high-intensity **accel**, given the need to brake rapidly from high-speed sprinting
- Greater intensity during **decel** (-5.7 to -6.3 m/s^2) than **accel** (4.4 to 4.7 m/s^2)

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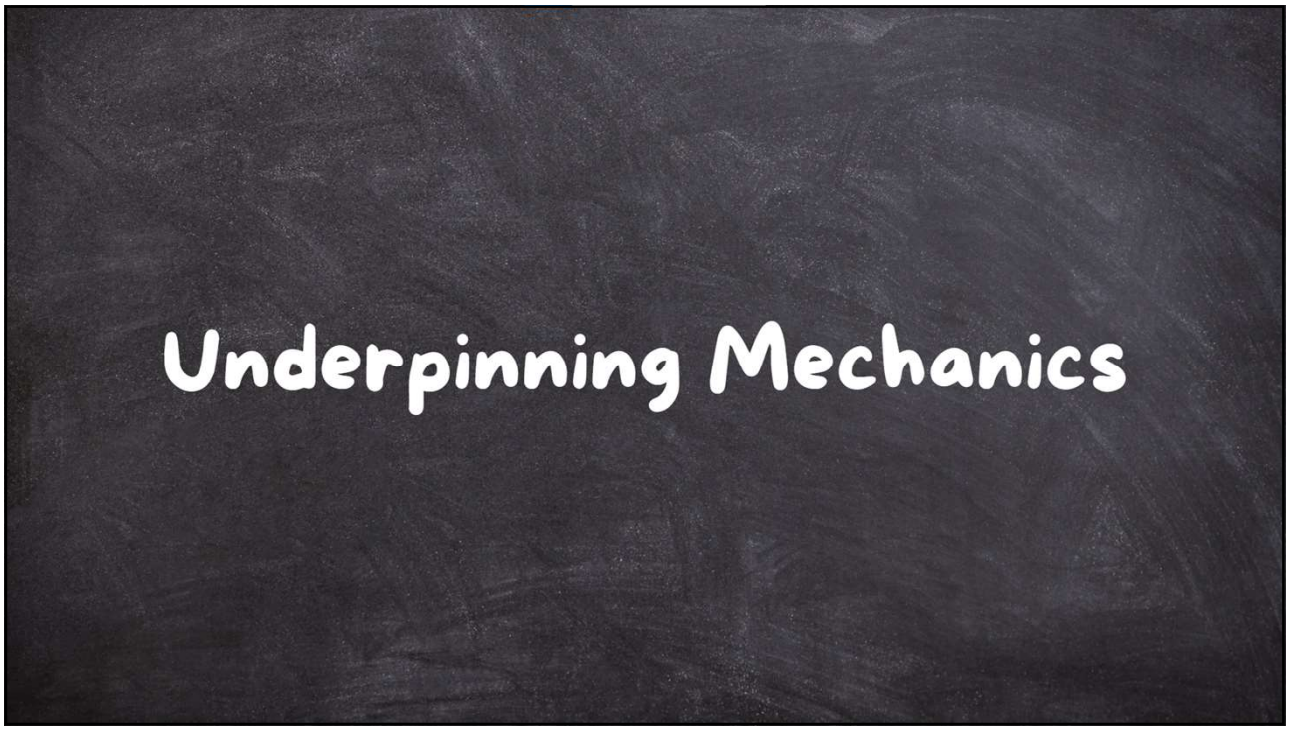

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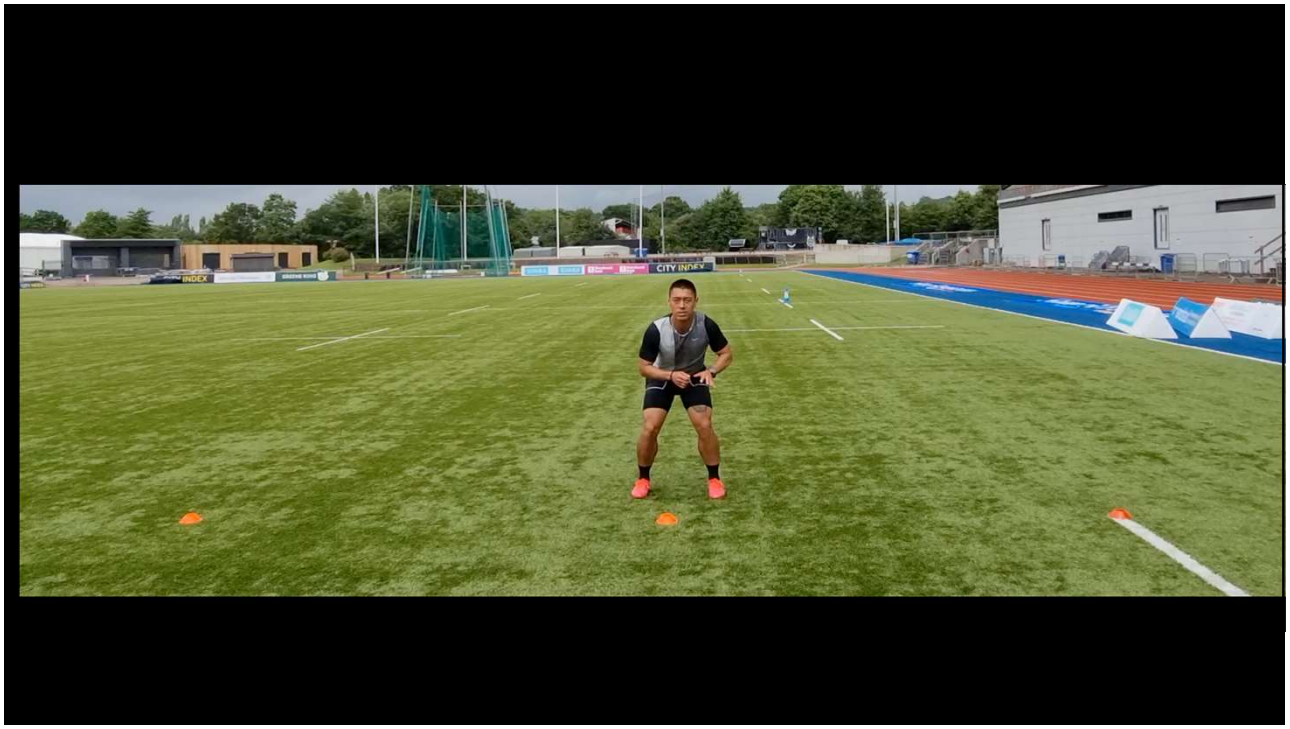

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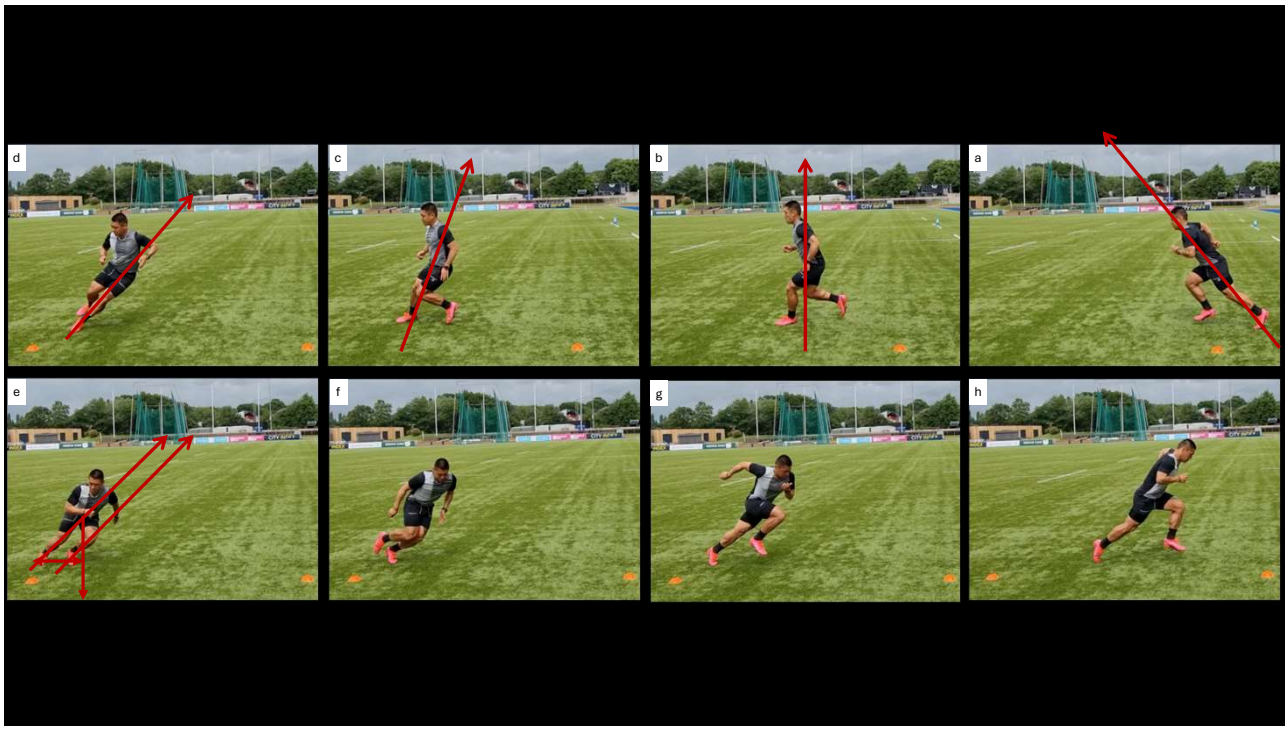

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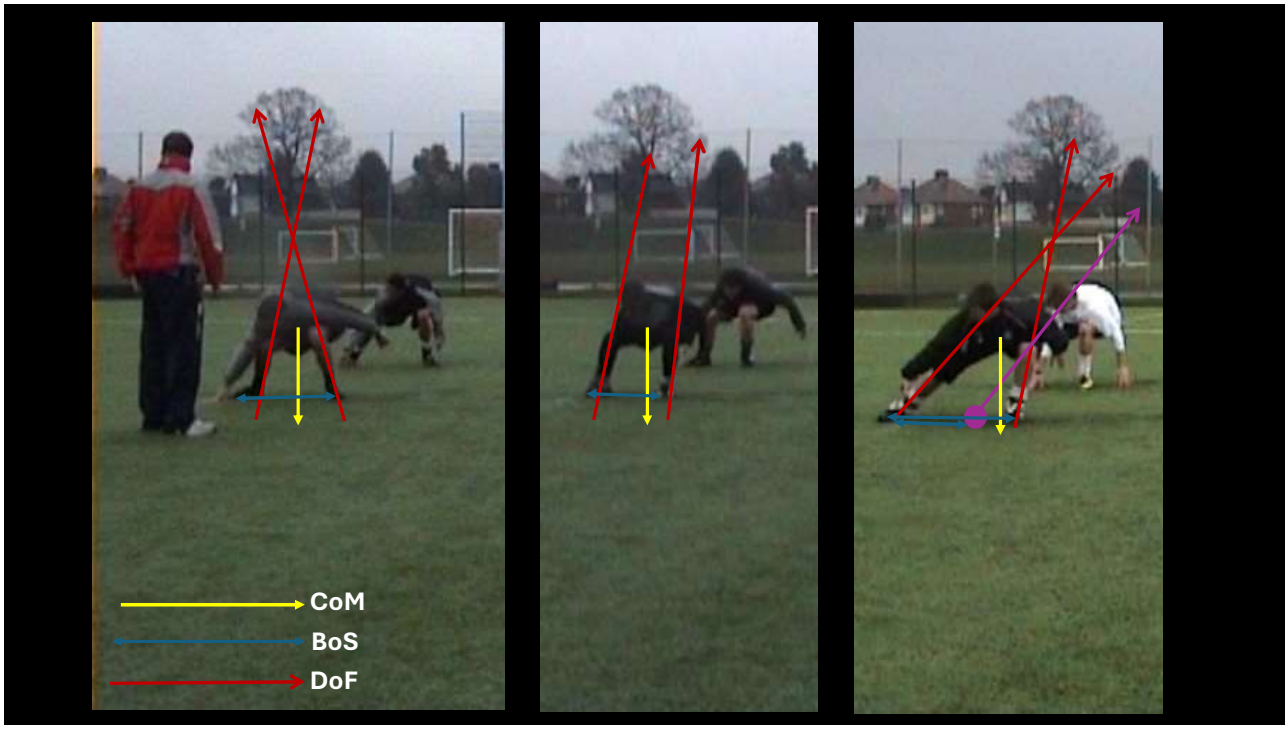

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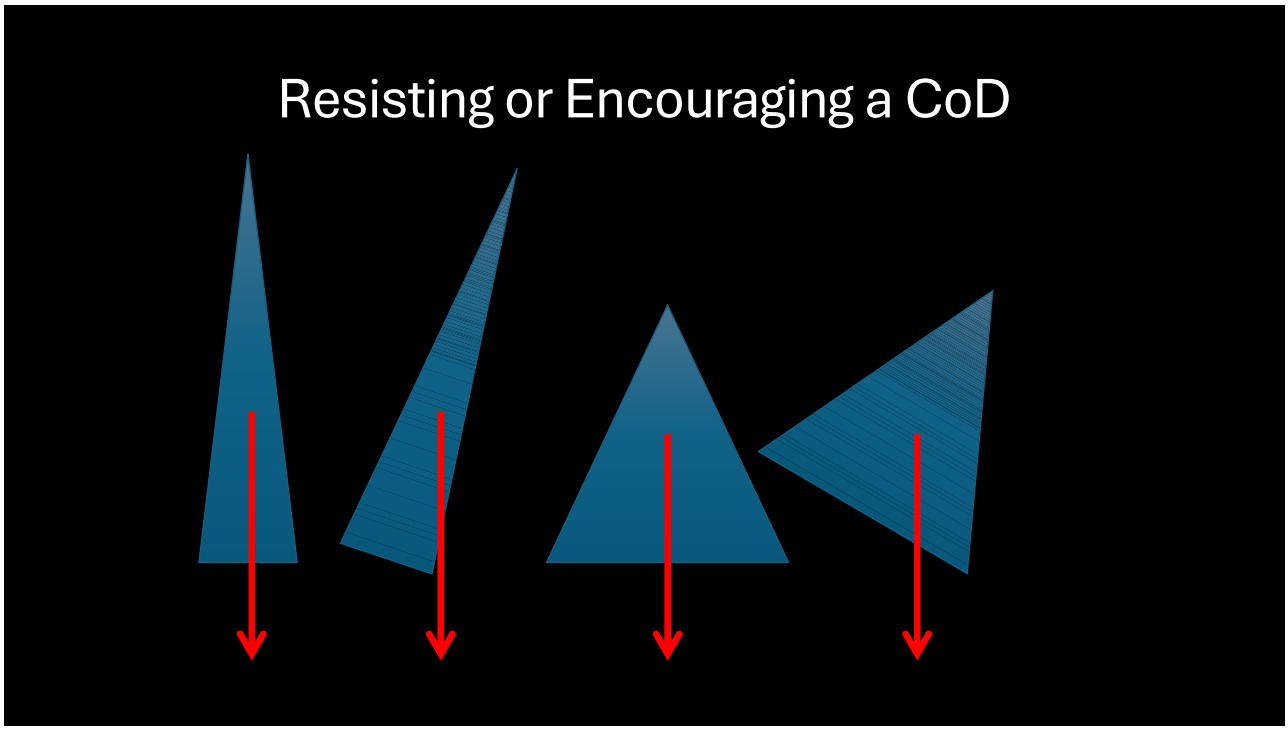

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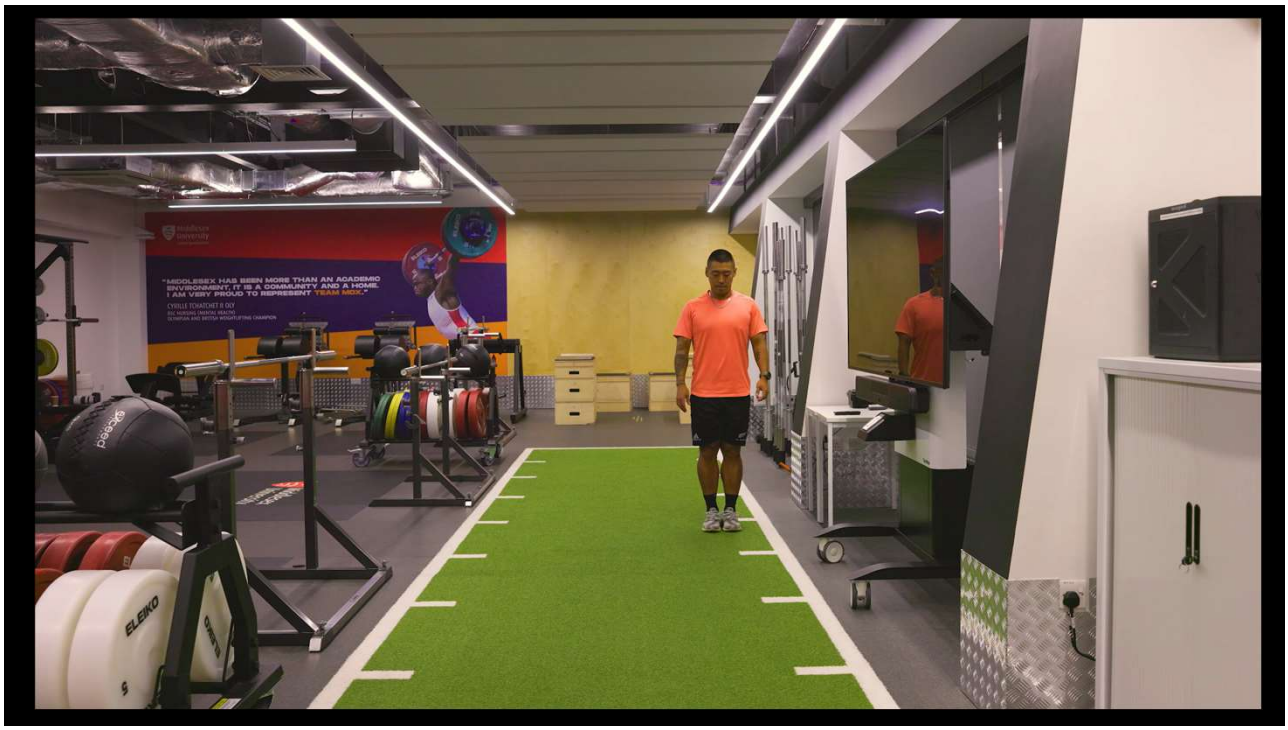

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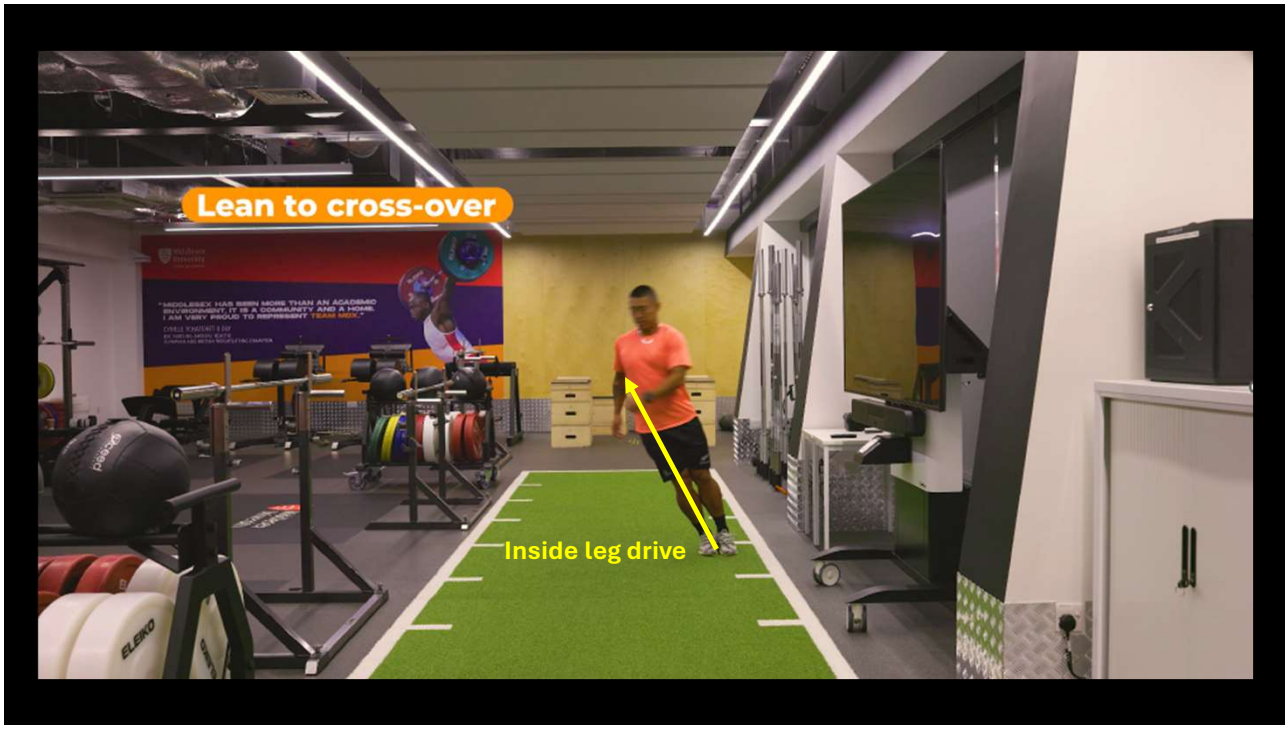

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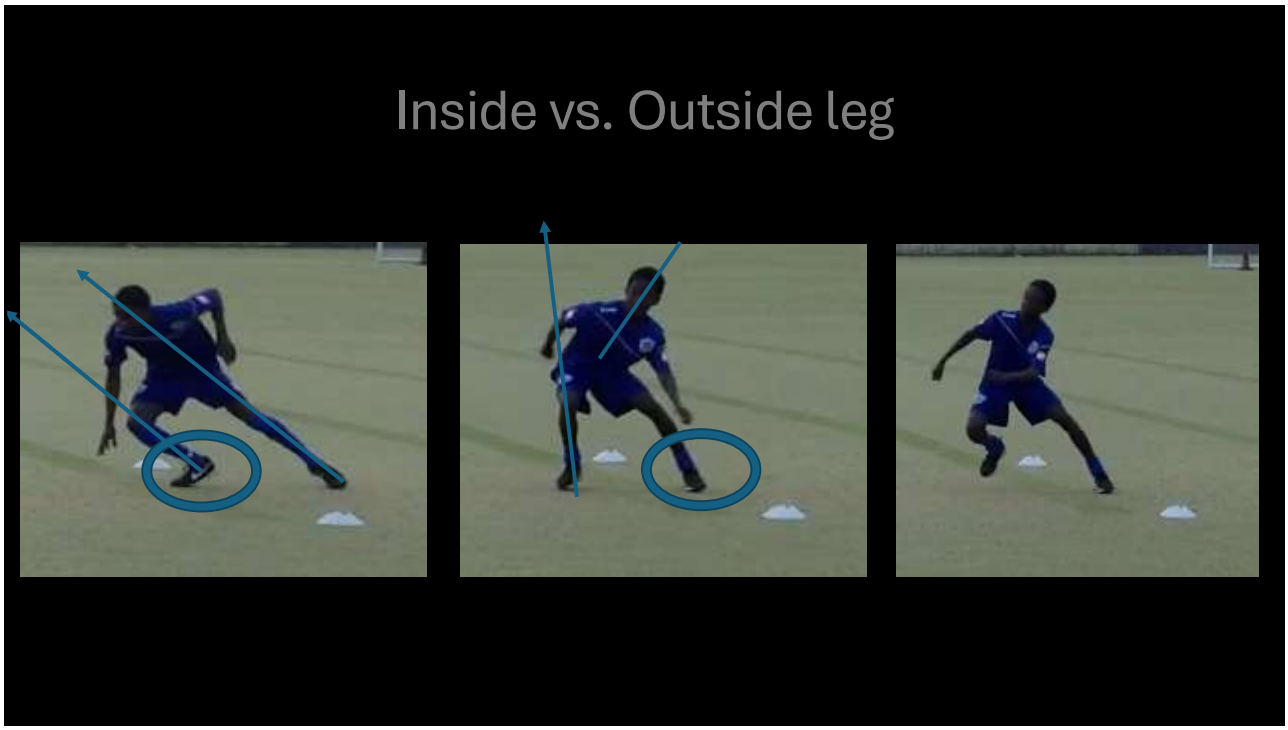

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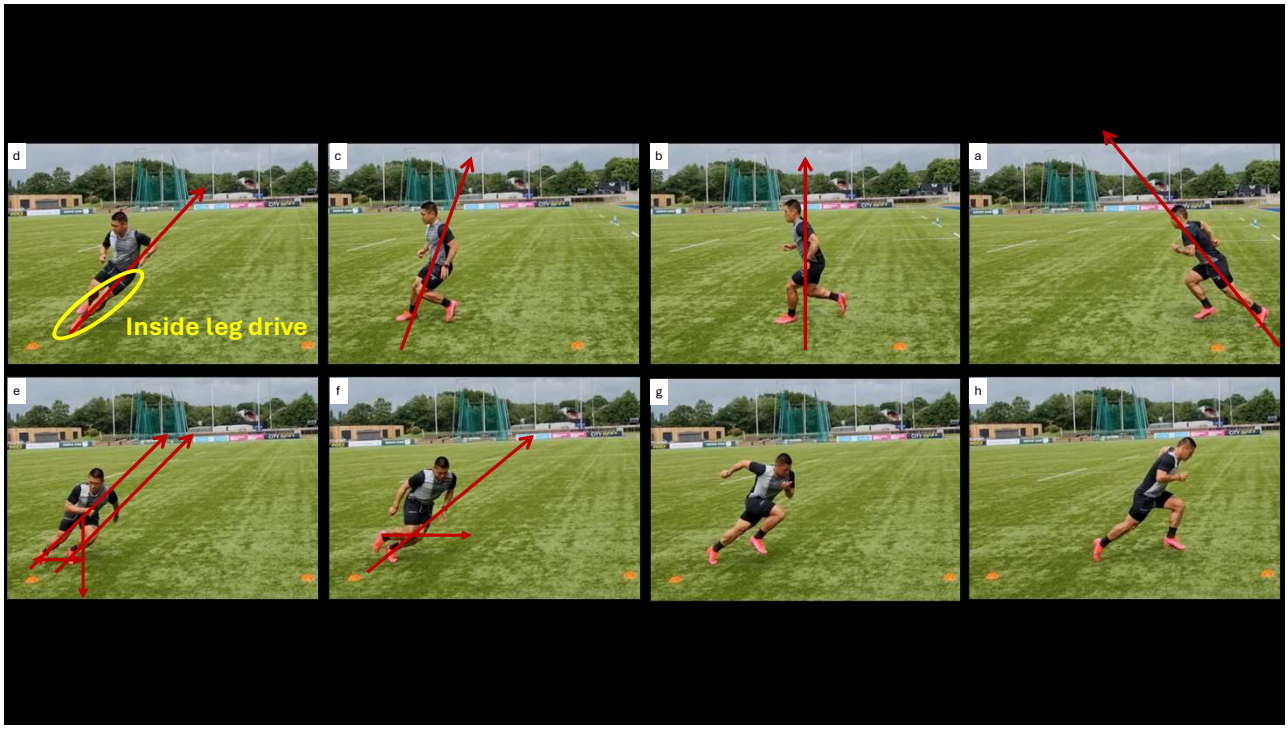

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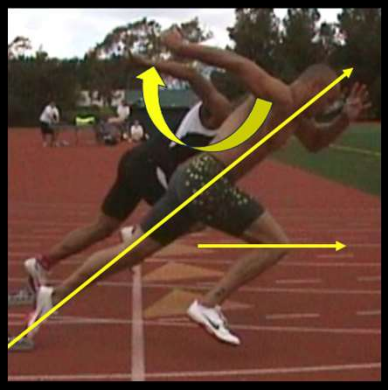
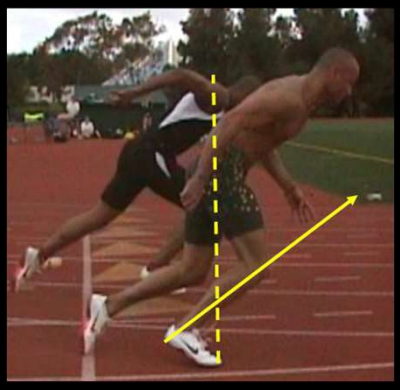
Acceleration check points

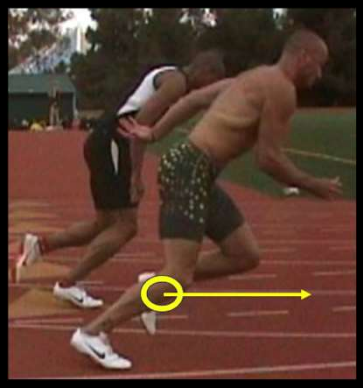
~ 45° lean, knee (~ 90°) through glass, arm snap



~ Land under hips, +ve shin angle



Low recovery (~ under knee) at ankle cross



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Principles first

- The Key is to understand the mechanics.
- With this you can train all CoD manoeuvres (e.g., 60°, 90° cut)
- It's about manipulating:
  DoF, BoS and CoM

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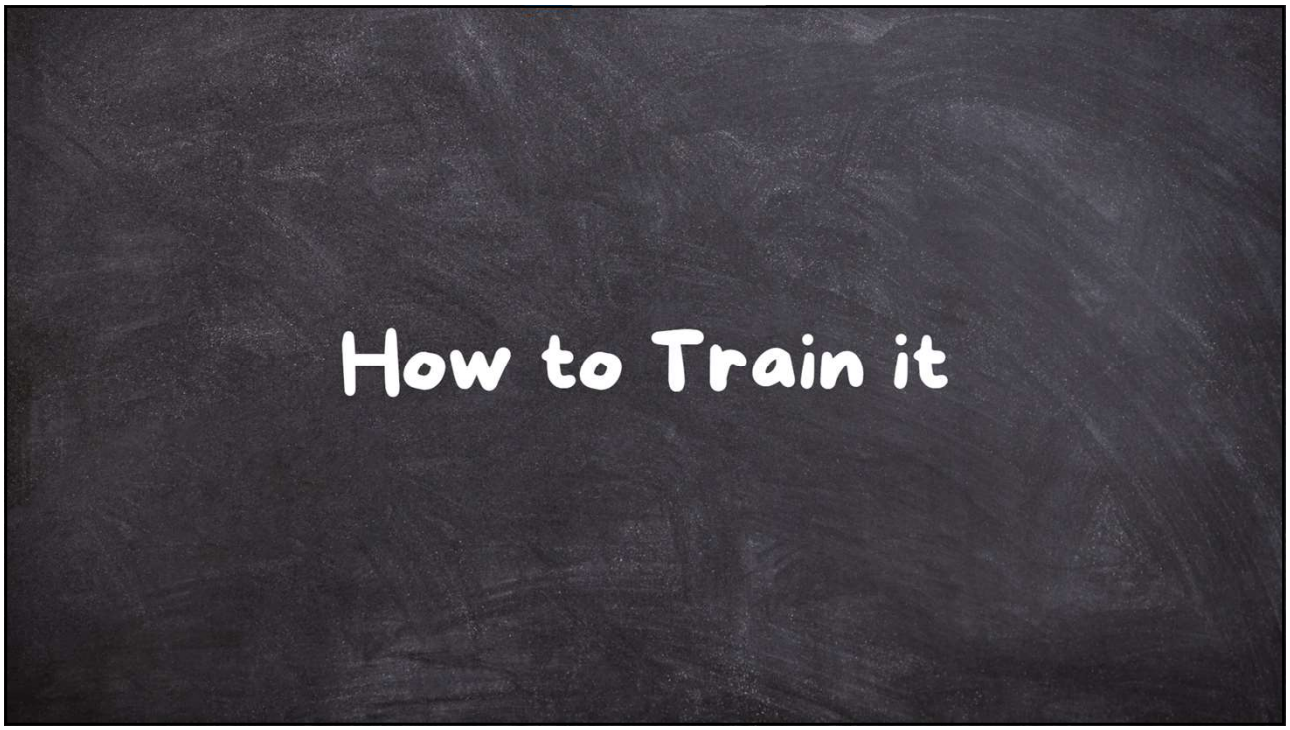

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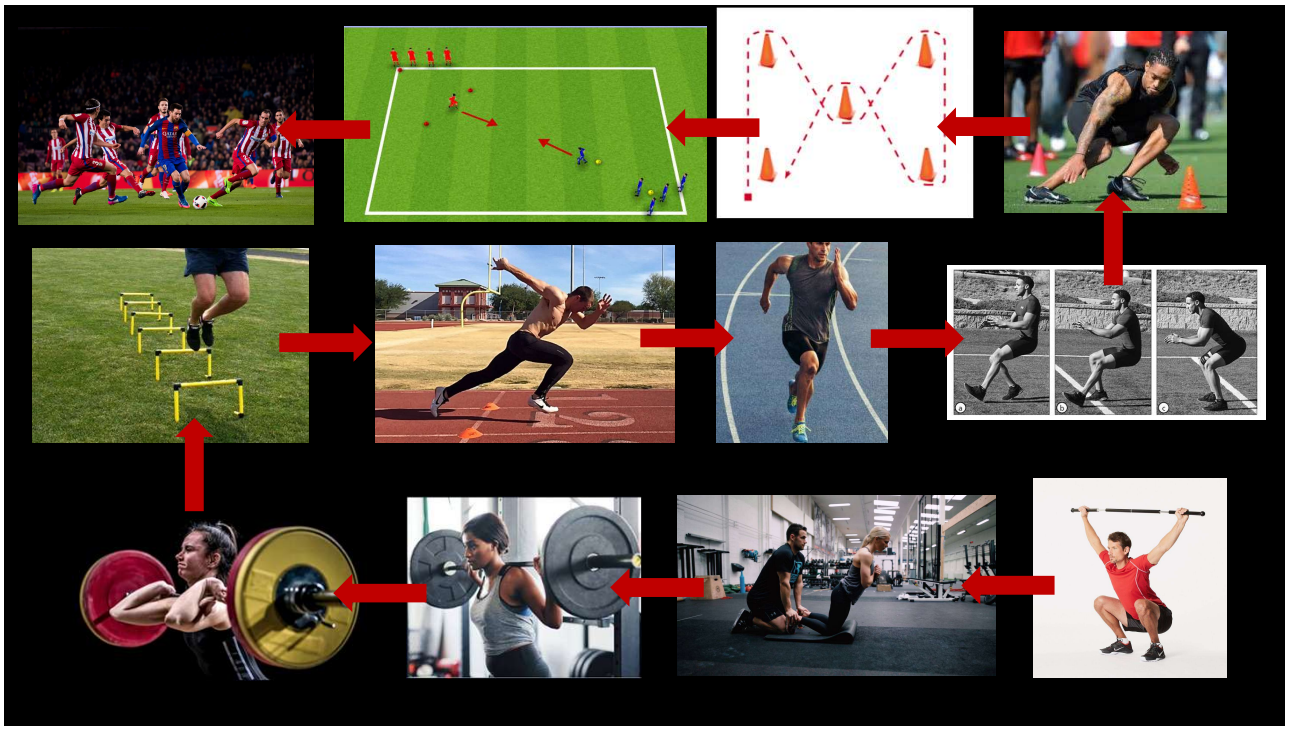

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“Head never goes between toes”

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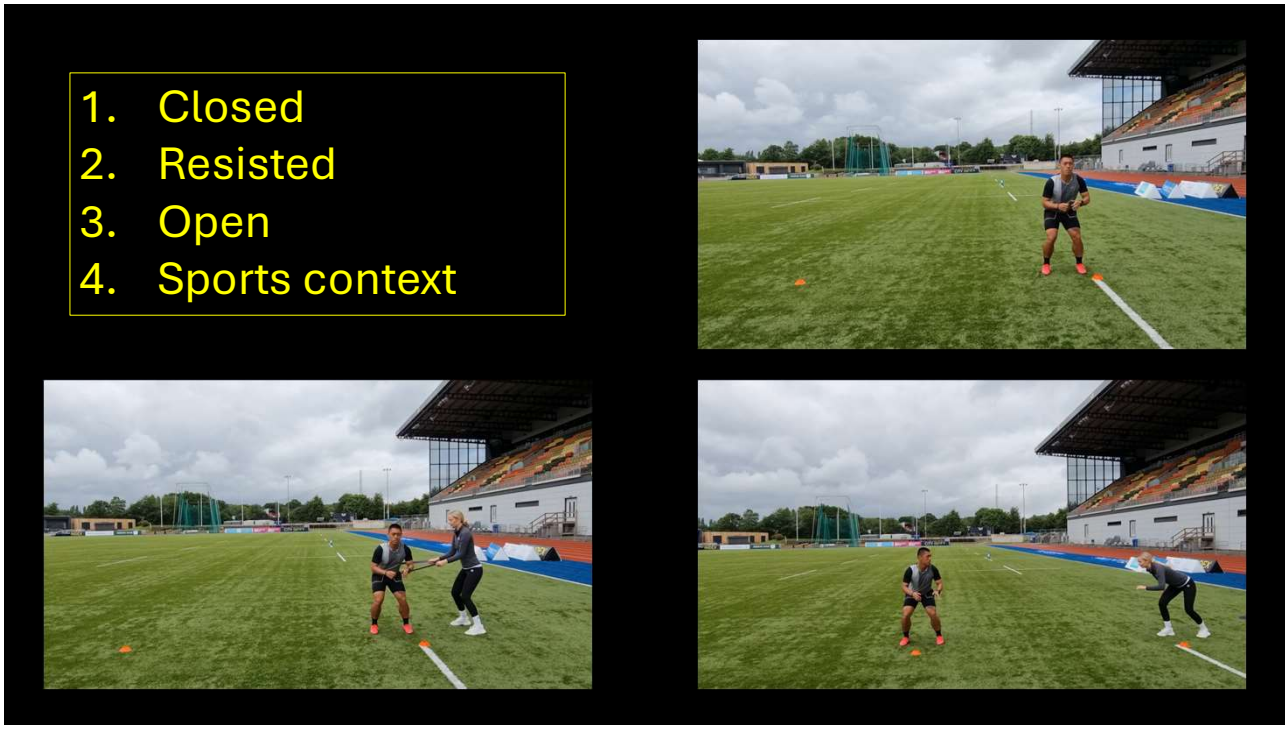
1. Closed
2. Resisted
3. Open
4. Sports context

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Inherent to training CoDS with
≥ 60° turns is deceleration

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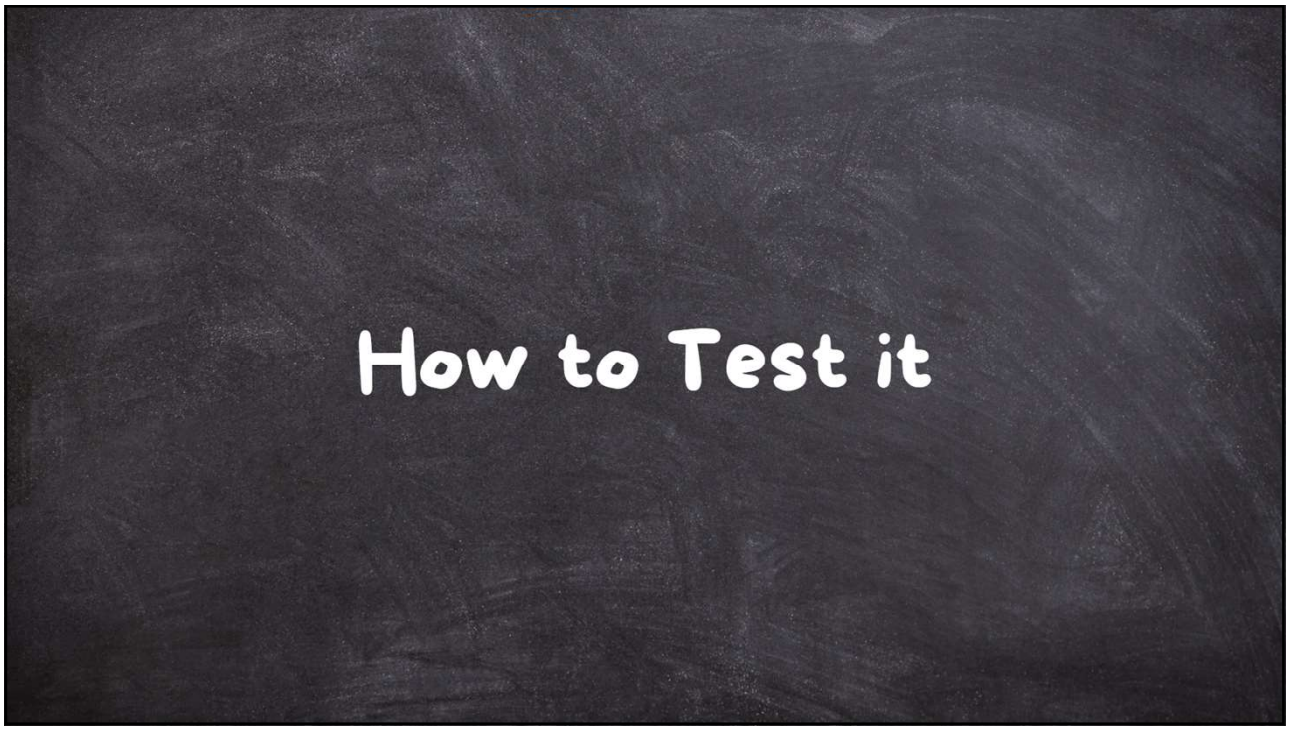
How to Test it

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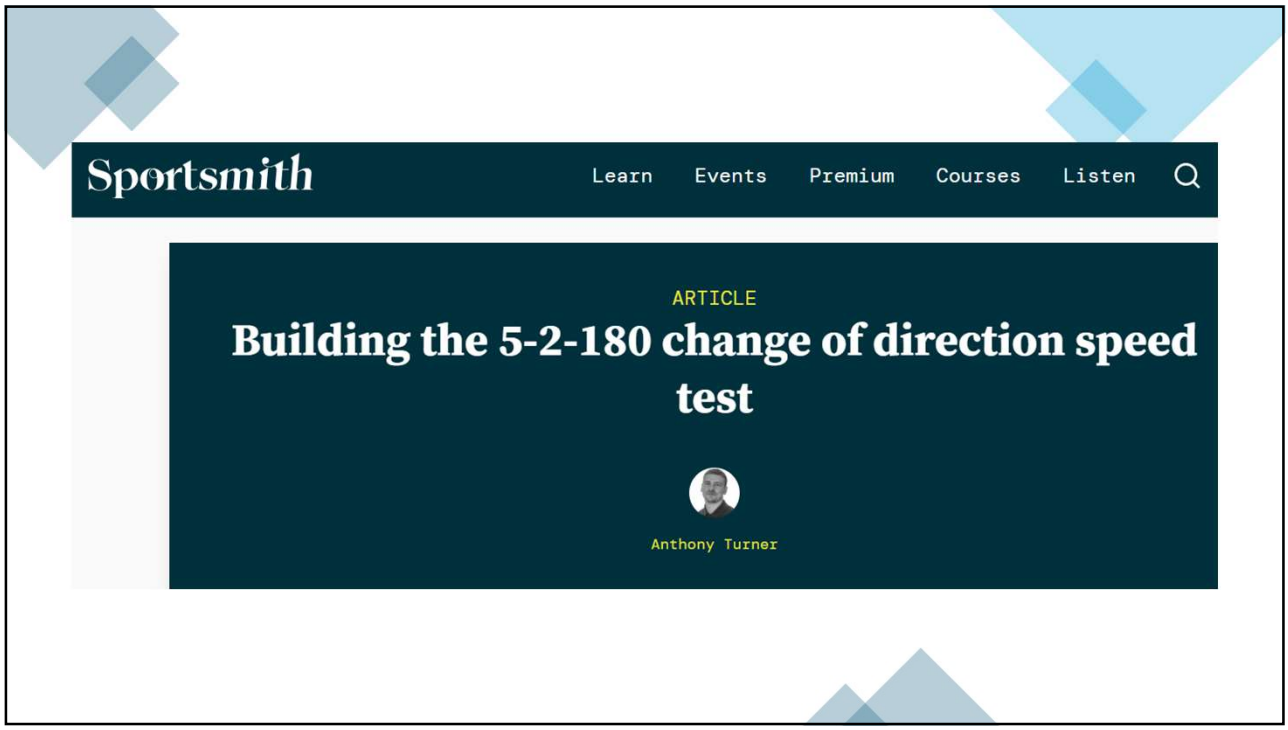

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The Academic vs. The Coach

Academic

- Validity + Reliability + reductionism
- We need to isolate the physical capacity and be sensitive to small changes

Coach

- Logistics + time + resources + utility
- Athlete is a complex system inseparable from their environment

Compromise is inevitable

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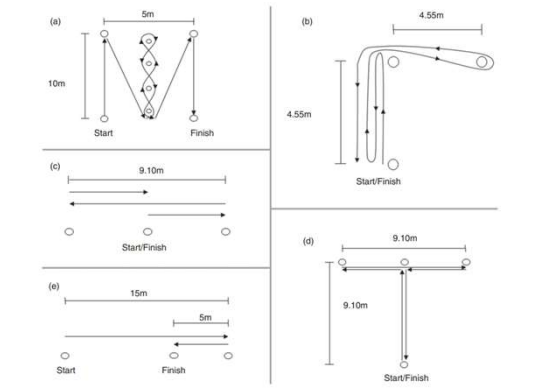

Fig. 1. A schematic of the five CODS tests used within this study. These are the Illinois (a), L-Run (b), Pro-Agility (c), *t*-test (d), and 505 (e).

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CoDS vs. Agility

- Elite athletes, compared to non-elite athletes, achieved faster times in an agility test involving players responding to a coach's movements.
- However, there was no difference between players during a pre-planned CODS test.

A compelling argument to include Agility tests?

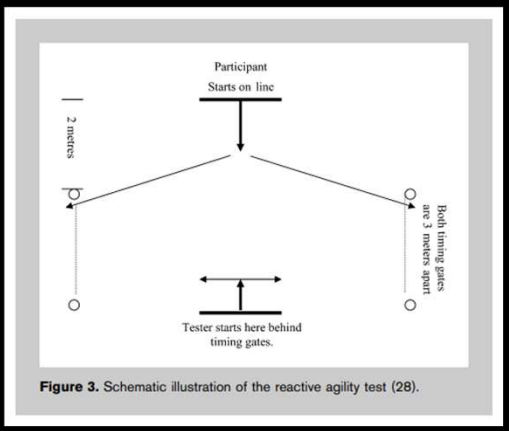

Figure 3. Schematic illustration of the reactive agility test (28).

SPEED, CHANGE OF DIRECTION SPEED, AND REACTIVE AGILITY OF RUGBY LEAGUE PLAYERS

TIM J. GABBETT,[1] JASON N. KELLY,[2] AND JEREMY M. SHEPPARD[3]
[1]*Brisbane Broncos Rugby League Football Club, Brisbane, Australia;* [2]*Runaway Bay Rugby League Football Club, Gold Coast, Australia;* [3]*Australian Institute of Sport, Canberra, Australia*

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Isolating CoDS

- if we don't want our CODS test to be a measure of speed, the turns need to be sharp (> 60°).
- ≥ 2 turns, but not so many that the test becomes a measure of anaerobic fitness.
- Total distance should be short.
- Maybe assess one turn, leaving us certain of what the test is measuring, e.g., CODS while turning 180° or 90°.

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How can we get more out of our CODS test?

E.g., deceleration via change of direction deficit (Sophia Nimphius)

Figure 1: Traditional 5-0-5. To ensure the athlete reaches ≥ 95% of their max 10 meter speed, place timing gates at the start line.

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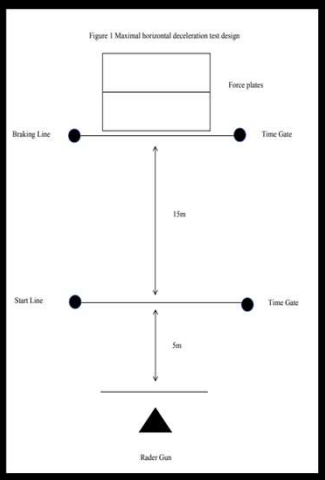
Or do we need to run separate Deceleration tests?

E.g., Acceleration-deceleration ability (Damian Harper)

- Inverse relationship between entry momentum and braking performance

- Momentum = mass x velocity
- Impulse = Force x time
- $J = F\Delta t = \Delta p = m\Delta v$



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Body mass = 70 kg

- Peak approach velocity = 4 m/s ∴ peak approach momentum = 280 kg·m/s
- Peak approach velocity = 5 m/s ∴ peak approach momentum = 350 kg·m/s
- Peak approach velocity = 6 m/s ∴ peak approach momentum = 420 kg·m/s

Peak approach velocity = 5 m/s

- Body mass = 60 kg ∴ peak approach momentum = 300 kg·m/s
- Body mass = 80 kg ∴ peak approach momentum = 400 kg·m/s
- Body mass = 100 kg ∴ peak approach momentum = 500 kg·m/s

Peak approach momentum = 350 kg·m/s

- Peak approach velocity = 4 m/s ∴ body mass = 100 kg
- Peak approach velocity = 4.5 m/s ∴ body mass = 77.8 kg
- Peak approach velocity = 5.5 m/s ∴ body mass = 63.64 kg

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Can we just train braking strength?

- You can't improve braking strength without improving propulsive strength
- The stronger you get, concentrically or eccentrically, the faster your entry velocity will be
- The faster your entry velocity, the greater the momentum
- The greater the momentum, the more steps (time) you will require to decelerate

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What about measuring limb Symmetry?

- The variability of the 5-0-5 (including modified), is often greater than the imbalance. E.g., a 2% imbalance with a 3% CV
- Even with differences greater than the error, because the output variable is time, you cannot readily determine the root cause of the existing side to side imbalance.
- Is it a: (1) weaker limb, (2) suboptimal motor pattern, (3) or some combination of those.
- So, is it worth the player's time and motivation to do 6 trials to get this!?

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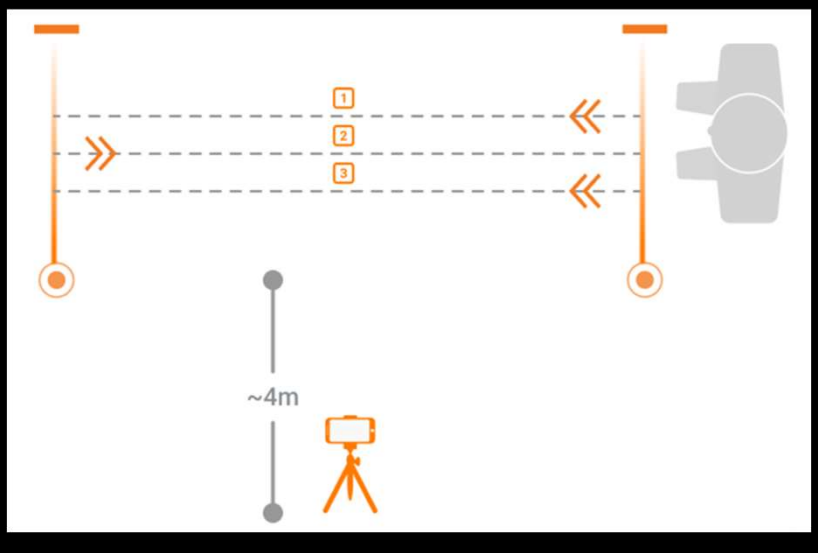
How should we test CoDS and deceleration capacity

E.g., consider the 5-2-180



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Entry velocity

SCIENCE AND MEDICINE IN FOOTBALL
https://doi.org/10.1080/24733938.2024.2439859

Routledge
Taylor & Francis Group

Check for updates

Frequency and intensity of change of directions in German Bundesliga soccer

Jan-Philip Deutsch [a], Lars Donath [a], Bjoern Braunstein [b,c,d,e] and Robert Rein [f]

- ≈ 93% of COD events occur at an entry velocity below 5.5 m·s −1.

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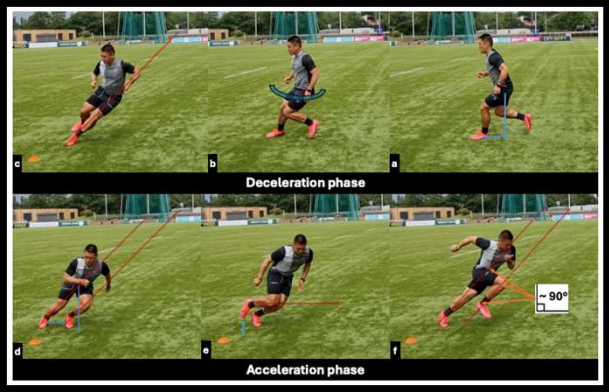
The 5-2-180 checklist



Phase		Movement sequence	Left leg	Right leg	Score
Deceleration	a	Distance between CoM (hips) and CoP (foot) increases as athlete "sits"	Yes ☐ No ☐	Yes ☐ No ☐	
	b	Athlete re-orients themselves into a side-on position	Yes ☐ No ☐	Yes ☐ No ☐	
	c	Penultimate foot contact: inside leg performs a shallow squat to transfer energy.	Yes ☐ No ☐	Yes ☐ No ☐	
Acceleration	d	At final foot contact:			
		- upper body and shins are aligned to direction of travel (~ 45□)	Yes ☐ No ☐	Yes ☐ No ☐	
		- CoM (belly button) falls outside narrow BoS (feet); head NOT between toes	Yes ☐ No ☐	Yes ☐ No ☐	
		Outside leg "bounces" off ground	Yes ☐ No ☐	Yes ☐ No ☐	
	e	Outside leg:			
		- knee drives ~ horizontally forward	Yes ☐ No ☐	Yes ☐ No ☐	
		- foot stays close to ground, and will pass ~ below opposite knee	Yes ☐ No ☐	Yes ☐ No ☐	
	f	Athlete achieves acceleration posture:			
		- ~ 90° at ankle (dorsiflexion)	Yes ☐ No ☐	Yes ☐ No ☐	
		- ~ 90° at knee	Yes ☐ No ☐	Yes ☐ No ☐	
		- ~ 90° at hips	Yes ☐ No ☐	Yes ☐ No ☐	
		- Shins run ~ parallel	Yes ☐ No ☐	Yes ☐ No ☐	
Total score (out of 24, 12 points per side)					

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