Practice Makes Perfect: Motor Learning Theory Into Application

Shawn Myszka, MS, CSCS*D
Before we begin...

Words to *always* live by in this field

“Absorb what is useful.
Discard what is not,
Add what is uniquely your own.”
Outline for Today

- Traditional Theories of Motor Control/Learning
- Constraints & their role in emergent movement
- Changing the perspective on Motor Learning
- Designing the Movement Practice Structure
- Use of Instructional Methods
- Delivery of Augmented Feedback
Question for you all to think about:

How do you currently view motor behavior (*control & learning*) and how does your understanding influence the way you coach & teach?
What is Movement Skill Acquisition?

• The internal processes that bring about relatively permanent changes in the learner’s movement capabilities (*Schmidt/Wrisberg)

• Distinct from the execution of skill (motor learning vs. motor performance)

• Is developed through practice, instruction, & experiences
What is Mastery in Movement?

Ownership, Optimization, Virtuosity, Efficiency, & Effectiveness
Everything in Life is Movement

Movement is not something you do. It’s something you are. It’s living, breathing, and moldable. Man is his movement.

*Myszka, 2013*
Everything in Life is Movement

Mastery of one’s behaviors leads to mastery of one’s movement

“We are what we repeatedly do. Excellence then, is not an act, but a habit.”

Aristotle
Traditional Theory of Motor Control

Generalized Motor Program/Schema Theory

*RA Schmidt, 1975
Traditional Theory of Motor Learning

Fitt’s Stages of Motor Learning

Stage 3: Autonomous Stage
- Almost automatic/habitual
- Subconscious control
- Multitask
- Minimal performance variability
- Very few errors

Stage 2: Associative Stage
- Associate environmental cues with actions
- Achieving consistency
- Refinement
- Fewer/smaller errors
- Can detect and correct errors

Stage 1: Verbal-Cognitive Stage
- Identifying task goal
- Self-talk/questioning
- Rapid performance
- Error-ridden
- Clumsy/inefficient

*Fitts & Posner, 1964
Implications for Movement Professionals from those theories

• Idealized movement patterns

• Perfect practice makes perfect

• The more practice...the better (do more reps)

• Offer constant instruction and feedback
There may be some limitations though

• How about authenticity?

• Degrees of Freedom Problem

• Our capacity storage is limited

• What about novel movements?

• *What really is perfect practice?*
Another MAJOR glaring problem

How can you prescribe the most accurate solution when you haven’t accurately defined the problem?
How does sport movement emerge?

An athlete performing a variable task in the ever-changing environment of sport

*Davids, et al 2008  *Newell
The 3 B’s of Movement Skill
How the HMS interacts with the environment

Interactions:
• An athlete’s intention (Brain)
• An athlete’s attention (Behaviors)
• Calibration (Biomechanics)

*Scott, 2004
The Perceptual-Motor Landscape

As a learner changes throughout skill acquisition the perceptual-motor landscape gets altered and begins to reflect the athlete’s intrinsic dynamics

*Davids, et al 2008*
Bernstein’s Problem

Mastering the redundant DOF (Bernstein 1967)
The Role of Movement Variability

• The large # of DOF naturally affords variability as a means of adaptation
• Think both inter and intra-individual
• Don’t always treat movement variability as a bad thing! Could just be the athlete exploring the perceptual-motor landscape & testing solutions
• As skill ACQ & mastery increase, the attractor well will widen and allow for less effects from task & environmental perturbations
Newell’s Model – Stage 1
Assembly of Coordination Pattern

• Establish basic relationships among key components of HMS
• Explore the perceptual-motor landscape
• Fix/freeze DOF in order to simplify the solution
Newell’s Model – Stage 2
Control of Coordination Pattern

• Begin to find a fit between the coordination pattern and the dynamic environment
• Start to add functional variability by taking advantage of affordances for action
• Begin to release/unfreeze additional DOF
Newell’s Model – Stage 3
Optimization of Coordination Pattern

- Start exploiting environmental info sources to have a tighter coupling for affordances
- Stable but flexible movement execution
- Characterized by fluidity, efficiency, and adaptability
Crafting the Perceptual-Motor Landscape (i.e. Skill Acquisition)

• Realize that movement skill ACQ is nonlinear

• Need to have the 3 B’s in movement practice

• Centered on error detection & correction

• Challenge the athlete in practice to explore
Crafting the Perceptual-Motor Landscape (i.e. Skill Acquisition)

From the man (Bernstein) himself; on his ideas towards proper movement skill acquisition practice (from way back in 1967!)

In Chapter 8 of the book referred to in ref. 23 there was a thorough discussion of how, and under the operation of what causes, the motor structure of movements which are repeatedly carried out may be formed and stabilized during the development of so-called motor habits through practice. As a brief extract we may here emphasize that even in the case of such uniformly repetitive acts the variability in the motor picture and in the range of initial conditions may at first be very great, and a more or less fixed program develops depending on the extent to which a motion is practised, and by no means at the first attempt. The process of practice towards the achievement of new motor habits essentially consists in the gradual success of a search for optimal motor solutions to the appropriate problems. Because of this, practice, when properly undertaken, does not consist in repeating the means of solution of a motor problem time after time, but in the process of solving this problem again and again by techniques which we changed and perfected from repetition to repetition. It is already apparent here that, in many cases, “practice is a particular type of repetition without repetition” and that motor training, if this position is ignored, is merely mechanical repetition by rote, a method which has been discredited in pedagogy for some time.*

*Bernstein, 1967
The Interaction of Constraints

• Organism (Who aka the Athlete)
  – The individual’s characteristics: genetics, anthropometric features, strengths/weaknesses, previous learning

• Environmental (Where)
  – The surface, temp, lighting, opponents, boundaries
  – Social constraints too (support, expectations, peer groups)

• Task (What)
  – Athlete’s intention of the goal and interaction w/rules, teammates, and opponents
Perception-Action Coupling

The organism’s solution to the task constraints are dependent on (but not reactive to) the constraints of the environment

*Davids, et al 2008*
Movement Skill Acquisition
Nonlinear Pedagogy

• More hands-off at key times
• Be a facilitator instead of an instructor
• Organize the environmental & task constraints based on what you see vs. want to see

Ultimately, continually change the task constraints to accommodate the athlete’s attunement to the affordances for action and more optimized movement solutions
Movement Skill Acquisition
Organization of Movement Practice

• Allow for exploration of the perceptual-motor workspace (self-organization)

• Don’t strive for an idealized movement pattern (instead think authentic & optimal)

• The goal isn’t to perform identical each time but instead to be able to achieve mastery under ever-changing conditions of sport
Movement Skill Acquisition

Organization of Movement Practice

To elicit the desired movement process changes and increase learning:

• Bend the rules of the activity

• Change the environmental workspace

• Contextual Interference (makes it sticky)

• Use Part-Task practice (w/info-movement coupling)
Movement Skill Acquisition

Organization of Movement Practice

• Encourage open dialogue (Screening begins!)

• Introduction/Debriefing (Never miss these)

• Establish a Quality Standard (It’s OK to be OCD!)

• Movement Preparation (aka 2nd Screen)

• Practice the 80/20 Rule (Details in Fundamentals)

• Be aware of AND use both Block & Random practice when necessary
Movement Skill Acquisition

Changing Movement Patterns

1. Solidifying existing groove (tweak & adjust)
2. Getting out of a bad groove (not easy!)
3. Create a new groove (time consuming)
Movement Skill Acquisition

Do Drills = Skills?

Which one came first:
The drill(s) or the athlete displaying proficient movement?

Drills don’t always transfer…but skills do!
Movement Skill Acquisition

“Optimal Challenge Points”

Balancing performance & learning in practice

*Guadagnoli & Lee, 2004
Movement Skill Acquisition

Repetition W/O Repetition...

1. Repetition of fundamental motor action using proper form
2. Implement the motor action into the motor program/pattern
3. Use of variations of the motor program/pattern
4. Intro simple environment changes and require display of pattern
5. Add movement variations/combos under environment changes
6. Intro problem solving w/sport specific strategies and begin to use in a competitive practice setting
7. Intro of the pattern into the actual sport (ONLY when ready!)

*Adopted from Myslinski, 2003 & Shumway-Cook, Woollacott, 1995
Movement Skill Acquisition

Contextual Interference in Practice

**BLOCKED:**
- Repeat same task
- Perform specialized work on technical execution
- Repeatable & predictable
- Useful for targeting kinematics (optimization!)

**RANDOM:**
- Perform one task then move to another
- Requires reading, recognizing and then reacting
- Increases complexity & contextual interference
- Never the same movement solution (transfer!)
Movement Skill Acquisition

Blocked vs. Random Practice

One of them = better performance
The other = better learning

*Shea & Morgan, 1979
## Movement Skill Acquisition

### Blocked vs. Random Practice - Example

<table>
<thead>
<tr>
<th>Schedule</th>
<th>Order (ex. 3 sets of 6)</th>
<th>Predictability</th>
<th>Error allowance</th>
<th>Performance/Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>SERIAL</td>
<td>A-B-C-A-B-C A-B-C-A-B-C A-B-C-A-B-C</td>
<td>Medium/High</td>
<td>Depends on mastery</td>
<td>Depends on mastery</td>
</tr>
<tr>
<td>RANDOM</td>
<td>C-B-C-A-B-B A-C-C-A-B-A A-B-C-B-C-A</td>
<td>Low</td>
<td>Lots</td>
<td>Lower/Higher</td>
</tr>
</tbody>
</table>
Coaching Movement
Deliberate (aka Deep) Practice

• Direction of attention (Mindful Movement)

• Into the “Learning Zone” (Comfy being Uncomfy)

• Chunk it as necessary (Part to Whole)

• S-l-o-w...d-o-w-n (Sensory, Perception, Control)

• Error Detection & Correction (Give Ownership)
Coaching Movement
Modeling & Observational Learning

• Observer Characteristics
  – Cognitive development
  – Movement Skill development

• Elements of the Demo
  – Model skill level (Expert model vs. Learning model)
  – Type of skill being demonstrated

• How will you evaluate its effectiveness?
Coaching Movement
Use of Instructional Methods

• Instructions...attention...perception...action: vital to understand for the correct display of movement & subsequent motor learning

• Athlete’s memory & attention span is limited: must be concise, clear, & selective

• Explicit vs. Implicit Instructions

• Internal vs. External Cueing
Coaching Movement
Guided Discovery/Communication

Communication should be a process of guided discovery (i.e. direct the athlete’s awareness & attention!)

Ask the athlete:
– What did you feel there?
– How did that one compare vs. the rep before?
– What errors were present in that execution?
– What would you like to correct next time?
# Coaching Movement

## Delivery of Augmented Feedback

<table>
<thead>
<tr>
<th>Feedback Schedule</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summary</strong></td>
<td>FB after a # of reps</td>
</tr>
<tr>
<td><strong>Bandwidth</strong></td>
<td>FB provided when athlete falls out of criterion range of performance</td>
</tr>
<tr>
<td><strong>Faded</strong></td>
<td>Decreasing frequency over time; Start with more and move to less</td>
</tr>
<tr>
<td><strong>Performer-regulated</strong></td>
<td>FB provided to athlete when he/she requests it after practice completion</td>
</tr>
</tbody>
</table>

*Farrow, et al 2013*
Coaching Movement
Rules for Guidance & Communication

- Ownership over dependency
- All verbal statements must be meaningful & understandable
- Different statements influence type of learning

When dealing with errors:
1. Make a list of the errors TO YOURSELF (as Therapist/Coach)
2. Prioritize list Re: errors’ impact to current execution
3. Give info about ONE of the errors

*When in doubt...less > more!*
Application

Discovery Learning

Construct the environment, give them an objective, use CI, and then get out of the way...this will:

• Will encourage self-organization

• Increase likelihood of implicit motor learning

• Usually involve more external cueing for focus of attention (i.e. effects of outcome)
Application
Affordances for Action

• The same situation can selectively invite different strategies and patterns from different performers (or from same performer at different times over time)

• As skill ACQ increases, experts begin to focus on right informational constraints at the right time to help enable the right action response
Application
Exploiting Metastability

Helping to enable the athlete to adjust movement strategies & patterns based on the changes to the on-going environment (Davids, et al 2014)
Calls to Action

Applying Theories in Movement Practice

1. Read up on & constructively think through the ideas of Motor Control and Motor Learning (where do you stand?!) 

2. Study the emergent movement behaviors of athletes within sport 

3. Begin incorporating proven Motor Learning theories into practice (even if some goes against your previous belief)
Resources for Further Reading

• *Dynamics of Skill Acquisition* by Davids, Button, & Bennett (2008)

• *Skill Acquisition in Sport* by Hodges & Williams (2012)

• *Developing Sport Expertise* by Farrow, Baker, MacMahon (2013)

• *A Guide to Better Movement* by Hargrove (2014)

• *Sport Movement Mastery* by Myszka (2016)
Conclusion

• Thank you to each one of you!
• Questions?
• Contact: shawn@optimizemovement.com
• Check out more on optimizemovement.com