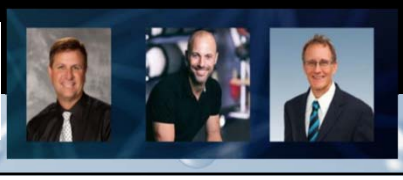
THE DECELERATION INDEX:
IS IT THE MISSING LINK IN REHABILITATION AND PERFROMANCE?
(Don't speed up what you can't slow down)



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Greetings from Nashville Tennessee

Effectiveness of our RTP decision making?

The increased risk of re-injury may stem from the neuromuscular consequences of ligamentous injury that traditional therapy may not adequately address.

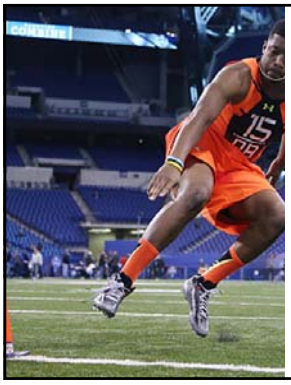
- ✓ Reinjury rates after ACL injury
  - ✓ Up to 30% Reinjury Rate Younger Athletes
    - *Barber-Westin & Noyes: JSH '20*
    - *Paterno et al: AJSM 14*
    - *Webster et al: AJSM '14*
  - ✓ *6x more likely injury in 24 months (over 50% first 72 athletic exposures)*
  - Ipsilateral knee: 2-3 x increase
  - Contralateral Knee: 2-4 x increase

One possible explanation lies in the inability of an athlete of rapidly decelerate.

- Athletes have been trained to develop considerable power in the form of acceleration, however, if they cannot control of decelerate this force, the potential for injury or reinjury exists.
- Therefore, a thorough understanding of an athlete's deceleration index or ratio of deceleration and acceleration is required to prepare the athlete for the force of athletic participation.

THE BIG PROBLEM

Most research and training have been directed at increasing an athlete's power or ability to accelerate.



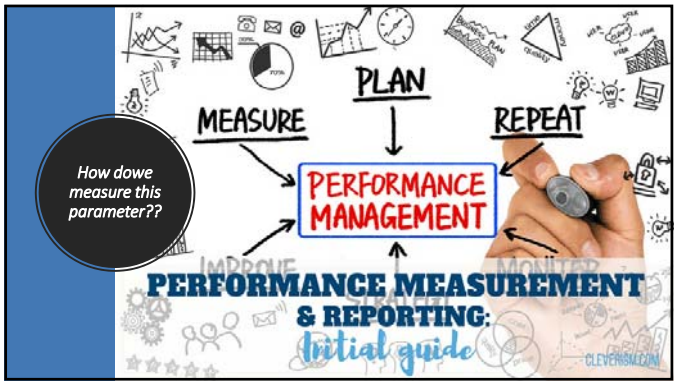
What is Deceleration?

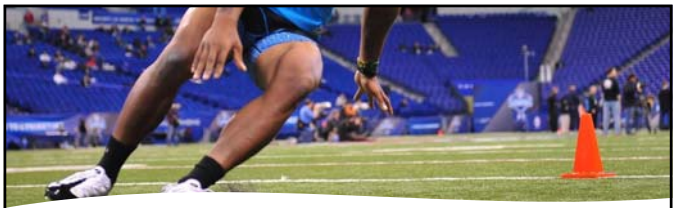
- **Deceleration refers to the ability to reduce speed or momentum with respect to time.**
  - **Deceleration is vital in change of direction, and a deficit in this category can have a major impact on the patient's performance.**

KEYS TO DECELERATION:

Key mechanical variables during the COD include braking forces and ground contact times

These have been found to be main components of determining COD speed performance.





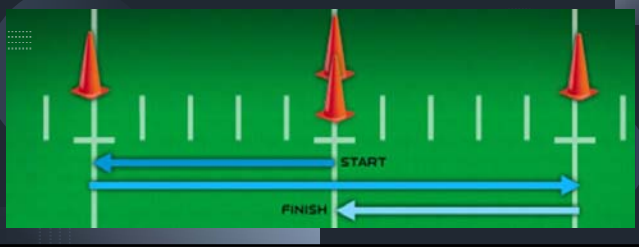
ONE KEY: Change of Direction (COD)

- Performance relies heavily on athletes' ability to react quickly in sports-specific situations, especially with regards to agility, coordination, and change of direction (COD).
  - Higher intensity accelerations and decelerations are fundamental components of COD movements and are integral to successful performance of COD.

3 Cone Drill

These change of direction speed (COD-S) tests are commonly used to identify an athlete's performance capability and potential risk of injury.

- To fully assess an athlete's ability to quickly change direction, a measurable evaluation tool should be used.



Shuttle Run

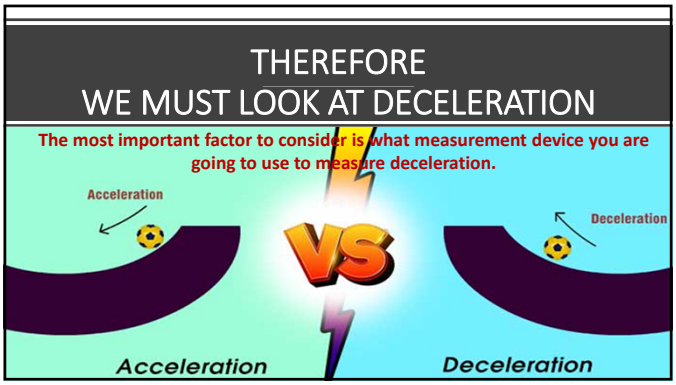
The drill tests an the athlete's lateral quickness and explosion, last a total of 20 yards but has participants sprinting in three different directions.

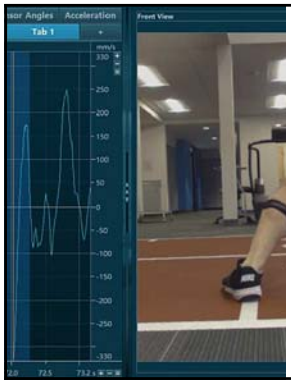
- Players start in a three-point stance and then sprint 5 yards to their right.
- There they bend down, touch the turf with their right hand.
- They then sprint 10 yards to their left, touch the ground again (this time with their left hand) and run another five yards.

Coaches view the drill -- which tests lateral quickness, explosion and agility

Unfortunately, most change of direction tests have been measured as a time-to-completion to perform the task.

- While this measure can grossly compare left and right COD ability and asymmetry, it gives very little insight into the component parts of COD.
  - The overall time does not quantify the initial acceleration, deceleration, and re-acceleration phases.
  - Longer tests are not possibly representative of CoD but rather anaerobic capacity and linear sprint ability.
  - Even in shorter tests, such as the modified 505 (m505) which consists of two 5 m sprints with a 180-degree turn, superior sprint capacity can still mask the CoD ability.





Acceleration vs Deceleration

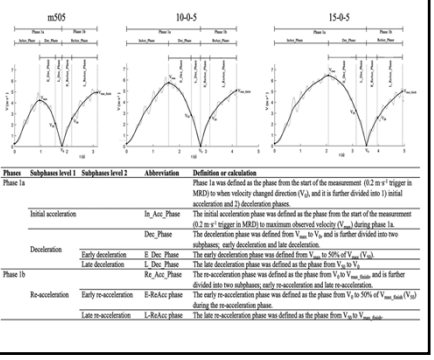
- Specifically, measurements of the velocity of the center of mass (COM) during the CoD testing should be measured.
  - To obtain an accurate measurement of deceleration, it is important to be able to precisely identify when the athlete reaches their peak velocity, which is essentially the start of the deceleration phase.
- To accurately identify the start of deceleration, we need to choose a measurement device that can capture the athlete's instantaneous velocity throughout the entire test.

Continuous Monitoring

Phase definitions of the m505, 105, and 155 tests.

The table in the bottom rows provides an overview of the phases and subphases with abbreviations used for the outcome measurements and definitions.

Ola Eriksrud

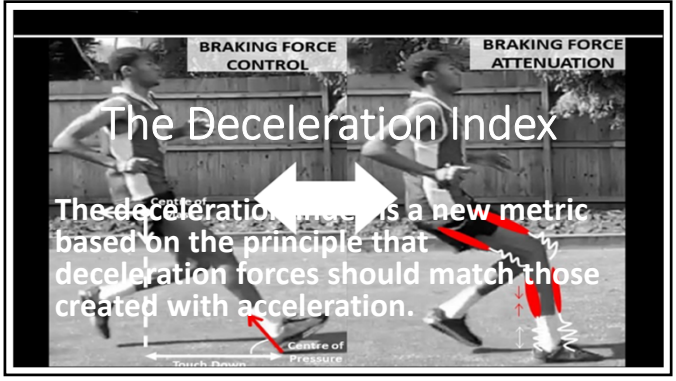


Phases	Subphases level 1	Subphases level 2	Abbreviation	Definition or calculation
Phase 1a				Phase 1a was defined as the phase from the start of the measurement (0.2 m s^{-1} trigger in MRD) to when velocity changed direction (V_0), and it is further divided into 1) initial acceleration and 2) deceleration phases.
	Initial acceleration		In_Acc_Phase	The initial acceleration phase was defined as the phase from the start of the measurement (0.2 m s^{-1} trigger in MRD) to maximum observed velocity (V_{max}) during phase 1a.
	Deceleration		Dec_Phase	The deceleration phase was defined from V_{max} to V_0, and is further divided into two subphases, early deceleration and late deceleration.
		Early deceleration	E_Dec_Phase	The early deceleration phase was defined from V_{max} to 50% of V_{max} (V_{50}).
		Late deceleration	L_Dec_Phase	The late deceleration phase was defined as the phase from V_{50} to V_0.
Phase 1b			Re_Acc_Phase	The re-acceleration phase was defined as the phase from V_0 to $V_{max\ finish}$, and is further divided into two subphases; early re-acceleration and late re-acceleration.
	Re-acceleration	Early re-acceleration	E-ReAcc phase	The early re-acceleration phase was defined as the phase from V_0 to 50% of $V_{max\ finish}$ (V_{50}) during the re-acceleration phase.
		Late re-acceleration	L-ReAcc phase	The late re-acceleration phase was defined as the phase from V_{50} to $V_{max\ finish}$.

Remember the Importance of Deceleration Ability

In addition to having an impact on the athlete's performance, a decrease in the ability to quickly decelerate or quickly reduce momentum could lead to injury.

- Poor deceleration capability has been identified as a potential mechanism associated with non-contact ACL injury due to the high forces generated during the deceleration.
- Additionally, due to the high eccentric braking demands associated with deceleration, this may have the potential to induce muscle damage.



EDITORIAL

THE DECELERATION INDEX - IS IT THE MISSING LINK IN REHABILITATION?

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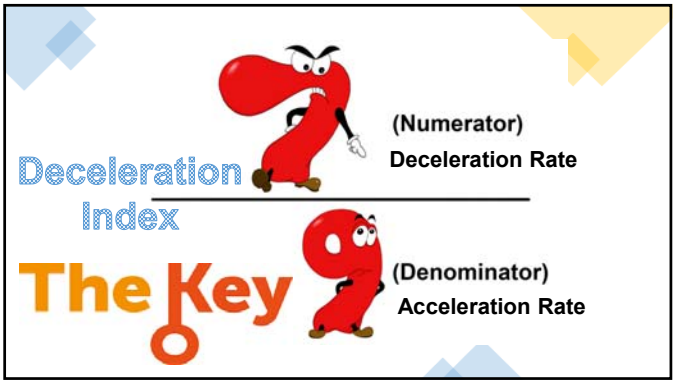
The Deceleration Index

The deceleration index is a measure of the rate at which an object slows down relative to its ability to accelerate.

- This measure has typically been used to describe the braking performance of a vehicle.
- The higher the deceleration index, the faster the vehicle can stop.
  - The deceleration index can be used to compare the braking performance of different vehicles and to determine whether a vehicle's brakes are operating properly.



The Deceleration Index

By dividing the deceleration time by the acceleration time, the deceleration index provides a measure of how quickly athletes can slow down relative to how quickly they can speed up.

IDEALLY – What do we really want to know?

- **REACT/Reaction Time** – The elapsed time from the presentation of a visual cue to the initiation of the correct movement response
- **SPEED** – Maximum speed achieved
- **START / ACCELERATION** – The measurement of the athlete's ability to accelerate (1st step quickness)
- **STOP / DECELERATION** – The measurement of the athlete's ability to decelerate (braking)

The Deceleration Index

How we measure it

Using motion capture devices, radar, force plates, light detection and ranging lidar, motorized resistance, and wearable GPS/accelerometry technology, a clinician can observe changes in speed throughout the movement. (Note: many of these now integrate automatic detection of key deceleration metrics using artificial intelligence (AI).

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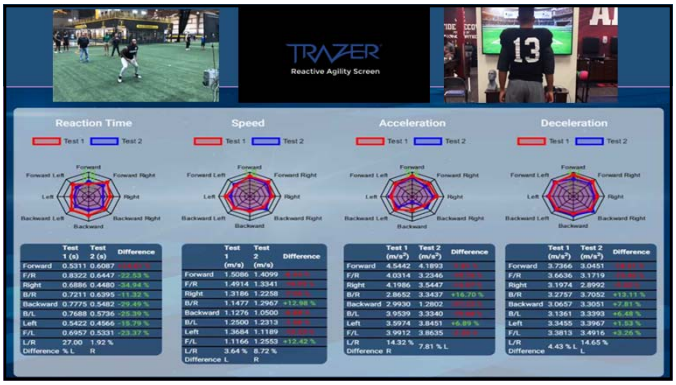
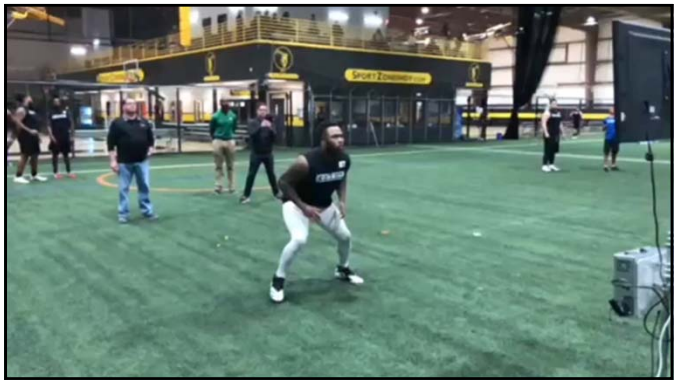
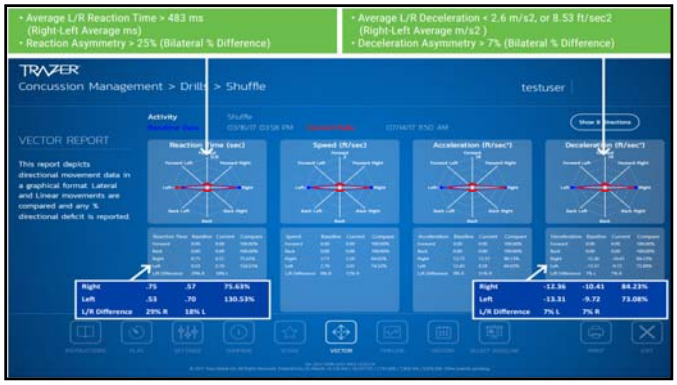
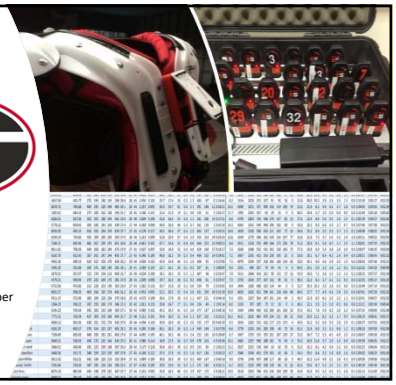


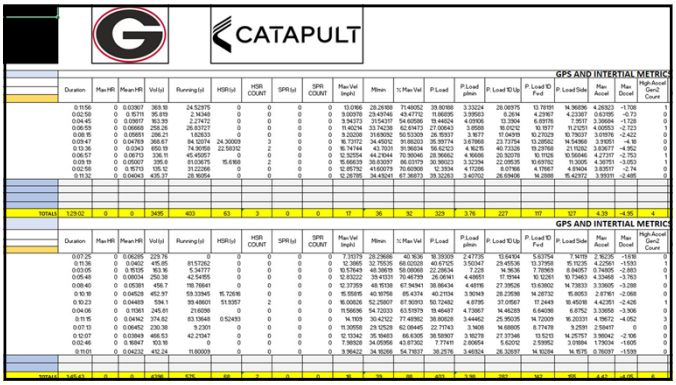




Catapult Sports Database



- Measures
  - Acceleration
  - Deceleration
  - Velocity
  - IMA (inertial movement analysis)
  - Player Load
  - Metabolic data
  - Heart Rate
- TOTAL: Over 10,000 data points per player per day



Conclusion

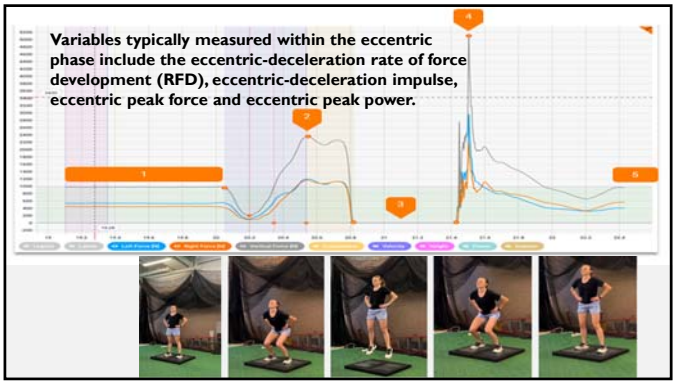
- **The Deceleration Index (DI) offers a straightforward measure of how an athlete's deceleration compares to their acceleration.**
- A high deceleration index indicates that an athlete is able to slow down quickly and efficiently, which may give them an advantage on the court or field.
- If an athlete's DI is consistently low, it may indicate that they need to focus more on eccentric training and deceleration drills in their training.

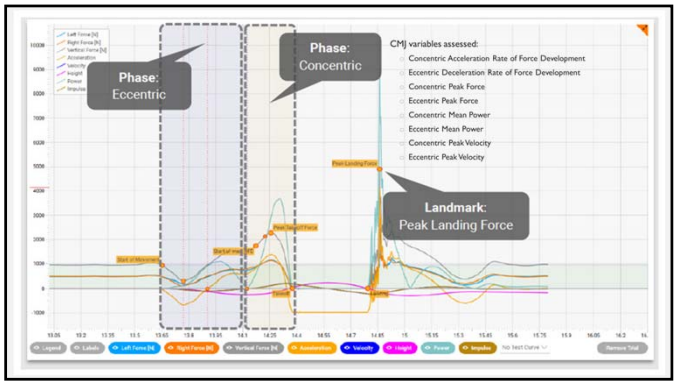
Injuries not occur in a straight plane or in a predictable manner

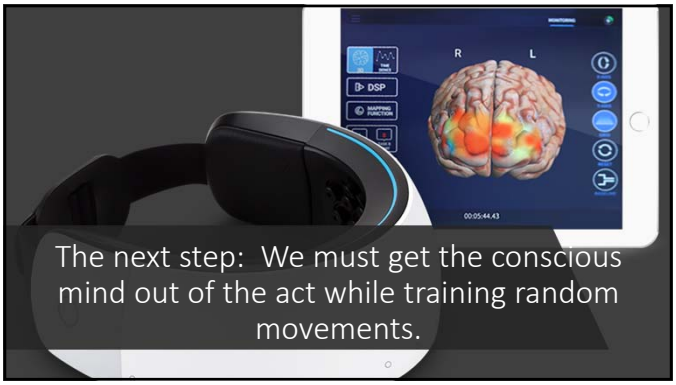
(Fatigue and cognitive ability also plays a role)

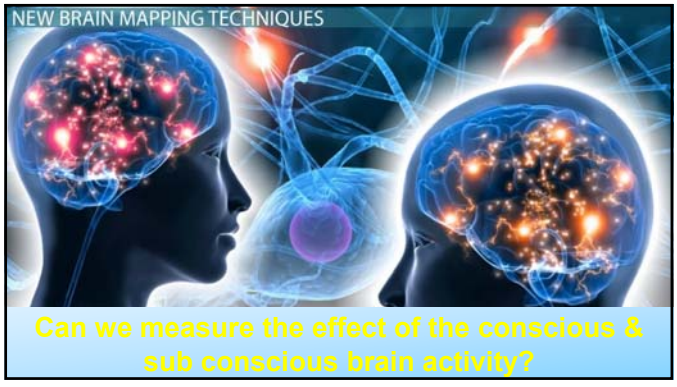
THE UNEXPECTED MOVEMENT

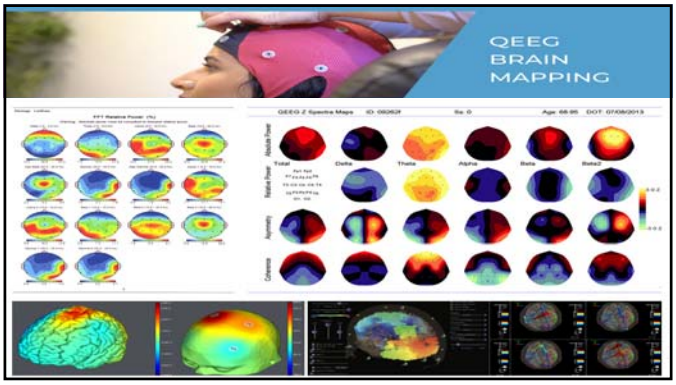
Injuries do not typically occur in a straight line or single plane & we believe that there is a component of fatigue that affects motor control and the ability to control these outside forces.











Conclusion

The Deceleration Index is poised to be the missing link in rehabilitation, allowing practitioners to make informed decisions with regards to an individual's training.

- With further research, athletes may soon reap the benefits of a reliable way to measure progress during rehabilitation exercises and reduce injury risk.