

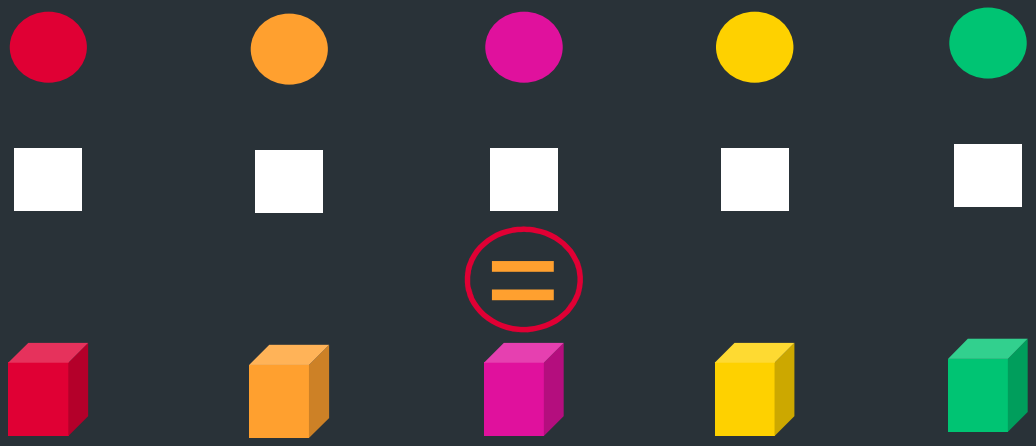

## LEARNING OBJECTIVES

- Contrast the difference between prevailing theories of motor control and motor learning
- Explain the role and importance of attention and memory in relation to coaching and skill learning
- Discuss considerations for optimizing the practice and training environment to improve skill learning
- Discuss considerations for improving instruction and feedback to improve skill learning


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Will the results be the same?



10 different athletes – same program

Not even close

# 01

## MOTOR CONTROL THEORIES

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## MOTOR CONTROL THEORIES

- Explain Coordination in terms of movement performance and skill acquisition
- Provide an explanation for Bernstein's "Degrees of Freedom Problem."

...Why?

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## MOTOR CONTROL THEORIES

- Coordination
  - Patterning of head, body, and limb movements relative to the patterning of environmental objects and events (Turvey, 1990)
- Degrees of Freedom Problem
  - Design problem involves determining how to constrain the system's many degrees of freedom so a specific result is produced (Magill, 2011 & Bernstein, 1967)

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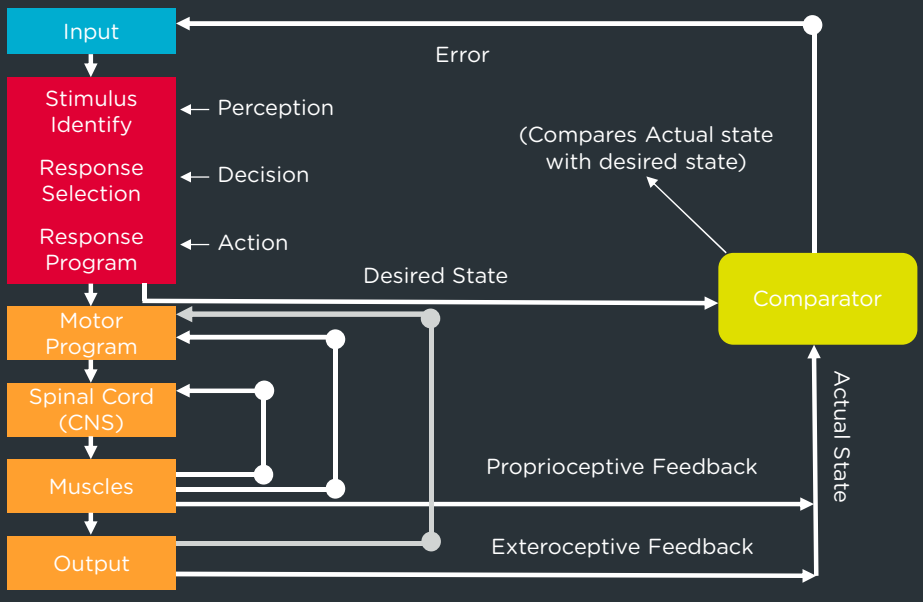
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# MOTOR CONTROL: THEORY ONE

- Central Control or Motor Program Theory
  - "a memory-based construct that controls coordinated movement" (Magill, 2011)
- Generalized Motor Program (GMP)
  - Memory based representation of a class of actions with common invariant features
  - Provides the basis for controlling a specific action within a class of actions
- Schema Theory (Schmidt, 1975)
  - A set of rules that provide the basis for a motor skill

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# MODEL FOR MOTOR PERFORMANCE: CLOSED LOOP




Adapted From: Schmidt and Wrisberg, 2008-
*Motor Learning and Performance- A Situation-Based Learning Approach*

## MOTOR CONTROL: THEORY TWO

- Dynamic Systems Theory
  - Approach to describing the control of coordinated movement that emphasizes the role of environmental information and the dynamic properties of the human body (Magill, 2011)
  - Nonlinear Behavior (Kelso, 1984)


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## MOTOR CONTROL: THEORY TWO

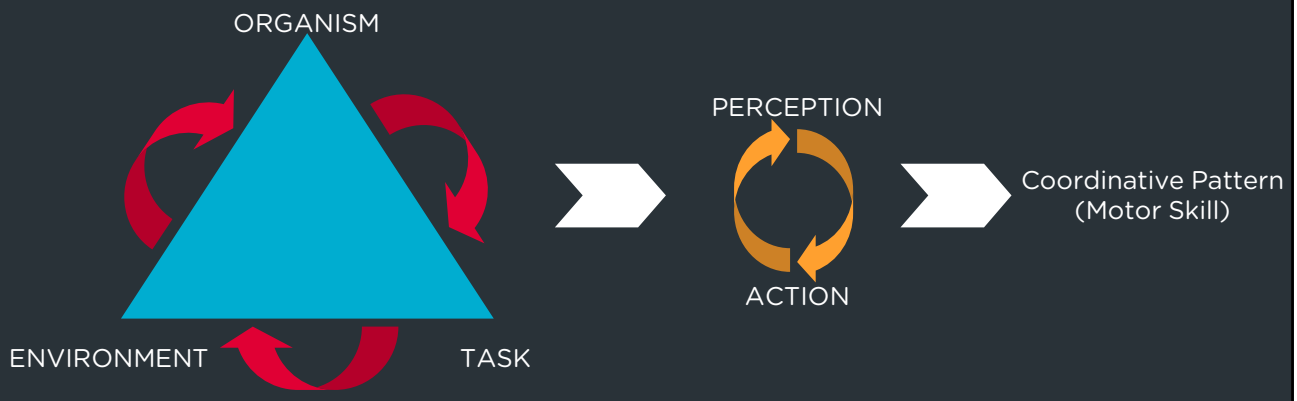
- Attractor State (Motor Program Equivalent)
  - A *preferred behavioral state* that is said to be *stable* or homeostatic
  - Occurs and can change in response to *constraints* within the human body, environment, and/or task
- Self-Organization
  - Spontaneous expression of a motor skill in response to specific tasks, environment conditions, and biological capabilities (Attractor State)


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## SELF-ORGANIZATION (CONSTRAINT-BASED) MODEL




"The optimal pattern of coordination is determined by the interaction among constraints specified by the person, the environment, and the task" (Newell, 1986)

Adapted From: Davids, K., Button, C., and Bennett, S., 2008

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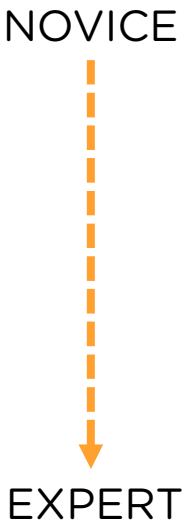

# 02

## MOTOR LEARNING THEORIES

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## MOTOR LEARNING MODELS

- Fitts and Posner 3-Stage Model (1967)
  - Cognitive Stage
  - Associative Stage
  - Autonomous Stage
- Gentile 2-Stage Model (1987,2000)
  - Initial Stage Learning
  - Later Stage Learning
- Newell 3-Stage Model (1985)
  - Coordination Pattern
  - Coordinative Structure
  - Optimization of Control
- Anderson and Lebiere (1998)
  - Declarative Phase
  - Procedural Phase




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## FITTS AND POSNER 3-STAGE MODEL

| COGNITIVE STAGE | ASSOCIATIVE STAGE | AUTONOMOUS STAGE |
|---|---|---|
| • Identify Objectives | • Associate with Cues | • Subconscious/Auto |
| • Self-talk/Questioning | • Refining/Consistent | • Multiple Tasks |
| • ↑ Errors/Variability | • ↓ Errors/Variability | • ↓↓↓ Errors/Variability |
| • Instruction/Feedback | • Identify/Correct Errors | • ↑↑ Identify/Correct Error |

PRACTICE TIMELINE

(Fitts and Posner, 1967, Davids et al., 2008, and Magill, 2011)

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# 03

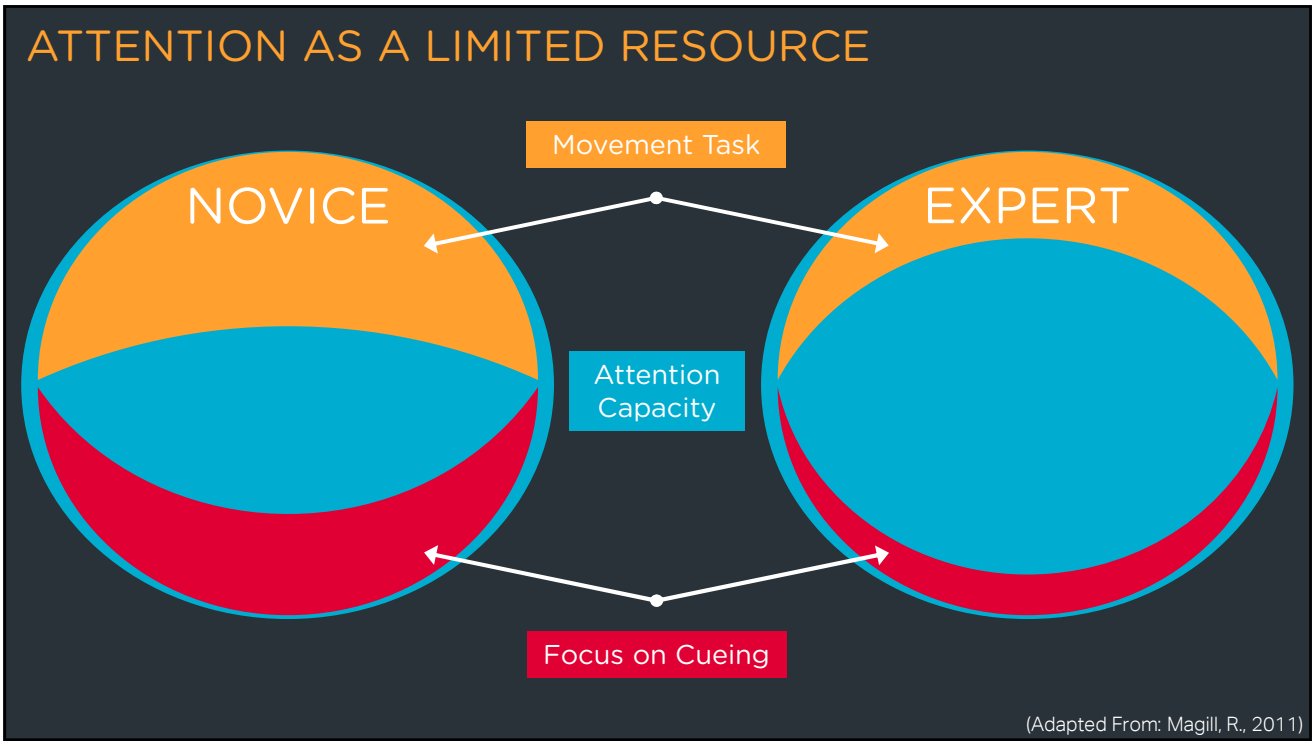
# ATTENTION AND MEMORY

## ATTENTION

- Characteristics associated with consciousness, awareness, and cognitive effort
- Relating to limitations associated with the performance of multiple skills and the detection of relevant information in the environment


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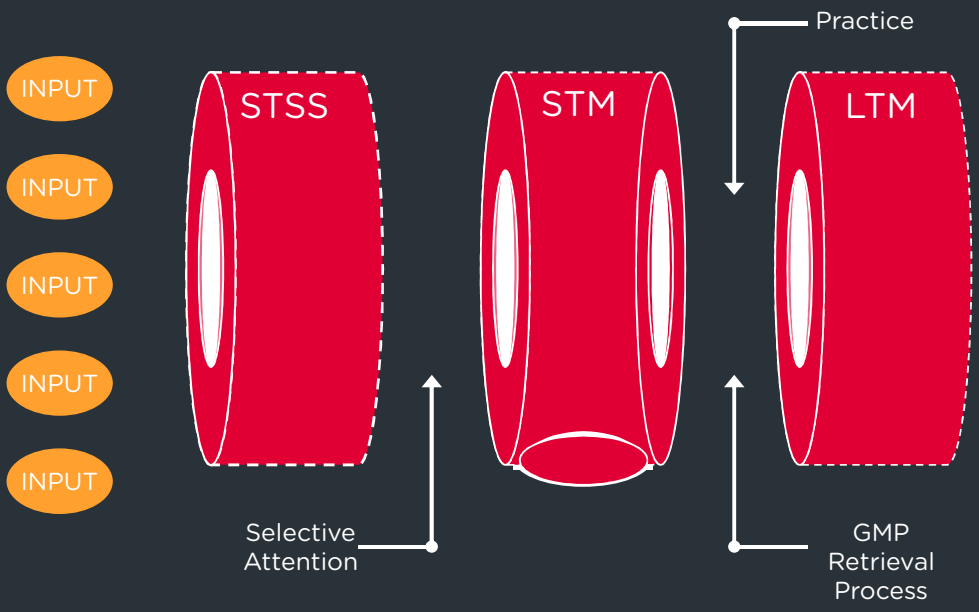



## MEMORY

- Short-Term Sensory Store:
  - Peripheral memory system, which holds incoming information until identified (lost after .5s)
- Short-Term Memory:
  - Allows retrieval, practice, processing, and transfer of information…Limited Capacity (7 ± 2 items & lost after 10s)
- Long-Term Memory:
  - Memory system that holds information and life experiences…Unlimited Capacity (contains GMP)

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## ATTENTION-MEMORY MODEL




(Adapted From: Schmidt and Wrisberg, 2008)

## CHECK FOR LEARNING 01

- Write down 3-5 sentences contrasting the central control and dynamic system theories of of motor control
- Write down the 3-stages of motor learning and 1-2 characteristics of each stage (Fitts & Posner)
- Write down 3-5 sentences discussing the role of attention and memory in coaching and learning



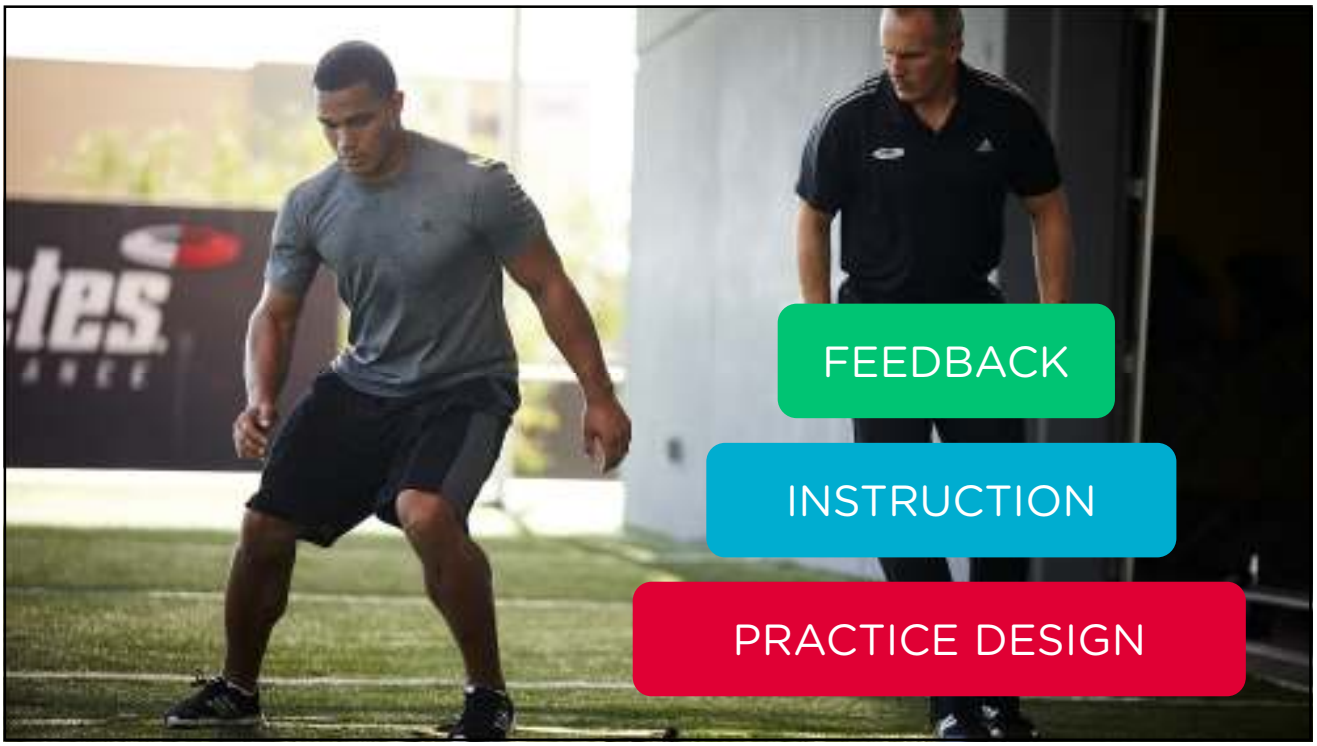
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# 04

## COACHING: FRAMEWORK




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# OPTIMIZING THE LEARNING ENVIRONMENT




## PRACTICE DESIGN

- Goal
  - Optimize learning and retention in an effort to reach maximum transfer to the sporting environment

- Key Terms
  - Practice Variability
  - Contextual Interference


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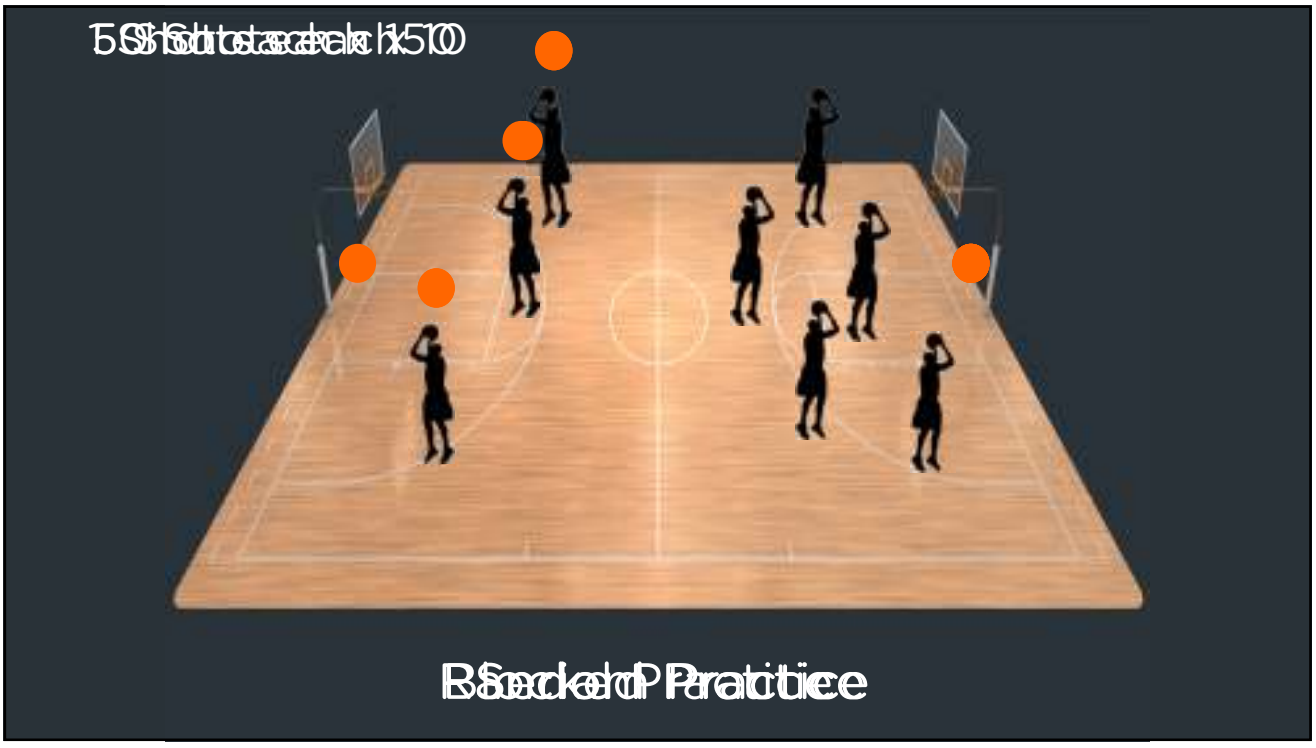
## PRACTICE DESIGN

- Practice Variability:
  - The variety of movement and context characteristics a person experiences while practicing a skill
- Contextual Interference (CI):
  - The memory and performance disruption that results from performing multiple skills or variations within the context of practice
- Contextual Interference Effect (Battig, 1979):
  - Learning benefit from performing multiple skills in a high CI practice schedule (i.e. Random), rather than skills in a low CI practice schedule (i.e. Blocked)

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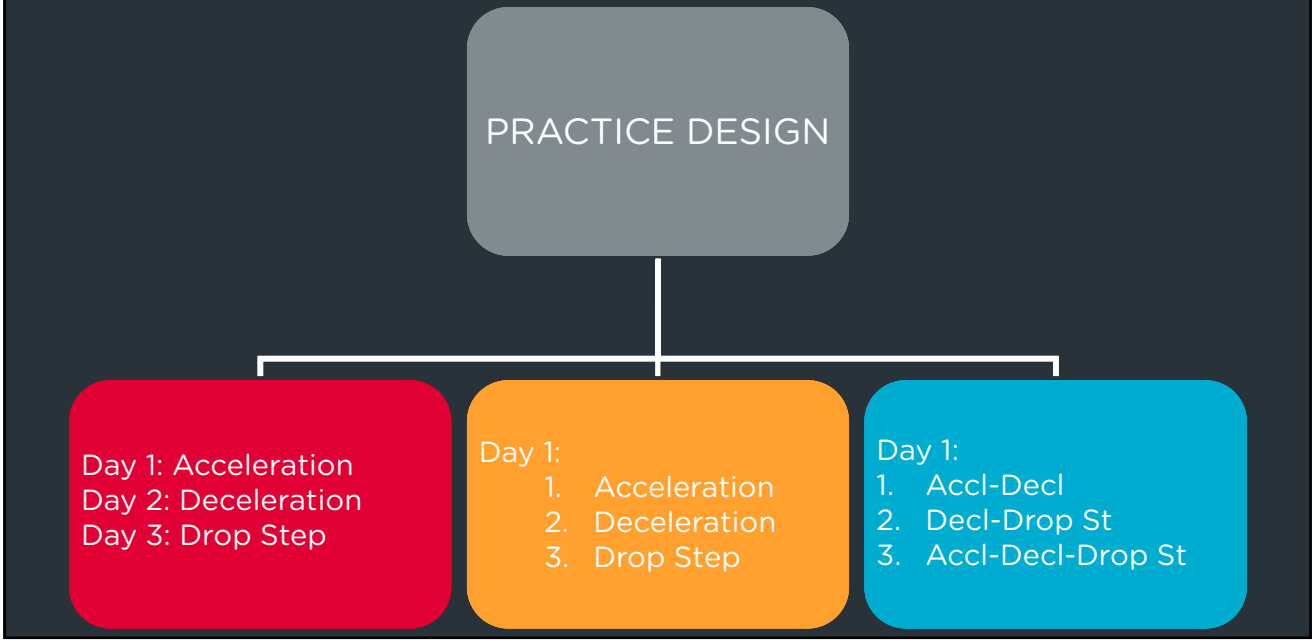

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## PRACTICE DESIGN

- CI and Practice:
  - High CI conditions may have a negative affect on current performance within a practice setting compare to low CI conditions
- CI and Retention/Learning:
  - High CI conditions can results in significantly higher retention and learning following a series of practice sessions

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## CONTEXTUAL INTERFERENCE APPLIED



## CHALLENGE POINT HYPOTHESIS

Children [A] ⟷ Adults

Low Skill Level [B] ⟷ High Skill Level

High Skill Complexity [C] ⟷ Low Skill Complexity

BLOCKED — SERIAL — RANDOM

(A: Brady, F., 1998; B: Hebert et al., 1996; B-C: Guadagnoli and Lee, 2004)

## Moderately Skilled Learners Benefit by Practicing with Systematic Increases in Contextual Interference

- Design:
  - N=45 practiced 3 different basketball passing strategies under a blocked, random or progressive practice schedule
- Results:
  - A progressive increase in CI from a blocked to random schedule improved retention of passing skills better than a random or blocked only schedule

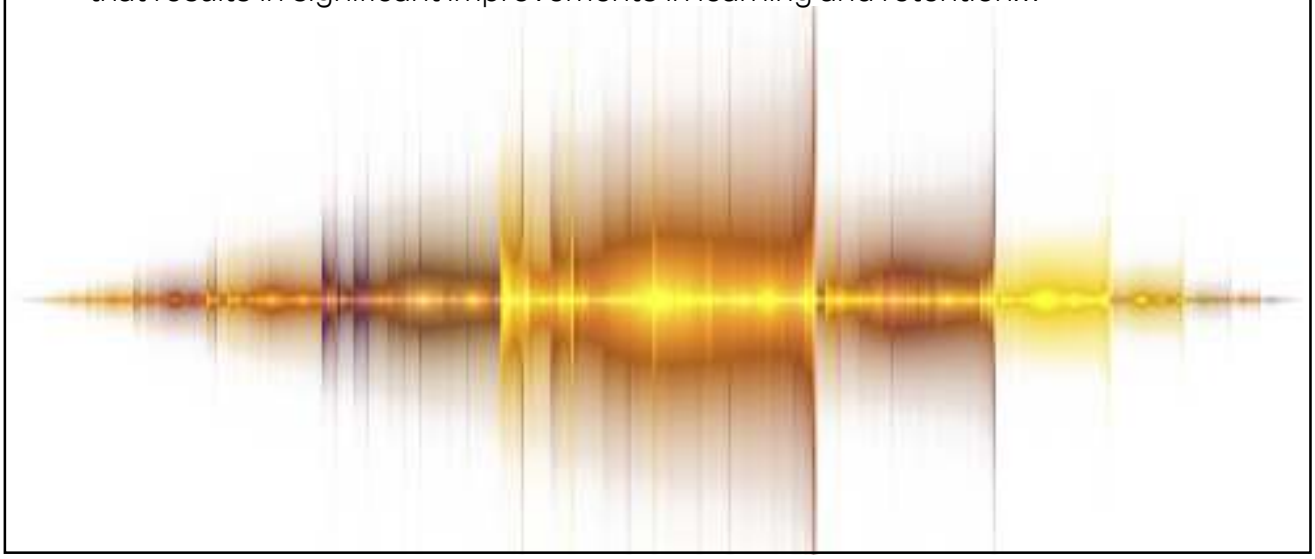


Porter et al., 2010

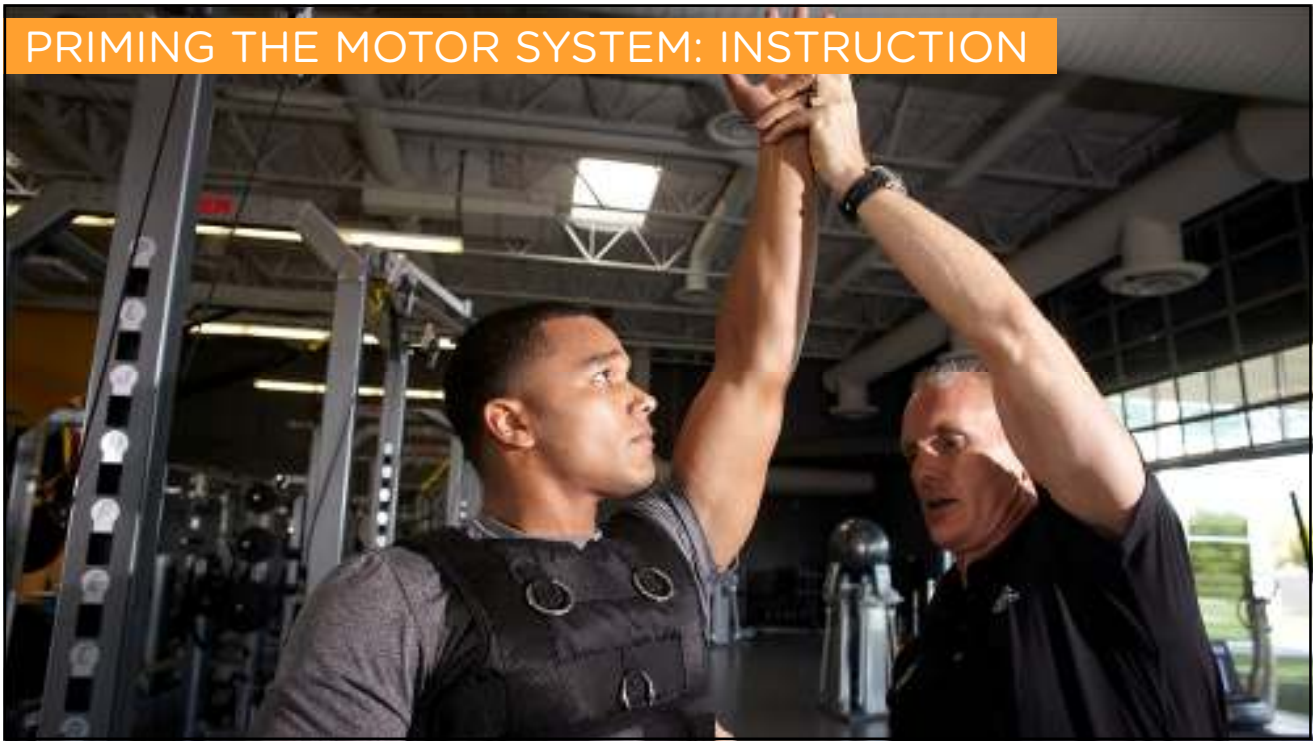
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## BIG TICKET ITEM…

- Increased CI is associated with a short-term performance decrement in practice that results in significant improvements in learning and retention…

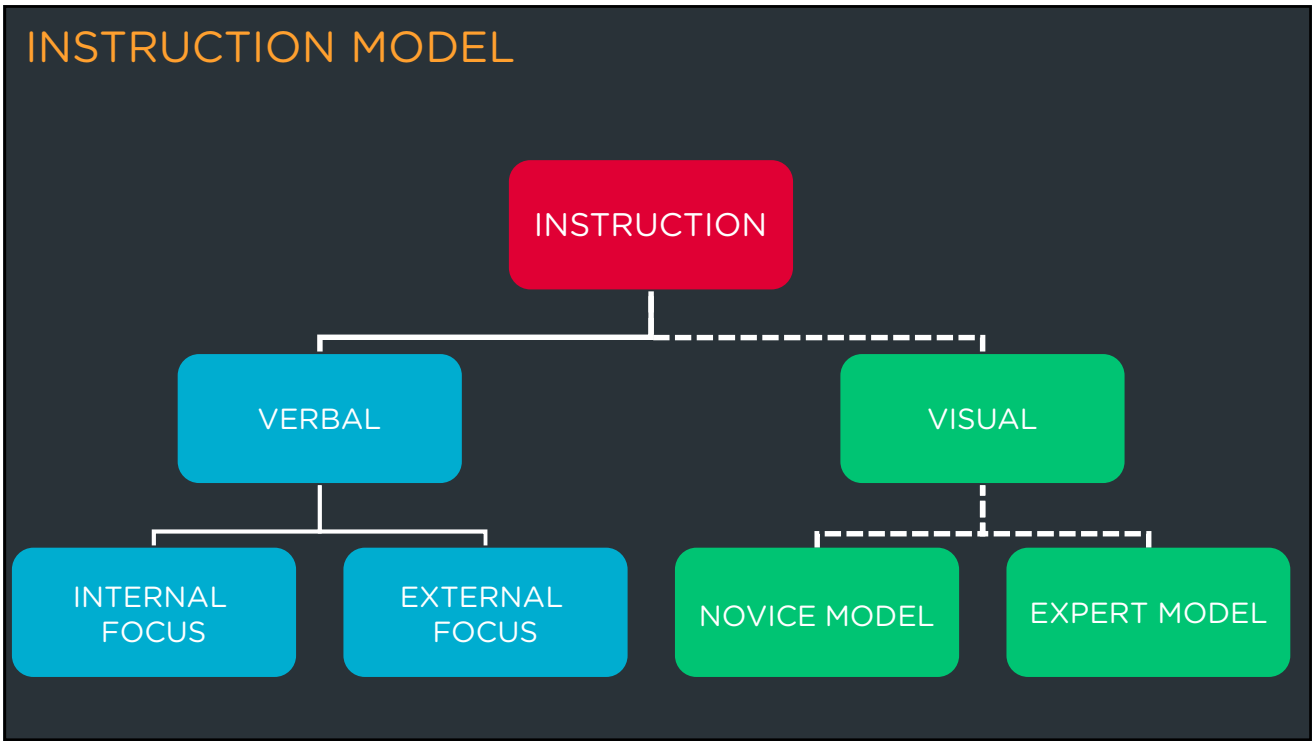


## PRIMING THE MOTOR SYSTEM: INSTRUCTION



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## INSTRUCTION MODEL




## VERBAL INSTRUCTION

- Provide 1-2 focus cues to build awareness
- Limit unnecessary information ("Over-Coaching")
- Start and finish instruction with what you want versus what you don't want
- Focus attention externally on the outcomes opposed to internally on the body process

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## VERBAL INSTRUCTION: CUEING

- Internal Cueing: Focused on "Body Movement"
  - Joint reference: "Squeeze your shoulder blades"
  - Muscle reference: "Squeeze your glutes"

- External Cueing: Focused on "Movement Outcome"
  - Environment reference: "Explode off the ground"
  - Outcome reference: "Jump as high as you can"


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## INTERNAL VS. EXTERNAL CUEING

APPLIED TO HOPPING

- Internal
  - "Explode through your hips"

- External:
  - "Explode off the ground"




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## External Focus Improves Performance during Practice and Retention of a Ski Simulator/Balance Task

- Design:
  - N=33 performed a ski-simulator task under internal ("outside edge of feet"), external ("outside wheels"), or a non-focus condition
- Results:
  - External condition out-performed internal as measured by platform amplitude and frequency during practice and retention



Wulf et al., 1998

## VISUAL INSTRUCTION: OBSERVATION

- Watching a expert performer
  - Mirror Neurons
- Watching a novice performer
  - Improves problem solving and discovery
- Combining both creates context to know what the novice is doing wrong and drives learning

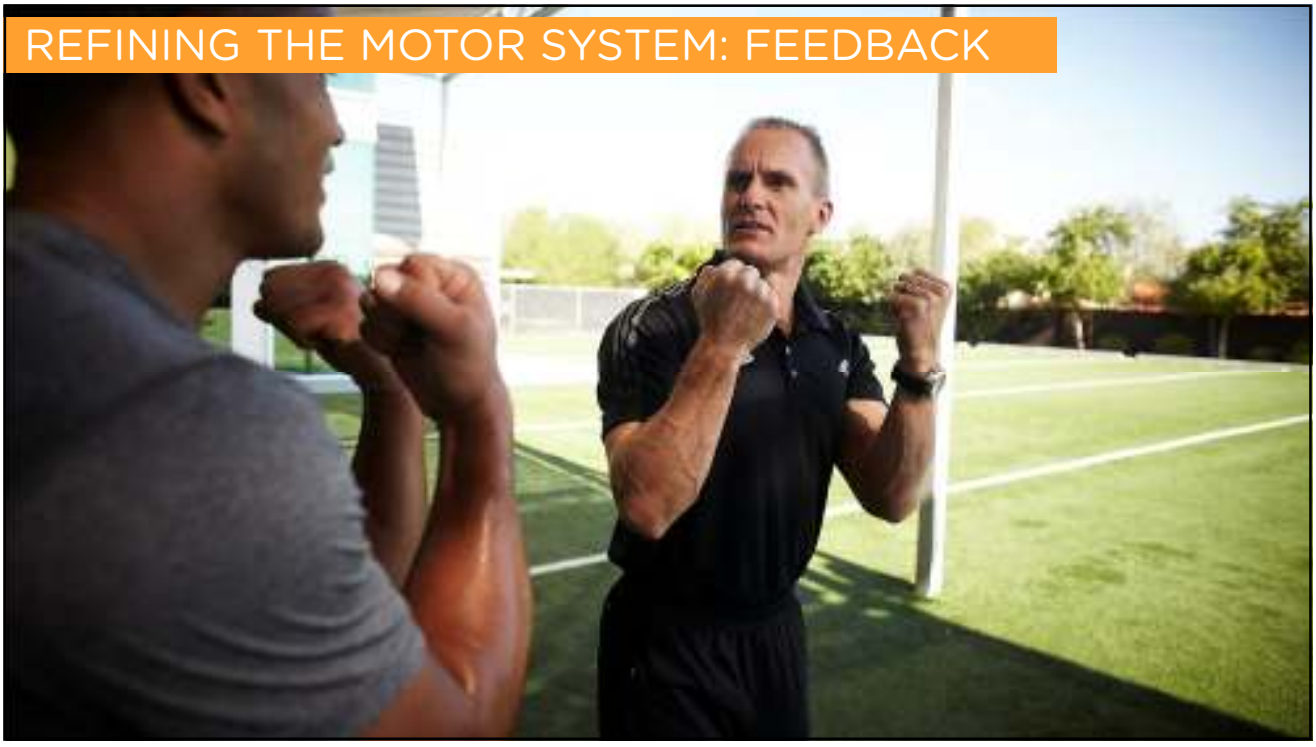
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## BIG TICKET ITEM…

- Combing visual and verbal instruction may be more beneficial than either independently…Visual creates an image and verbal (external focus) can drive the outcome of what the image represents…

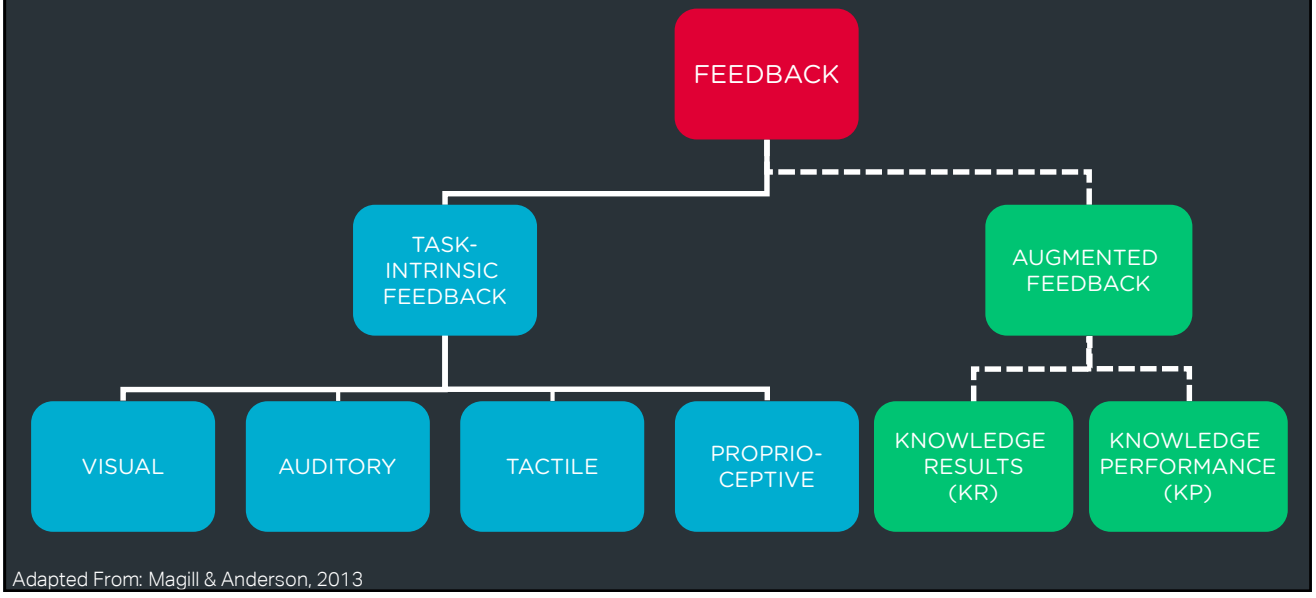


## REFINING THE MOTOR SYSTEM: FEEDBACK



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# FEEDBACK MODEL




Adapted From: Magill & Anderson, 2013

# FEEDBACK: AUGMENTED

- Knowledge of Results: Information about the outcome of a skill or if a goal was achieved
  - Quantitative
- Knowledge of Performance: Information about movement characteristics that led to the outcome
  - Qualitative
- Example…Running a 40yd Sprint
  - KR: "You ran the 40yds in 4.56s"
  - KP: "Focus on pushing off the ground during the start"

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## FEEDBACK: TASK-INTRINSIC

- The higher the task-intrinsic feedback the less need for augmented feedback
- The lower the task-intrinsic feedback the greater need for augmented feedback


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## FEEDBACK: HOW MUCH?

- Guidance Hypothesis (Salmoni et al., 1984)
  - Feedback guides the athlete/client towards the correct movement skill, but when given too frequently can have detrimental affects on the movement skill and create feedback dependence…


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## The Frequency of Feedback has a Direct Effect on Performance Outcomes in Practice and Retention

- Design:
  - Design: N=52 participants took part in a passing accuracy task. Feedback frequency and internal vs. external focus was examined. (100% Int, 100% Ext, 33% Int, 33% Ext)
- Results:
  - An external focus was superior to an internal focus
  - 33% feedback was superior to 100% feedback for INT Focus
  - 33%/100% feedback were equally effective in EXT Focus



Wulf et al., 2002

## FEEDBACK: DANGERS OF TOO MUCH

- Coach dependence "DVD Player Analogy"
- Less dependence on intrinsic process
- False view of improvement…
  - Practice well, but when feedback is removed retention/learning is not expressed on the field
- "Paralysis by Analysis"

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## FEEDBACK: TIMING

- Bandwidth
  - Feedback given when error reaches a limit of is outside the correct bandwidth
- Summary/Average
  - Feedback is given after a number of trials have been observed and the average errors have been identified
- Fading
  - Feedback is given more frequently at the beginning of a session and is progressively decreased
- Self-Selected
  - Feedback is given to the athlete at their request
  - Very Good…Not Sure…Very Bad

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## FEEDBACK: CONTENT

- Movement Analysis
  - Major Technical Components
  - Direct Feedback at Weakest Link
    - Cause vs. Symptom (Prioritize)
- Guide rather than prescribe
  - Ask a question before you give an answer
- Coach the "how" not the "what"

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## CHECK FOR LEARNING

02

- Write down 2-3 ways you can integrate contextual interference into movement on the field and strength in the weight room
- Write down 2-3 key strategies for optimizing instruction
- Write down 2-3 key strategies for optimizing feedback



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# 05 CLOSING

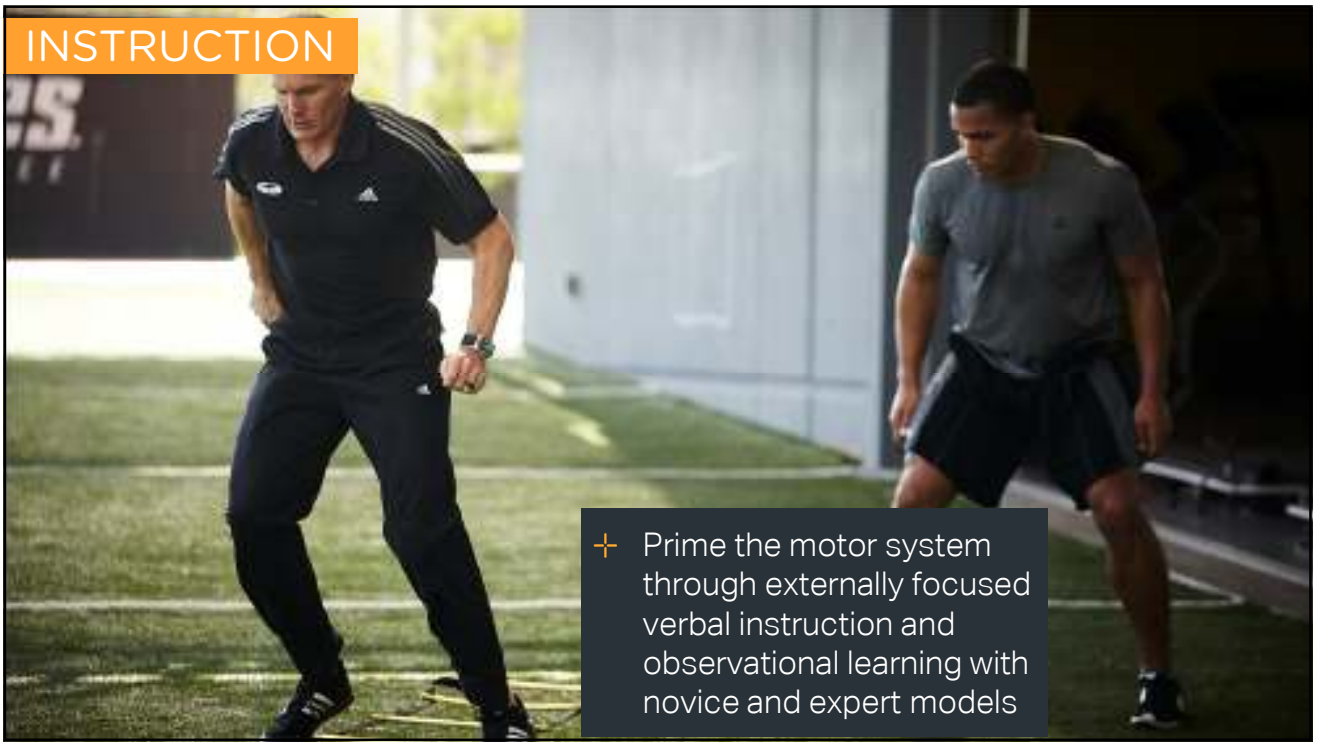
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## ENVIRONMENT



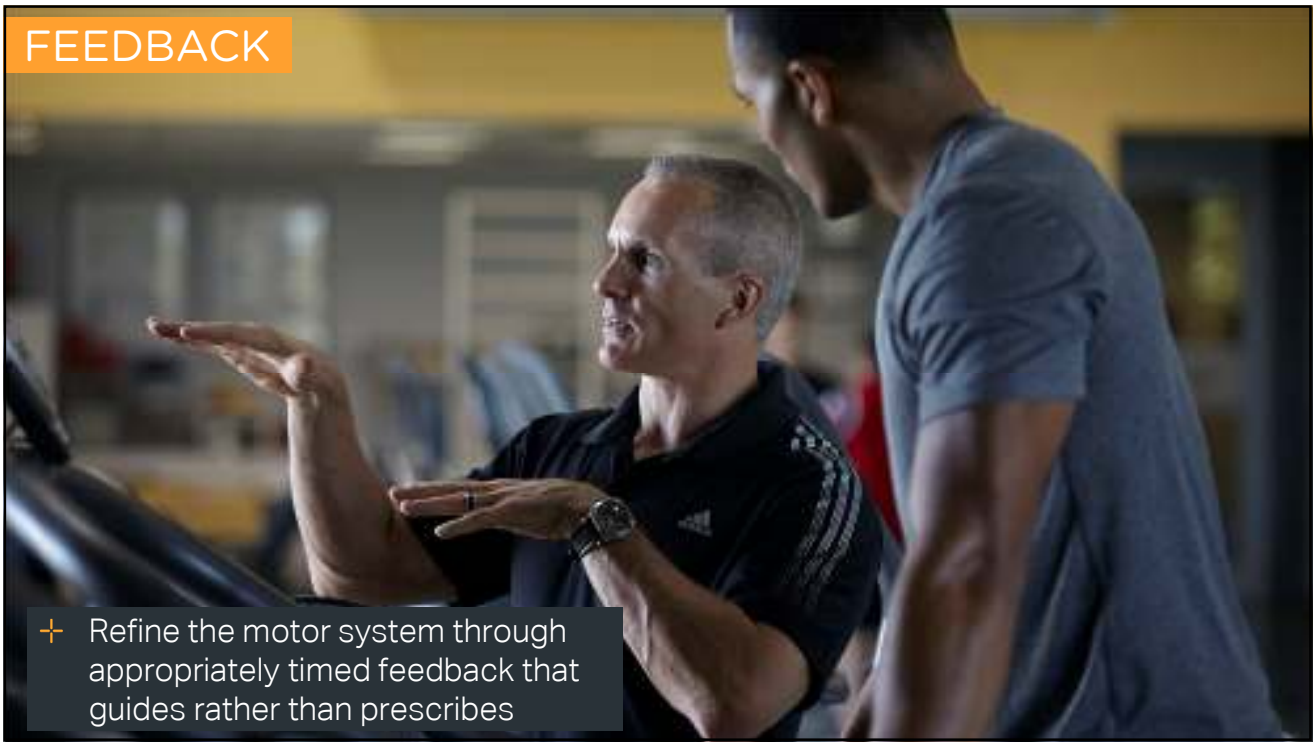
- Optimizing practice and training conditions to improve learning and transfer to sport and life

## INSTRUCTION



- Prime the motor system through externally focused verbal instruction and observational learning with novice and expert models

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