Principles of Strength Training and Conditioning

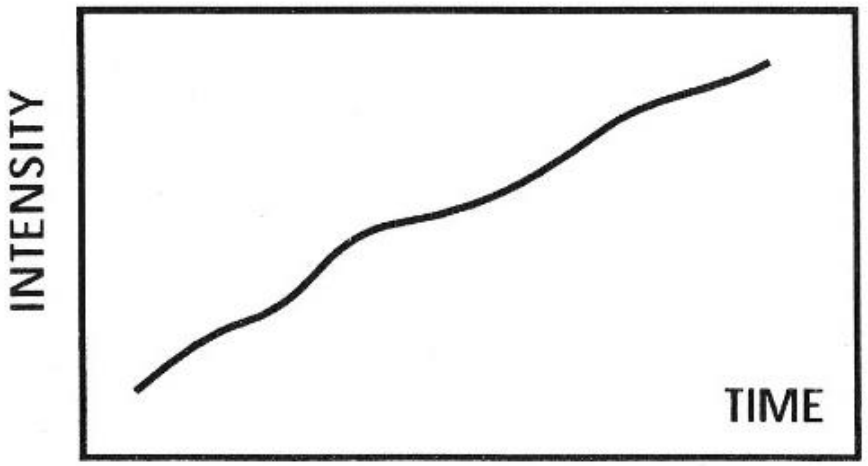
Training Principles

- The success and extent of training outcomes are dependent on the following principles
  - Progressive overload
  - Specificity
  - Variation (progression model)
  - Individualization
  - Recovery / De-loading

Progressive Overload

- Accommodation
  - Biological law where the response of a biological system to a given constant stimulus decreases over time
  - Can be viewed both as a positive and a negative outcome

- Progressive overload: gradual increase in stress placed on the body during training



Training time

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Progressive Overload

- In principle, there are two ways to produce an overload
  - Qualitative – selecting difficult/complex exercises
  - Quantitative –varying training load and goal
- Options:
  - Exercise complexity
    - e.g. squat: back → front → overhead
  - Resistance / load
  - Sets | Repetitions | Rest intervals
  - Training frequency
  - Lifting velocity with submaximal loads may be increased once technique is mastered

Progressive Overload

- Options (con't)
  - Training methodology, examples:
    - Rest/pauses (aka cluster sets): short 10-20s between single or a group of repetitions
    - Drop sets: performing successive sets to failure w/ decreasing resistance
    - Iso-dynamic contrasts: 3-5 s pause at the midpoint of a rep (reversal from ECC-CON)
    - Tempo contrast: performing some reps (odd) slowly and some (even) quickly
  - Improve mental focus:
    - Creating an efficient nervous system
    - Mental aspect (mind-body link) should not be dismissed

Principle of Specificity

- All training adaptations are largely specific to the stimulus applied
  - Fitness enthusiast: look good and move well while being healthy
  - Athletes: focus is on field performance
- Specificity as an issue of transfer may be Positive | Negative | Neutral
- Specificity of adaptation increases with the level of fitness for both athletes and fitness enthusiasts
  - For beginners almost all exercises are useful and yield positive transfer
  - For advanced individuals the transfer is lower
    - Increases in strength and power are not as critical as the mastery of skill itself

Principle of Specificity

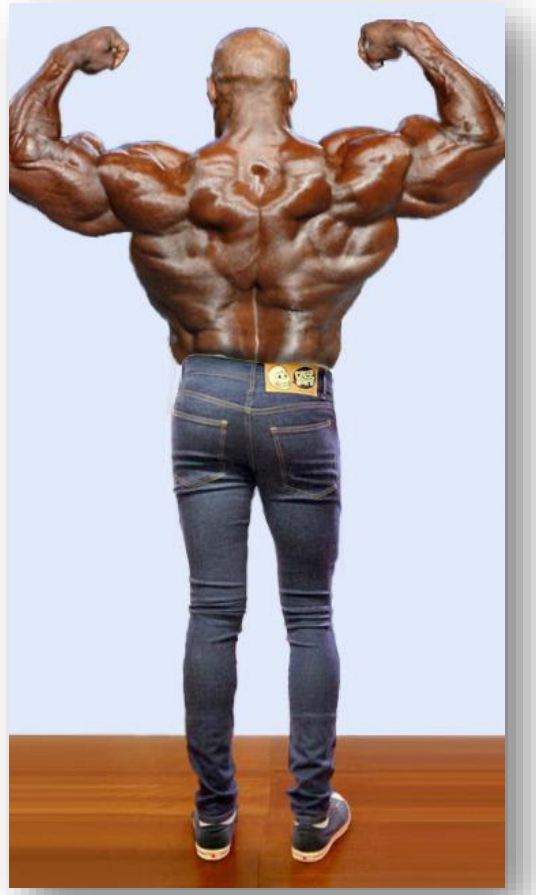
- Muscle Action
  - ECC, CON & ISOM actions increase muscle strength
  - Strength gains are specific to the type of muscle action trained
- Range of Motion
  - Partial ROM training strength increases are specific to the joint angles trained
  - Partials may be warranted where the demand for high force production is needed
    - Primarily for sport application purposes

Principle of Specificity

- Velocity of Movement
  - Greatest strength increases take place at or near training velocity
  - Isokinetic experiments
    - Some carryover effect above and below training velocity
    - Moderate velocity (180 - 240°/sec) produces greatest strength increase across all testing velocities
  - Greatest carryover effects seen in untrained or moderately trained individuals
  - Advanced trainees benefit greatly from training at a velocity specific to their needs
  - Strength/power athletes benefit most from high velocity movements

Principle of Specificity

- Muscle Groups Trained
  - Adaptations occur mainly in muscle groups that are trained
  - Lower body training ⟷ upper body training
  - Training all major muscle groups is important for:
    - Attaining muscle balance
    - Reducing risk of injuries
    - Optimizing performance



Principle of Specificity

- Energy Metabolism
  - Adaptations to training are specific to energy system involvement
  - Energy systems adapt mostly by increasing:
    - Enzyme activity
    - Substrate storage/usage
  - Interaction between volume, intensity, repetition velocity, & rest-interval length is critical to eliciting acute metabolic responses that target different systems

Principle of Specificity

- Movement Patterns
  - Free weights versus machines
    - Free weight duplicate actual movement patterns more closely than machines
  - Open- vs. closed-chain kinetic exercises
    - Extremity free to move against load vs fixed
    - Upper body typically functions in an open-chain kinetic system
    - Lower body typically functions in a closed-chain kinetic system
      - Questionable value of liable surface exercises for strength and power training

Principle of Specificity

- Movement Patterns
  - Unilateral Training
    - Cross education: strength gain carried over to opposite limb
      - Strength increase of ~7-8% or about ⅓ of the trained side
      - Useful when a limb is injured
  - Bilateral Deficit
    - Max force produced in bilateral contraction is less than the sum of limbs contracting unilaterally
      - Deficit ranges approximately 2-20% in upper limbs
      - Deficit ranges approximately 10-25% in lower limbs

Principle of Specificity

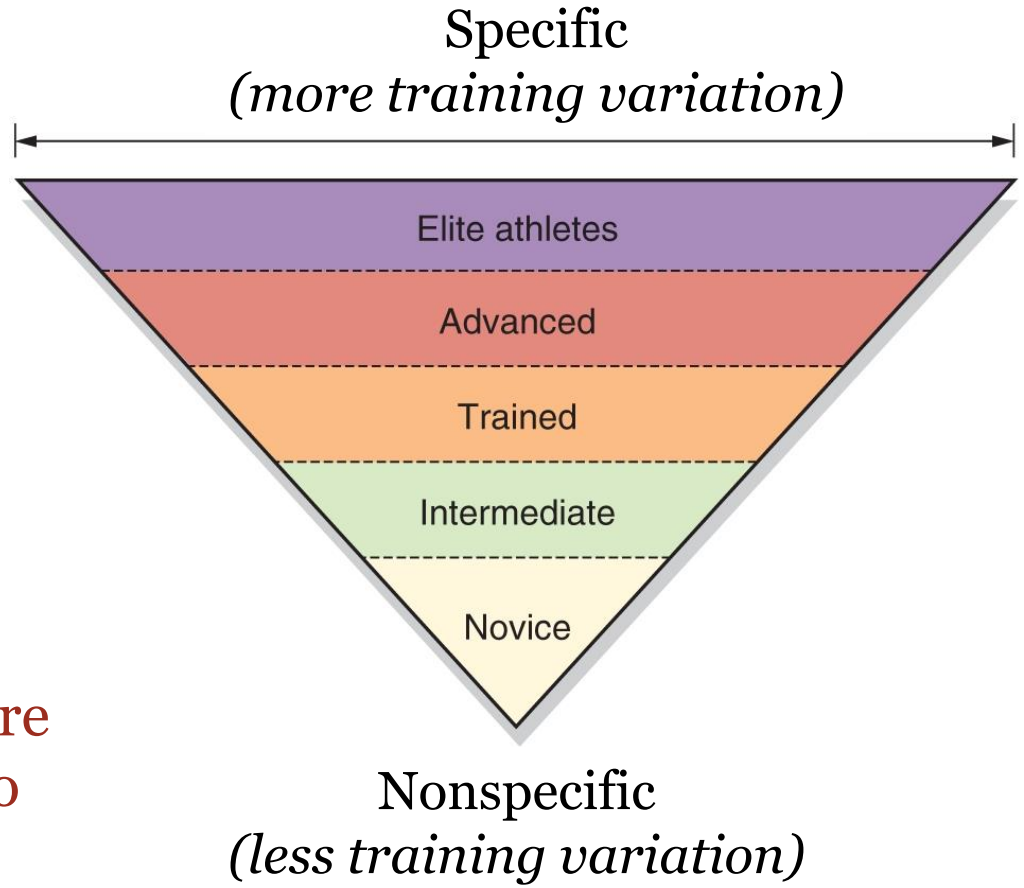
- Movement Patterns
  - Movement-specific training
    - Overweight/underweight implements should not exceed 5% - 20% of normal load for throwing athletes
      - Alter movement mechanics

Progressive Overload + Specificity = Variation

- Alterations to program variables is key to providing optimal training stimulus
  - Human body adapts rapidly to stress
  - Variation is critical for subsequent adaptations to take place
  - Systematic variation of volume & intensity is most effective for long-term progression
- Training status dictates the pattern of progression for a fitness component
  - Rate & magnitude of progression decrease with higher levels of conditioning
  - Plateaus near genetic ceiling

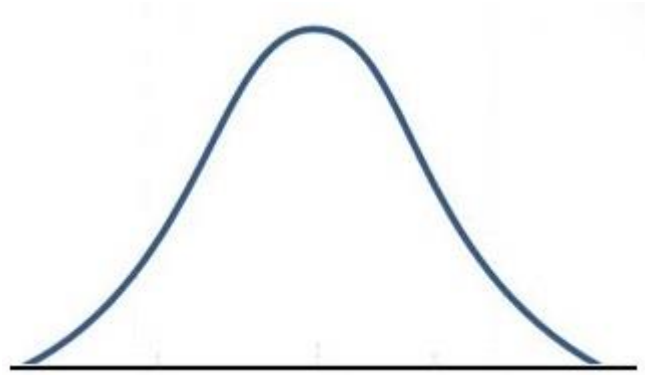
Progressive Overload + Specificity = Variation

- General-to-Specific Model of Progression
  - Untrained people
    - Less-specific training is sufficient
    - No need for complexity
    - Training characterized by:
      - Learning proper technique
      - Building conditioning base
  - Advanced training targeting progression is more complex & requires greater variation specific to training goals



Principle of Individualization

- All individuals respond differently to training
- Factors involved in individual level of adaptation:
  - Genetics
  - Training status
  - Nutritional intake
  - Program
- The most effective programs are those designed to meet individual needs



Performance response to a given training stimulus

Principle of Recovery / De-loading

- Detraining: near or complete cessation of training
  - Loss of adaptations associated with training may occur in as little as 2 weeks
- Progressive overload principle is not sustainable
  - Should be more correctly applied as fluctuating overload
- Periodic training modification to further gains in fitness is the central premise of periodization

Principle of Recovery / De-loading

- Recovery / De-loading options:
  - Volume reduction (total reps per exercise reduced by 40%)
  - Intensity reduction (with an increase in reps)
  - “Testing-only” week
  - Rehab week (therapeutic exercises)
  - Learning a new movement
  - Complete rest
  - Active rest (non-RT)
  - Exercise or frequency reduction

Movement Prep

Warm-Up

Benefits of Warm-Up

- An adequate warm-up minimizes the risk of injury and aids performance
- Neurological benefits:
  - Facilitates neural transmission and muscle activation
  - Improves rate of force development and reaction time
  - Improves strength and power
- Metabolic benefits:
  - Accelerates chemical reactions

Benefits of Warm-Up

- Circulatory benefits:
  - Increases blood flow to muscles
  - Improves oxygen delivery
- Movement benefit:
  - Increase body and muscle temperature
  - Increases proprioception (spatial awareness)
  - Heightens coordination and joint stabilization
  - Emphasize general movement patterns

General Warm-Up

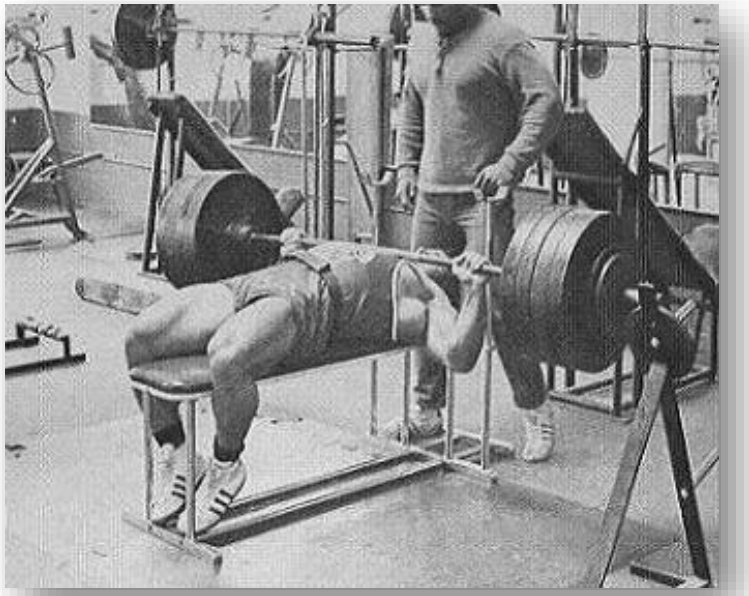
- Goal of a general warm-up is to increase blood flow and muscle temperature
- Especially important when exercising in the morning or in a 'cold' state.
- May be Passive or Active
  - Passive: hot shower, sauna, heat application
  - Active: 5-10 min of low intensity cardiovascular exercise

Specific Warm-Up

- Relies on the actual movement of the activity performed easily at first to provide a highly specific WU and neuromuscular preparatory phase.
- 5 - 15 min focusing on movements that work through the range of motion required by the activity
- Progression in exercise specificity & intensity
  - Include: calisthenics, technique drills, resistance exercises, medicine ball drills, flexibility exercises, plyometrics, sprint and agility drills
- Content & structure is activity specific

Specific Warm-Up for Resistance Training

- Generally includes preparatory movements and some initial ‘warm-up’ sets to an exercise
- Are often inappropriately performed, either:
  - too brief (e.g. 1-2 sets w/ light weights)
  - too long (e.g. multiple sets, almost rep’ing-out with progressively heavier weights)



Specific Warm-Up for Resistance Training

- A proper specific RT WU should include 'warm-up' and 'weight acclimation' sets
  - Acclimation sets prepare muscle and supporting soft tissue for upcoming heavy weights

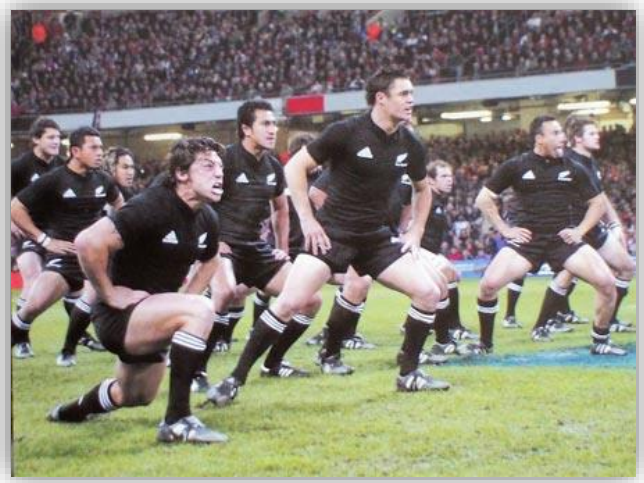
Example: Bench Press, target training weight 275 lbs

	Common Approach	Better Approach	
	135 lbs x 10-15 reps	135 lbs x 5-8 reps (warm-up)	
50	185 lbs x 10 reps	185 lbs x 3 reps (acclimation)	50
20	205 lbs x 5 reps	225 lbs x 1 reps (acclimation)	40
20	225 lbs x 5 reps	245 lbs x 1 reps (acclimation)	20
20	245 lbs x 5 reps	275 lbs x *~4-6 reps*	30
30	275 lbs x *~2-3 reps*	*w/ multiple sets*	

35-40 reps vs. 10-13 reps

Stretching as Part of a Warm-Up

- Stretching alone does not appear to reduce the risk of injury
  - Also, stretching before or after exercise has no effect on the prevention DOMS
- Stretching in and of itself does not constitute a warm-up
  - Although it may be included as part of one
- If stretching routines are to be included in a warm up, they should not interfere with the WU's goals and benefits



Principles of Stretching

- Synchronize breathing with movement
  - Short-rapid breathing stimulates SNS
- Match stretching method to the conditions at hand
  - Warm up versus cool down
- Prioritize stretching of tight muscles
- Gain ROM without pain
  - Should not feel tight or sore after stretching
- Employ multiple planes of movement
  - Movement is generally non-linear

Static Stretching

- Positions typically held between 15 – 90 seconds
  - 30s considered optimal
- Likelihood of injury proportional to intensity
- Literature suggests:
  - Impaired blood flow during the stretching period
  - Strength (force) deficit immediately following stretch
  - Power (vertical jump) impairments immediately following stretch
  - Decreased muscle activation (EMG) immediately following stretch
  - Decreased reaction and movement time and balance
  - Prolonged ground contact times

Dynamic (Active) Stretching

- Consists of controlled movements / swings that take the limbs to the limits of their range of motion
- 8-15 repetitions are typically performed over 10-20 yard distance
- Most closely matches the general goals of a warm up