



Endurance Athlete Strength & Conditioning

Joe O Connor

CIT 23rd January 2019

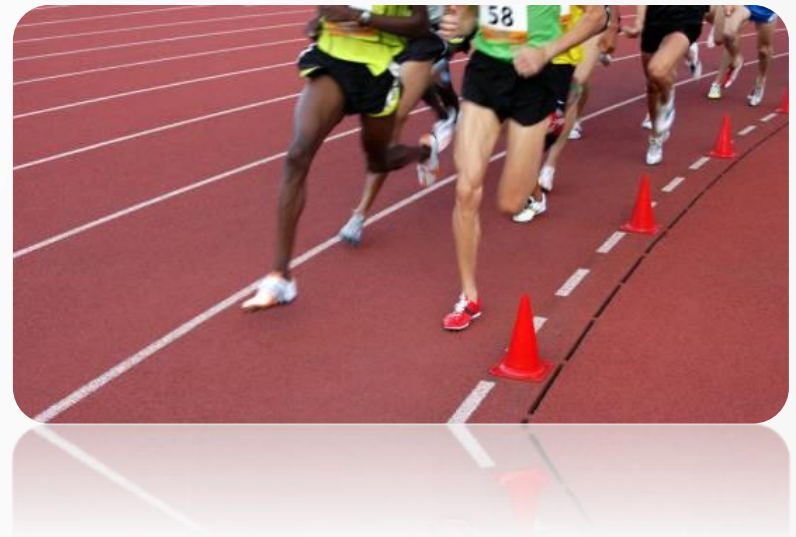
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Today's Content

1. Key Considerations
2. Central vs. Peripheral Capacity
3. Current Research Findings
4. Power, SSC & RFD and Pathway
5. General Guidelines

Key Considerations - General

- ✓ Runner First
- ✓ Stronger not Bigger
- ✓ Training Volume
 - ✓ (Acute vs. Chronic)
- ✓ Polarised Training
- ✓ Consistent Application

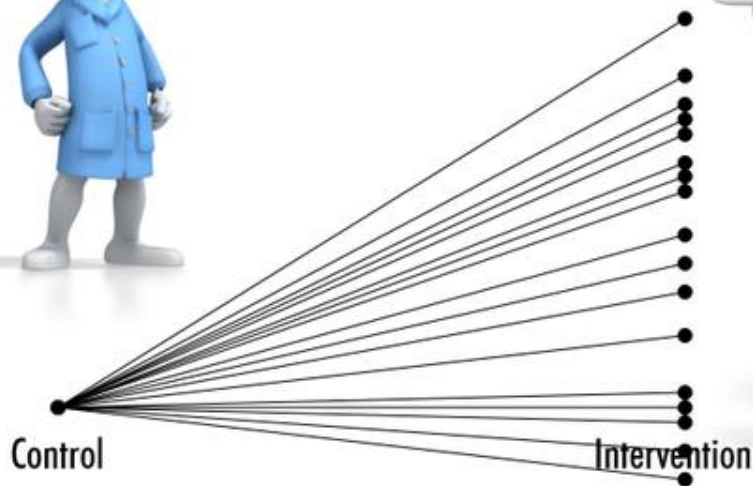


SCIENTIST

Providing general guidelines



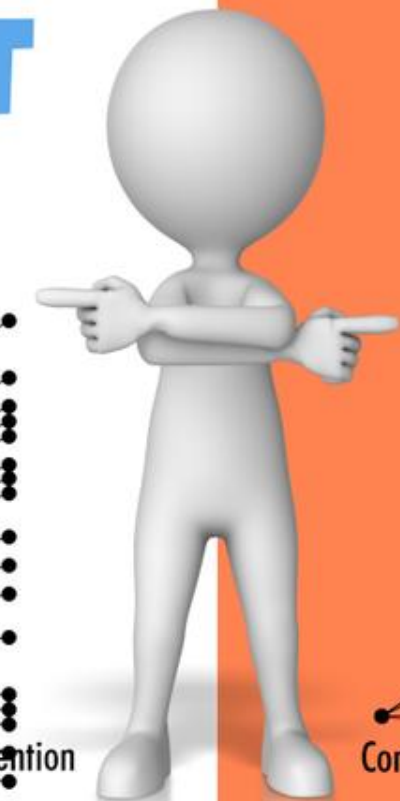
↑ Positive response



↓ Negative response

CONCLUSION OF THE SCIENTIST

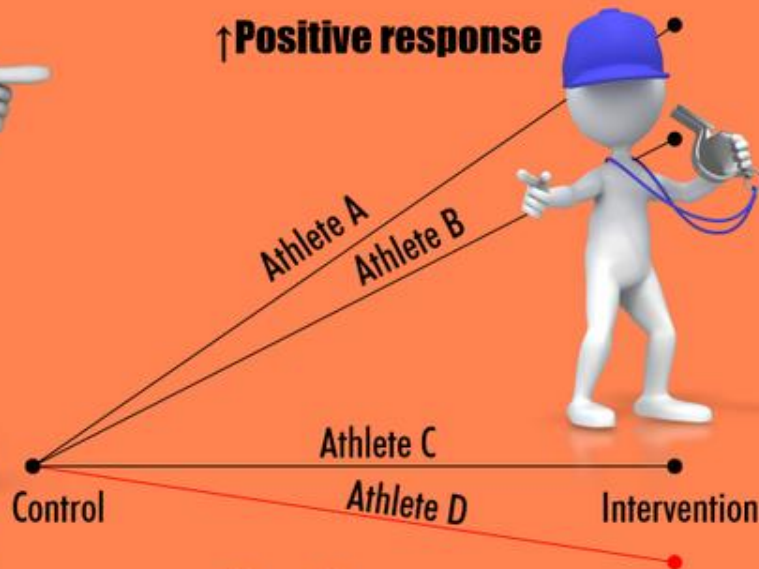
LIKELY POSITIVE EFFECT



COACH

Optimizing individual training strategies

↑ Positive response



↓ Negative response

CONCLUSION OF THE COACH

"I observe mitigated responses. I'm using it only with athletes A & B but it does not work for C & D"

IT IS NOT NECESSARILY CONTRADICTIONARY!

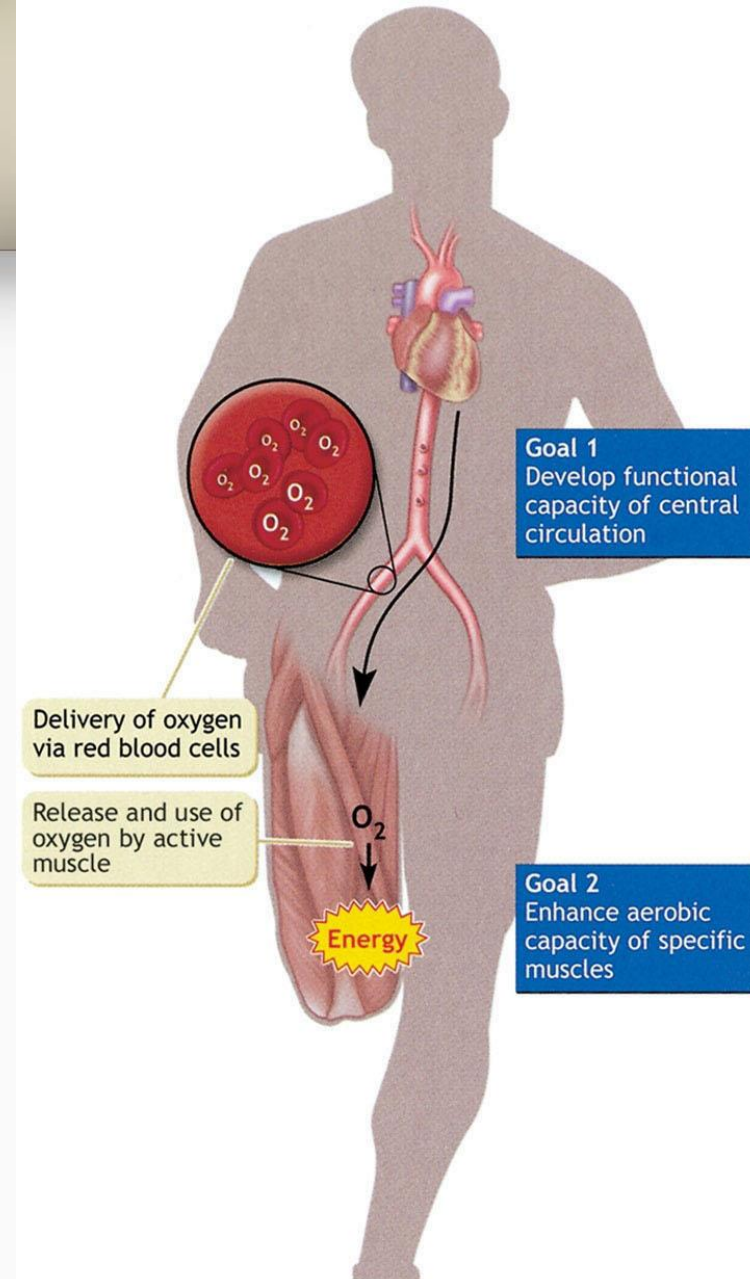
Key Considerations - Specific

- ✓ Movement patterns & mechanics
- ✓ Speed of Contraction
- ✓ Type of Muscular Contraction
- ✓ Energy Demands of Sport

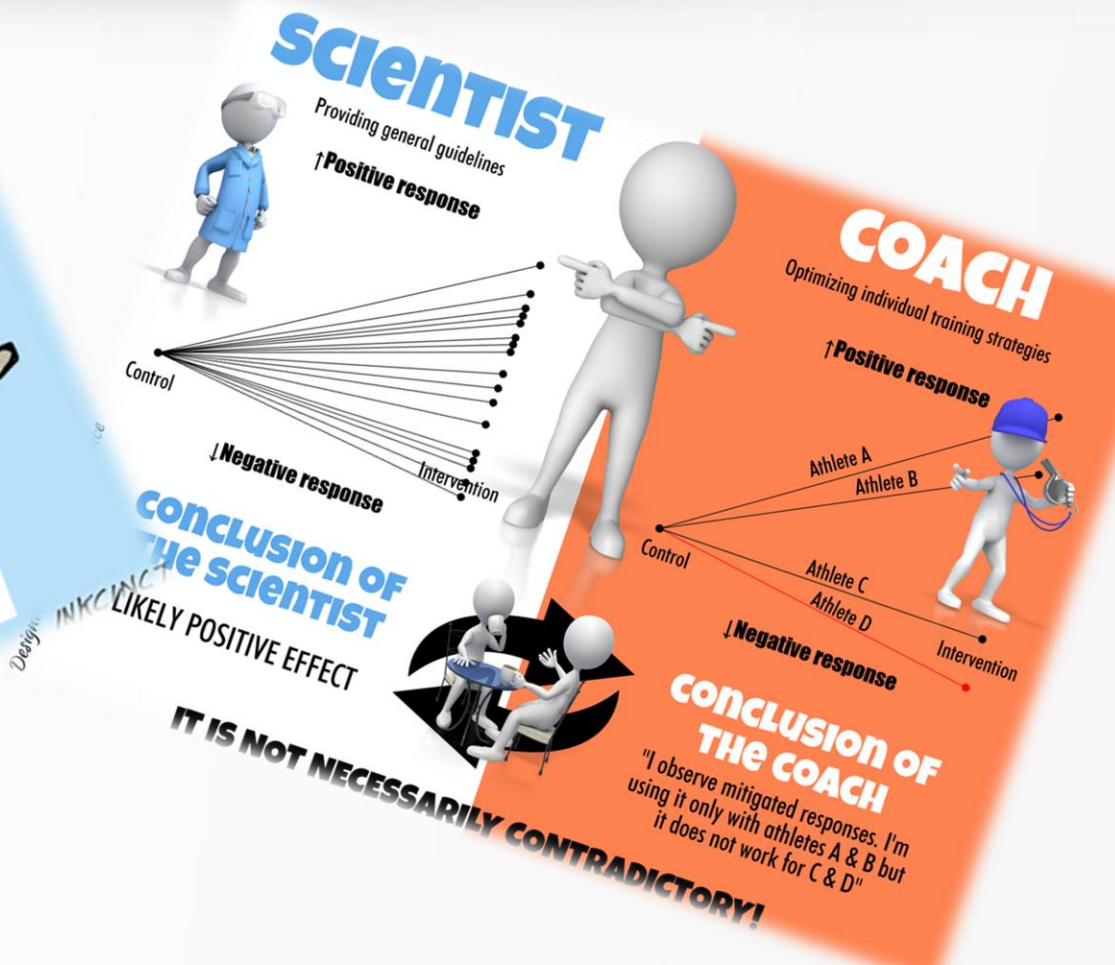


What's more Important?

- ✓ Central Capacity
- ✓ Peripheral Capacity



Research



Damasceno et al, 2015

European Journal of Applied Physiology

- “Effects of resistance training on 10km Running Performance”
- 18 runners (~40mins for 10k), 8 Weeks (Str vs Con)
- Str: 2 Sessions/Week, 8-10RM to 3-5RM
- Findings – 1RM +23%, Drop Jump +13%, Peak Treadmill Speed +3%, 10km TT -65sec's
- Higher Speeds during last 2800m of 10km TT

Karsten et al, 2015

International Journal of Sports Physiology and Performance

- “Effects of Sports Specific Maximal Strength & Conditioning Training on 5km Race Performance”
- 16 Moderately Trained, Recreational Endurance Runners
- Endurance Training vs. Concurrent MaxStr & End
- Combining a 6 Week S&C Program significantly improves 5km time trial performance. Removing S&C has negative effects on performance

Karsten et al, 2015

International Journal of Sports Physiology and Performance

Concluding Recommendations

- Integrate a twice weekly heavy resistance S&C
- Minimum of 6 weeks
- Maintain lower volume resistance training throughout competitive period
- 4x4 @80% for Maximal Strength Gains

“Strength Training for Endurance Athletes”

- Strength Training Exercises should involve similar muscle groups and imitate the sports specific movements
- RFD increased when athlete focuses on performing the concentric phase of the lift
- 2 Strength Training Sessions per week on a DUP model for a 12 week period
- Heavy for Strength. 2/3 x 4-10RM [3min]
- In Season: 1 Low Vol. High Int. Session/week

CONCURRENT TRAINING IN PREPUBESCENT CHILDREN

By Alves et al., JSCR, December 2015

Designed by @YLMSSportScience

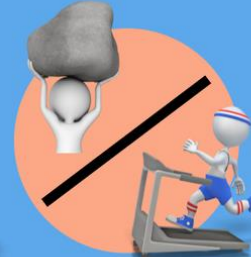
168 Children, aged 10-11 years old were randomly selected and assigned to three training groups to train twice a week for 8 weeks



CONTROL
No training



**COMBINED
STRENGTH &
AEROBIC TRAINING**
Same session



**STRENGTH &
AEROBIC
TRAINING**
Different sessions



**STRENGTH
TRAINING**

VO2MAX



JUMP



**1KG BALL
THROW**



Higher gains were observed for concurrent training when it was performed in different sessions. This finding suggests that concurrent training in two different sessions appears to be an effective and useful method for training-induced explosive strength and VO2max in prepubescent children



STRENGTH TRAINING FOR ENDURANCE PERFORMANCE

By Aagaard and Raastad, Endurance Training: Science & Practice, 2012



Designed by
@YLMsportScience



Strength training can be successfully used to increase short-duration and long-duration endurance capacity in untrained and well-trained individuals, as well as in highly trained top-level endurance athletes



- Fast-twitch type IIX fibres are converted into fatigue resistant type IIA muscles fibres along with improved muscle strength and rapid force characteristics

- Improvements in neuromuscular function and musculotendinous stiffness, the latter being especially important in sports involving stretch-shortening cycles as in running may also contribute to improved endurance performance

Strength training should involve multiple exercises (at least 2) for main targeted muscle groups

5-8 RM

Using heavy loadings performed in 3-5 sets



6-16 weeks

using a periodized training progression



THE EFFECTIVENESS OF EXERCISE INTERVENTIONS TO PREVENT SPORTS INJURIES

By Lauersen et al. in British Journal of Sports Medicine, 2014

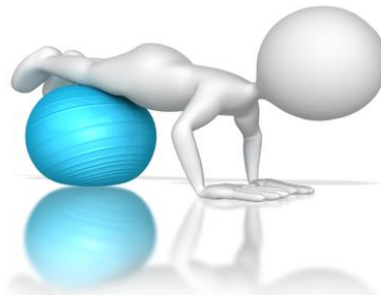


Designed by
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**26 610
subjects**

Do strength training, stretching or proprioception exercises protect against sports injury?

**3464
injuries**



- No benefit of stretching
- Injuries prevented by training proprioception or strength

1/3

Strength training reduces sports injuries to less than one third



50%

Overuse injuries could be almost halved by adequate strength training



PERFORMANCE

81%

Studies reported an increase in muscle power after a plyometric training program (observed in both athletes & non-athletes).



Reduces ground reaction test times

Improves running economy



WORKS FOR



PLYOMETRIC TRAINING

By @YLMsPortScience

Plyometric training involves performing bodyweight jumping-type exercises and throwing medicine balls using the so-called stretch-shortening cycle (SSC) muscle action.

INJURY PREVENTION

IF TRAINING LOAD IS WELL CONTROLLED

- NEUROMUSCULAR CONTROL
- MUSCLE STRENGTH
- MUSCLE-TENDON STIFFNESS
- BONE DENSITY
- ⋮ INJURY RISKS (ACL, etc.)



2-3 SESSIONS PER WEEK

>8 WEEKS



Employed to
➤ jumping ability

➤ sprint performance

➤ performance in endurance athletics events

➤ agility performance

SURFACES



"Aquatic- or sand-based plyometric training could elicit similar increases in jumping & sprinting perf as traditional plyometric training, but with substantially less muscle soreness."

Reference:
Markovic & Mikulic
Sports Medicine, 2010



“The systematic manipulation of the acute variables of training over a period that may range from days to years”

(Stoppani, 2006)

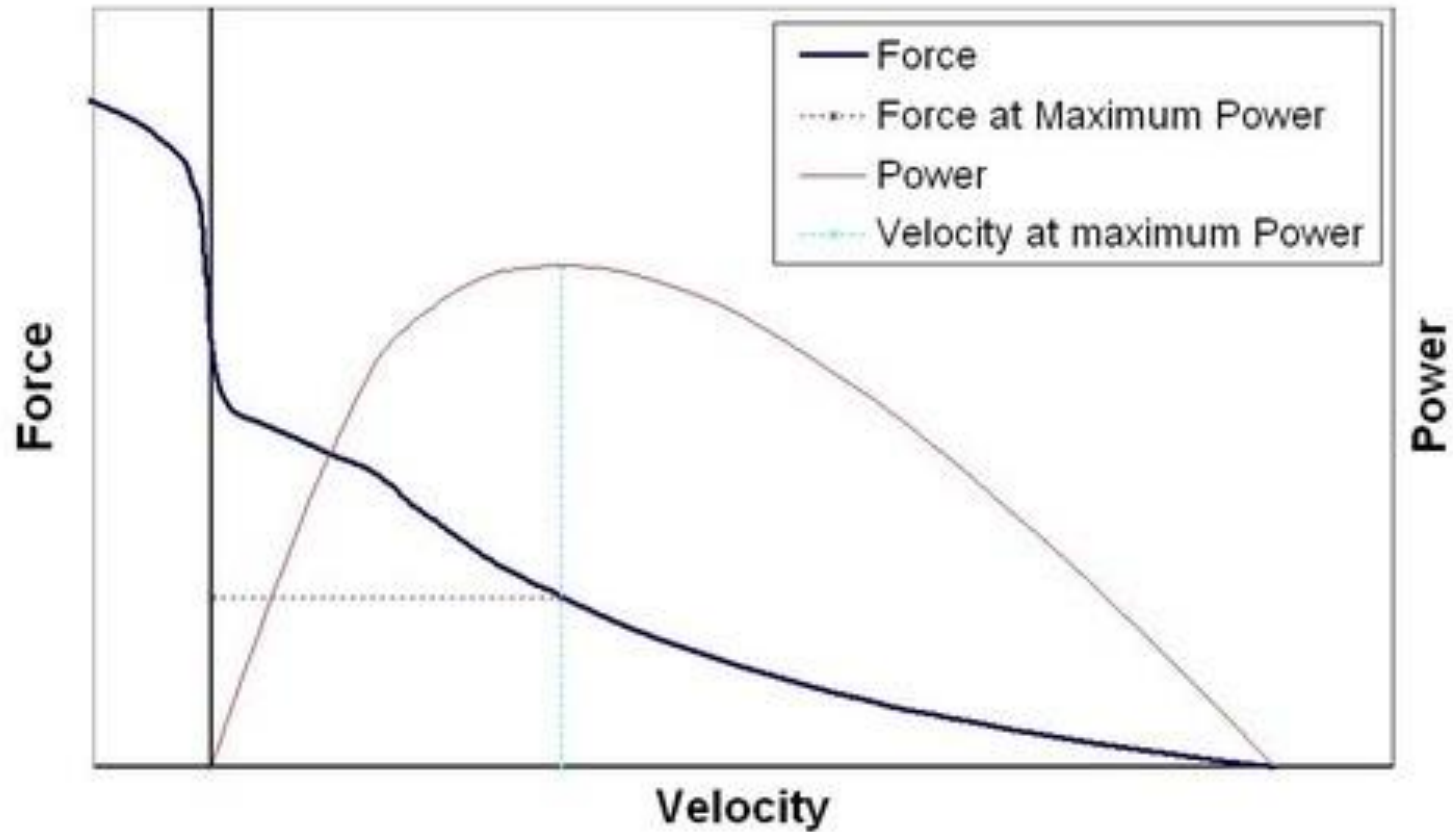
Power Periodization

“Everything works, but nothing works forever”



$$\text{Power} = F \times V$$

Force-Velocity Relationship



Power Periodization

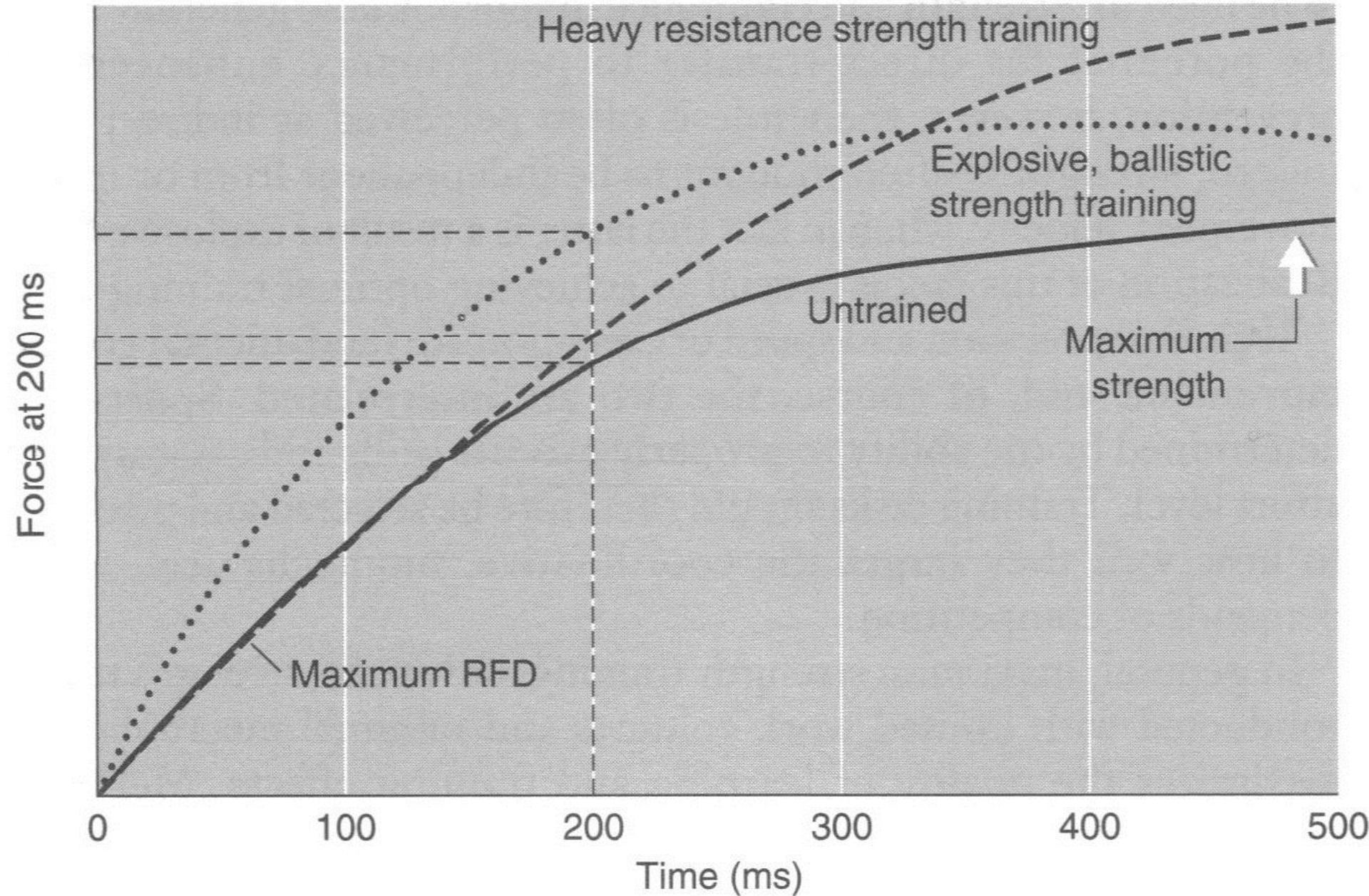
Execution times of most athletic tasks require a high **RFD** (Rate of Force Development)

E.G: Force is applied for 0.1 to 0.2 sec's during ground support phase

Locomotion activities are usually determined by the ability to generate force quickly resulting in a change in momentum (Force & Time)



Rate of Force Development and Impulse



Power Periodization

Thus, a basic objective of strength (Power) training is to improve RFD

The ability to generate greater impulse during the limited time (and distance) in which force is applied

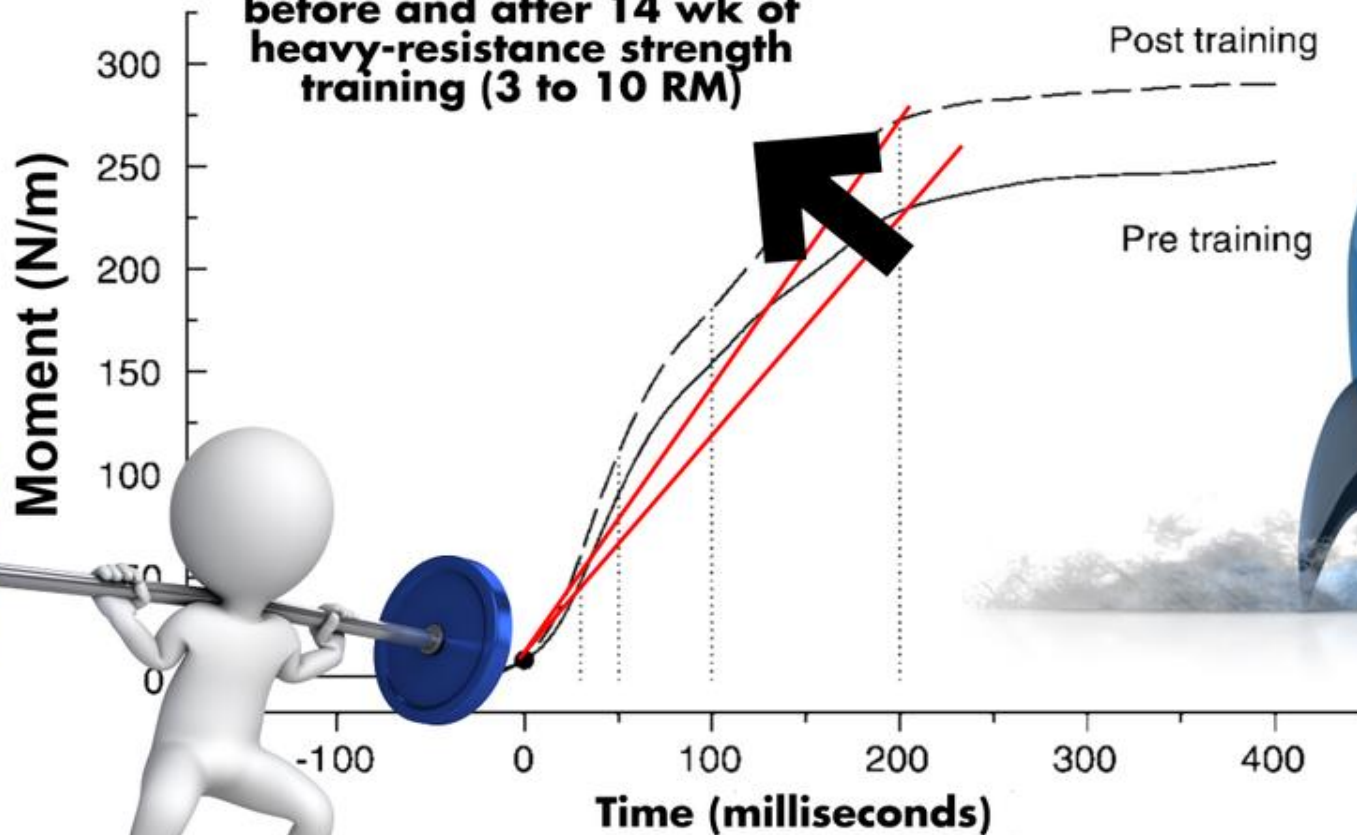
Force time relationship is a central component in motor programming and has important implications for motor control and learning



Increase your rate of force development with heavy-resistance strength training

Designed by @YLM SportScience

15 male participants tested before and after 14 wk of heavy-resistance strength training (3 to 10 RM)



Reference

by Aagaard et al.
Journal of Applied Physiology 2008

Increases in explosive muscle strength (contractile rate of force development and impulse) were observed after heavy-resistance strength training. These findings could be explained by an enhanced neural drive

Power, SSC, RFD and Pathway

Considerations:

- ✓ Movement patterns & mechanics
- ✓ Speed of Contraction
- ✓ Type of Muscular Contraction
- ✓ Energy Demands of Sport

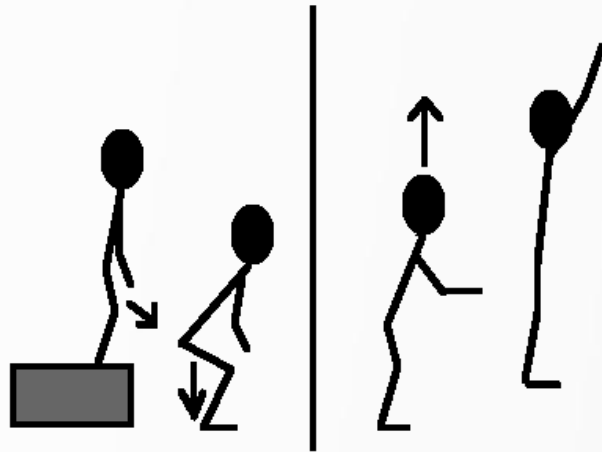


Power, SSC, RFD and Pathway

Stretch Shortening Cycle

Many Functional movements involve spring-like muscle-tendon actions and are ballistic in nature.

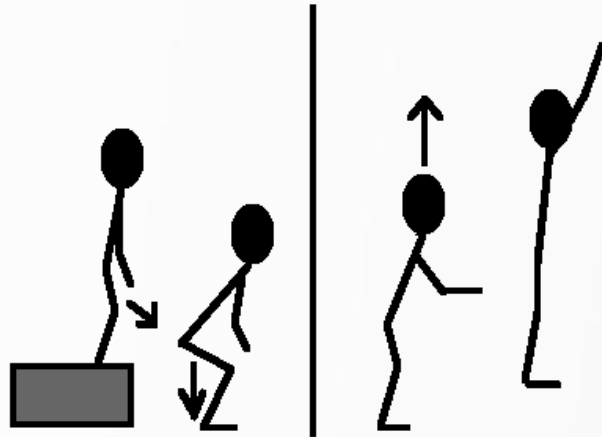
Eccentric-Concentric coupling is referred to as the SSC



Power, SSC, RFD and Pathway

Stretch Shortening Cycle

Begins with a preparatory countermovement in which the involved muscles are rapidly and forcibly lengthened or “stretch loaded” and immediately shortened in a reactive or elastic manner.



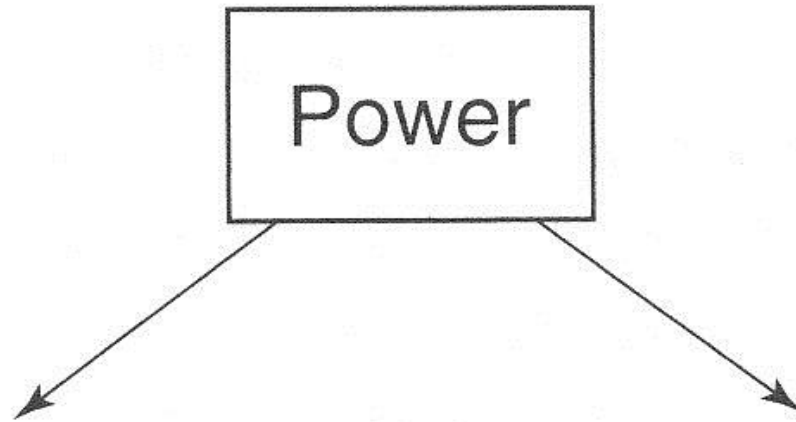
Power, SSC, RFD and Pathway

- Eccentric-Concentric coupling is referred to as the SSC.
- Sports involving:
 - Running
 - Jumping
 - Throwing
 - Rapid changes in direction & speed

FAST – Br Colm O Connell

Focus
Alignment
Stability
Timing





Phase 1	Phase 2
Increase recruitment of fast-twitch fibers	Increase the discharge rate of fast-twitch fibers

Figure 11.1 The physiological strategy used to increase power, speed, and agility.



Practical Guidelines

- Where to start with an athletes S&C?
- How many Sets & Reps?
- What Kind of Exercises?



Practical Guidelines

P P P - Hd Kd – Tb Tr Tar



Power, SSC, RFD and Pathway

Phases of Resistance Training

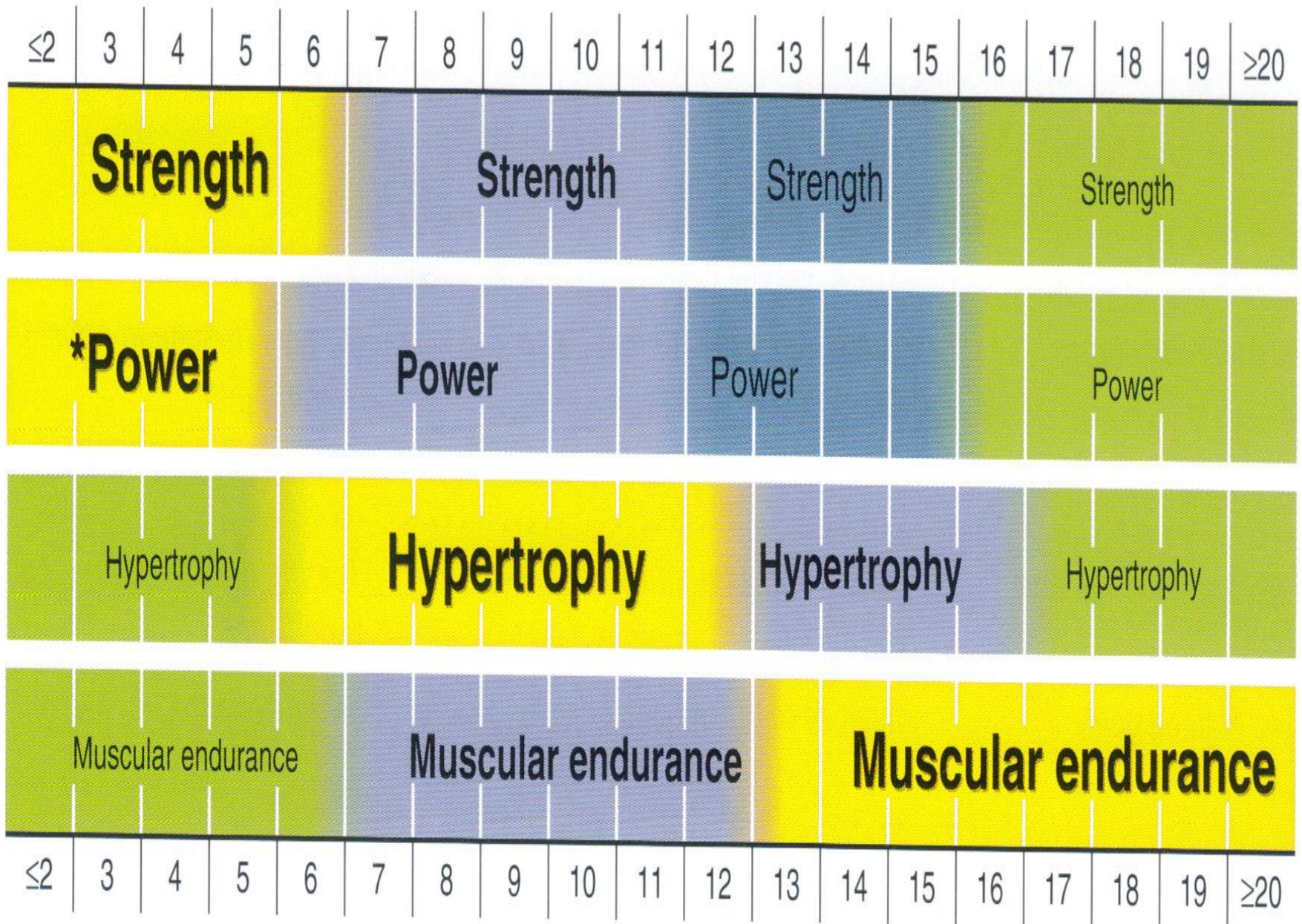
1. Anatomical Adaptation
 2. Hypertrophy Phase
 3. Maximum Strength Phase

 4. Conversion/Power Phase
 5. Maintenance Phase

 6. Cessation Phase
 7. Compensation/Transition Phase
- General Conditioning*
- Specific Conditioning*
- Transitional Conditioning*



Training goal



Repetition maximum continuum

NSCA, 2010

Practical Guidelines

Anatomical Adaptation

- **Goal:** To allow the ligaments, tendons and joints to adapt to external forces
- **Sample Session:** Circuit Training
- **Sample Exercises:** Bodyweight Push Ups, Squats, Pull Ups, Lunges, Plank, Side Plank, Superman, Donkey Kicks etc.



Practical Guidelines

Hypertrophy

- **Goal:** To increase Lean Body Mass.
- **Sample Session:** External Resistance than fatigues the body between 8 and 12 repetitions
- **Sample Exercises:** Chest/Bench Press, Lat Pull Down/One Arm Row, Squat/Front Squat, Upright Row, Lunges ,Shoulder Press, Horizontal Pulls, Shrugs



Practical Guidelines

Max Strength

- **Goal:** To increase the contractile strength of muscle fibres.
- **Sample Session:** External Resistance than fatigues the body between 4 and 6 repetitions
- **Sample Exercises:** Deadlift, Chest/Bench Press, Lat Pull Down/One Arm Row, Squat/Front Squat, Arnold Press, Step Up's, Seated Rows,



Practical Guidelines

Considerations for Specificity

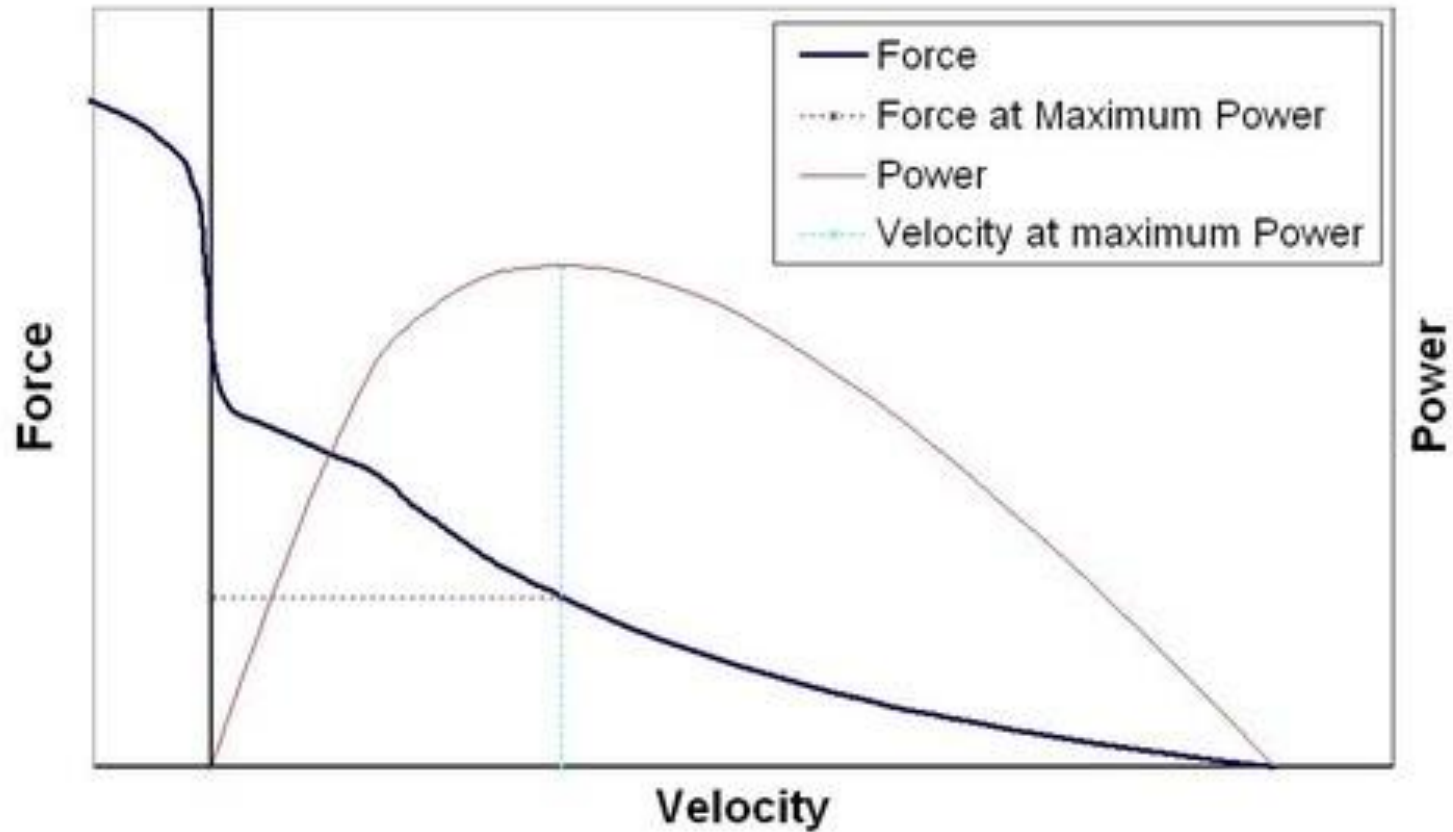
- Movement patterns & mechanics
- Speed of Contraction
- Type of Muscular Contraction
- Energy Demands of Sport

*Where can we develop Power from?
Are Olympic Style Lifts used with your Athletes?*

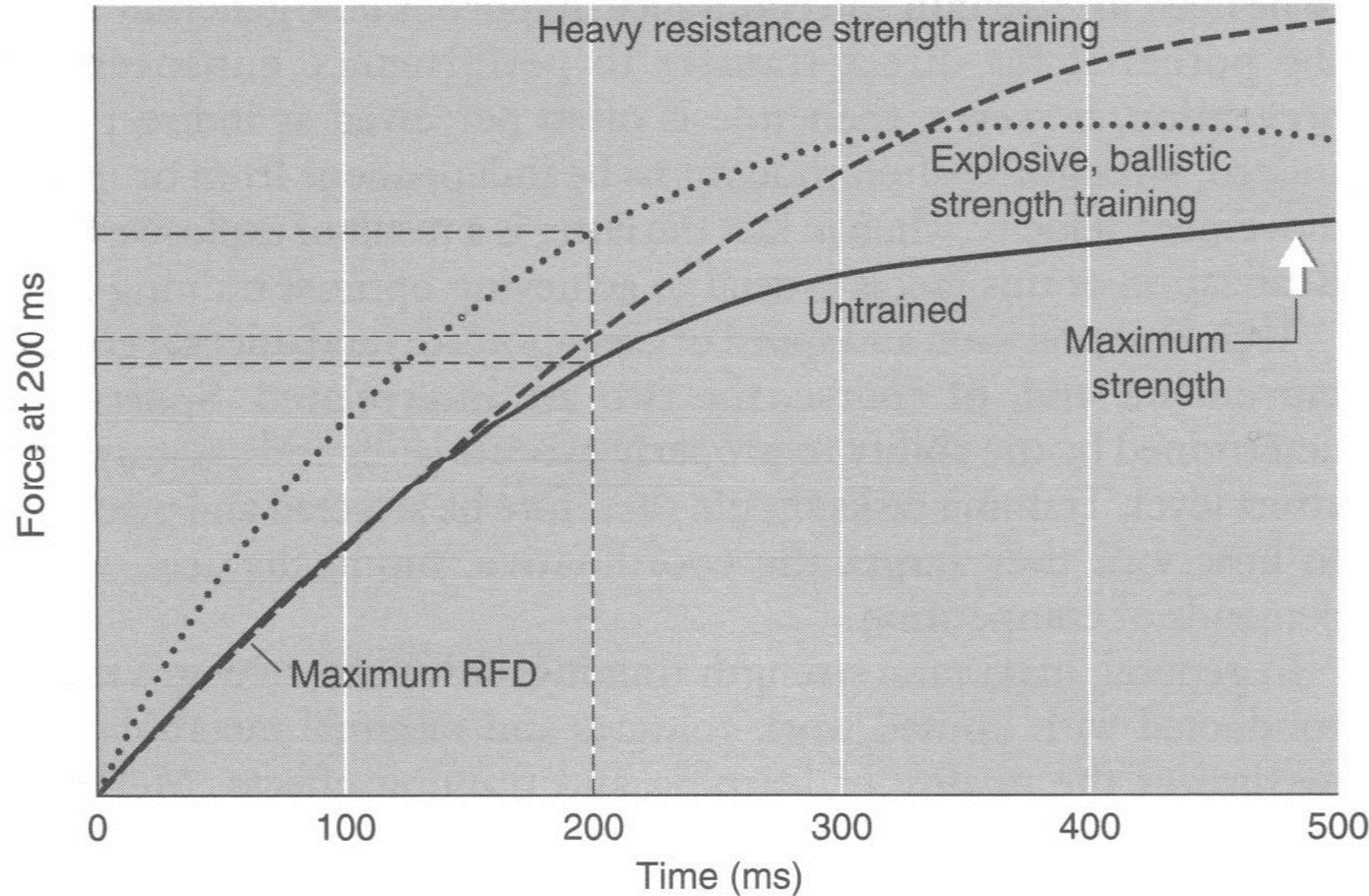


$$\text{Power} = F \times V$$

Force-Velocity Relationship



Rate of Force Development and Impulse



Practical Guidelines

Olympic Style Lifting for Athletes? – PRO's

- **Power**
 - Olympic lifts have produce a peak power 4-5 times of that of the Deadlift or Squat and 11–15 times of the bench press
- **Motor Coordination**
 - Orientation
 - Reactiveness, Rhythm and Balance
 - Combinatory and Adaptive Abilities
- **Systemic Effect**
 - Production of endogenous hormones
 - Stimulate muscle mass and strength to a greater degree



Practical Guidelines

Olympic Style Lifting for Athletes? – CON's

- **Extended Period of Time**
 - In order to optimise the benefits of Olympic Lifting as part of your training you need to first condition the body over a long period of time
- **Risk of Injury**
 - Greater force leads to greater risk of injury
- **Technical**
 - Each Compound lift comprises of many movements. Each has to be mastered to complete a safe & effective lift
- **Energy Taxing**
 - Metabolic Requirements are very high therefore extended recovery time is required.



Practical Guidelines

Power

- **Goal:** To achieve Peak Power Potential
- **Sample Session:** (A) Complex Training* (B) Olympic Lifting (C) Transfer to Event Specific Med Ball Sessions
- **Sample Exercises:**
 - Combine Compound lift with Plyometrics Exercise
 - Clean, Clean & Jerk, Split Clean & Jerk, Snatch,
 - Various Med Ball and Event Specific Exercises



Concluding Thoughts

Effective Strength Training

is

“Functional”



Concluding Thoughts

Phases of Resistance Training

1. Anatomical Adaptation
2. Hypertrophy Phase *General Conditioning*
3. Maximum Strength Phase

4. Conversion/Power Phase *Specific Conditioning*
5. Maintenance Phase

6. Cessation Phase
7. Compensation/Transition Phase *Transitional Conditioning*



Concluding Thoughts

Muscles act in functional task groups rather than in isolation

Therefore, athletes should emphasize compound or multi-joint exercises as a general approach to strength training.



Concluding Thoughts

Effects of heavy and explosive strength training on endurance performance

Designed by
@YLMSSportScience

Improved exercise economy

PROVEN

Improved lactate threshold

Improved maximal speed

No increased body mass

No reduced capillarization



Improved anaerobic capacity

Reduced or delayed fatigue

Improved maximal speed

No compromised relative VO₂max

Improved endurance performance

By Ronnestad & Mujika, Scand J Med Sci Sport, 201





Q&A

CIT 23rd January 2019

