Are your athletes getting better and how would you know?

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Background

- Fundamentally, our goal is to make sure our athletes are getting better in the right ways.
- But how do we know we are actually accomplishing this?

Tests that we use need to be:

- Reliable
  - *Are we getting consistent measurements when we should be?*
- Valid
  - *Does the test measure what we think it measures?*

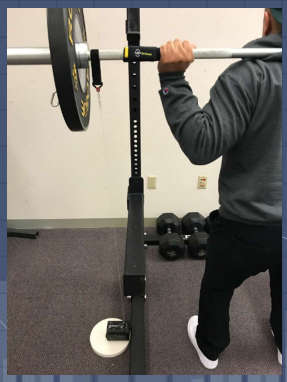
Tests that we use should be:

- Specific to our athlete's needs
  - *Does this test reflect qualities that are related to her performance?*
- Practically feasible
  - *Do we have the equipment, facilities, expertise, and time to do this test?*

Isolating the information we want

- Measured Value = True Value + Error

=



+ noise

Such as:
- Fatigue
- Weather
- Time

What is error/noise?

- Anything that obscures our ability to measure the 'true value'
- Sources of error
  - Test conditions
    - environment, time of day, proximity to training sessions, where in training year
  - Tester
    - Instructions, encouragement, sport coach present?
  - Athlete being tested
    - Fatigue, soreness, injury, motivation

Tracking Change

Test Reliability

- Reliability of test is related to noise
- A less reliable test = harder to determine actual change

- Suppose a vertical jump test under perfect conditions has error of ±5% on average. This means that you need to see a change of >5% before you even consider that there *might* be a change!

Test Reliability

- Note that variations in how you conduct a test (instructions, time, etc) will generally decrease reliability, resulting in more difficulty detecting change
- That ±5% error on a vertical jump test could increase without consistency of test conditions!

Test Reliability

- Look to the published research on a given test – this will tell you how much error is typical for a given test, with a given population
- Look for "Typical Error (TE)" or "Standard Error of Measurement"
- Can be calculated from ICC:
  - $TE = SD \times \sqrt{1 - ICC}$

Hopkins, "Precision of Measurement" in: A New View of Statistics, 2012.

Test Validity

- Does this test reflect the qualities I'm interested in measuring?
  - (Remember that we aren't interested the test itself)
- Example:
  - Medicine Ball chest pass and plyo pushup
- Note that athletes must be familiarized before a test is considered valid

C. Harris, et al. Strength Cond. Res. 25 (2011) 2344–2348.

Test Specificity

- Test needs to reflect qualities that are specific to:
  - Athlete's training history
  - Athlete's sport
  - Athlete's level of play
  - Others?
- Medicine ball chest pass may be a valid measure of upper body explosiveness, but does it reflect any aspect of on-field performance for your athlete?

Test Specificity

- General tests of strength, explosiveness, balance, speed can be useful, especially at lower levels of play and ability
- The greater the level of competition and ability level, the greater the need for higher test specificity (but not necessarily)

Test Specificity

- Example test battery for a high school softball player:
  - 60 ft sprint
  - Vertical jump with evaluation of landing
  - Deadlift 3RM
- Example test battery for a DI college softball player:
  - Home to 2nd base sprint, split time at 1st
  - Backwards MB throw for distance
  - Side MB throw for distance
  - Power clean 3RM

"Real change" versus "meaningful change"

- A "real change" is one that you are reasonably sure took place
- A "meaningful change" is one in which the magnitude of change matters

How do we know when real change has occurred?

- Consider the magnitude of change in relation to error of the test
  - Conservatively, look for change of greater than ~2.8X typical error of the test (called smallest detectable difference, or SDD)
  - $SDD = 1.96 \times \sqrt{2} \times TE$
  - If change is greater than this, you can be confident a change actually occurred.

H. Beckerman, et al., Qual. Life Res. 10 (2001) 571–578.

How do we know when real change has occurred?

- Is an increase of 2 in jump height measured with the Vertec "real" for a D1 football player?
  - Probably yes. SDD from one study was 0.86in.
- Is an increase of 5 lb in power clean 1RM for a novice athlete "real"?
  - Probably not. SDD from one study was 8.3lb.

V. Brodt, D.R. Wagner, E.M. Heath, J. Strength Cond. Res. 22 (2008) 1382–1385.
P. Comfort, J.J. McMahon, J. Strength Cond. Res. 29 (2015) 3089–3096.

How do we know when meaningful change has occurred?

- Consider the magnitude of change in relation to other athletes on the team
  - Called "Smallest Worthwhile Change" (SWC)
  - Look for change of greater than 0.2*standard deviation of group results for the test
  - This indicates that the athlete has made meaningful change compared her peers

Hopkins, "Precision of Measurement" in: A New View of Statistics, 2012.

How do we know when meaningful change has occurred?

- Is an increase of 2 in jump height for Vertec "meaningful" for a D1 football player?
  - Probably yes, SWC in one study was 0.63in
- Is an increase of 5 lb in power clean 1RM for a novice athlete "meaningful"?
  - Probably not, SWC in one study was 10.6lb

V. Brodt, D.R. Wagner, E.M. Heath, J. Strength Cond. Res. 22 (2008) 1382–1385.
P. Comfort, J.J. McMahon, J. Strength Cond. Res. 29 (2015) 3089–3096.

How do we improve our ability to detect change?

- Choose good tests
- Be consistent
  - Use the same equipment
  - Same time of day
  - Same instructions
  - Same tester
- Ensure athlete is rested, uninjured etc
  - Ideally 72h after last hard training session
- Do multiple trials and average them

Countermovement Jumps

1. Verify that they do not have any injuries that would preclude them from this testing (knee, back etc)
2. Explain that the goal of testing is to jump as high as possible, and that when they land, they need to initially land with straight legs
3. Hand them a PVC pipe to hold across their shoulders
4. 50% effort trial
    a. Explain that this will be a 50% warmup trial
    b. Have them step on the force plate
    c. Have them find their jumping stance, and then stand upright very still
    d. Say "3,2,1 jump"
    e. Verify that they land "tall"
    f. Verify that they had a stable baseline leading into unweighting phase of CMJ
5. 75% effort trial
    a. Repeat step 4
6. 100% trials
    a. Explain that goal is to jump as high as they possibly can
    b. Ensure that file is named correctly: "Subject xx - CMJ trial yy"
    c. With athlete off of the force plate, click zero
    d. Click "start"
    e. Athlete steps onto plate, finds jumping position
    f. Remind "jump as high as you can"
    g. Say "3,2,1 jump"
    h. Click stop
7. Repeat 6 until you have 2 good trials
    a. Ensure stable baseline
    b. Ensure that you got maximum effort (you can usually see when it wasn't a max jump - you can ask athlete too)

Ballistic Ball Validation Data Collection Sheet -

Subject Number	
Height	
Weight	
Age	
Date	
Time	

How do we improve our ability to detect change?

- Be mindful of:
  - Practice effect
  - Fatigue effect
- Consider:
  - What is optimal order of my tests?
  - Should I spread out tests to multiple days?

Summary

- Testing is critical for ensuring that your athlete is improving, and in the right way
- Making "real" and "meaningful" changes requires greater magnitudes than you think
- Note that to detect a change that is both "real" and "meaningful", the change should be higher than the SDD AND SWC.
- Pick tests based on usefulness to your situation, but…
- Ensure they are reliable and valid

Some numbers for common tests

- 300m shuttle, female high school basketball
  - TE: 2.2s SDD: 6.1s SWC: 1.1s
- 1RM back squat males and females
  - TE: 2.5kg, SDD: 7.28kg, SWC: 6.8kg
- 40yd dash in college football
  - Electronic: TE: 0.03s, SDD: 0.09s, SWC: 0.05s
  - Hand timed: TE: 0.08s, SDD: 0.23s, SWC: 0.08s

K. White, M. DeBeliso, T. Sevene, K. Adams, J. Sports Sci. 3 (2015) 214–218.
P. Comfort, J.J. McMahon, J. Strength Cond. Res. 29 (2015) 3089–3096.
J.L. Mayhew, J.J. Houser, B.B. Briney, T.B. Williams, F.C. Piper, W.F. Brechue, J. Strength Cond. Res. 24 (2010) 447–451.

You can calculate all of these yourself

- Online Link to Spreadsheet
- Local link to spreadsheet

Thank You! Questions?

- Link to slides and spreadsheet:
  - http://georgebeckham.com/ghpfiles
- Contact:
  - gbeckham@csumb.edu
  - georgebeckham.com