CORE A·I·M

Connect - Challenge - Elevate

An educational resource for growing youth athletes

Unit 6 – Core A.I.M.™ The Science of Motor Learning

Unit 6 – Motor Learning "Science" Objectives

1. Present evidence-based practice for methods of *teaching skill acquisition* to utilize during exercise prescription.
2. Develop an understanding of various *motor learning theories*.
3. Develop an understanding of different learning methods & stimulate thought around how we *deliver information*.
4. Develop an understanding of types of *feedback* & stimulate thought around how we give feedback.
5. Learn what type of *cueing* achieves the desired response.
6. Learn how to *apply this information* to optimize learning for our youth athletes.

A Framework for Athlete Management

G – Gather knowledge.
R – Relay & relate it.
O – Outline the process.
W – Work with purpose.
T – Teach & train together.
H – Highlight successes.

Gather Knowledge

The Role of Deliberate Practice in the Acquisition of Expert Performance

K. Anders Ericsson, Ralf Th. Krampe, and Clemens Tesch-Romer

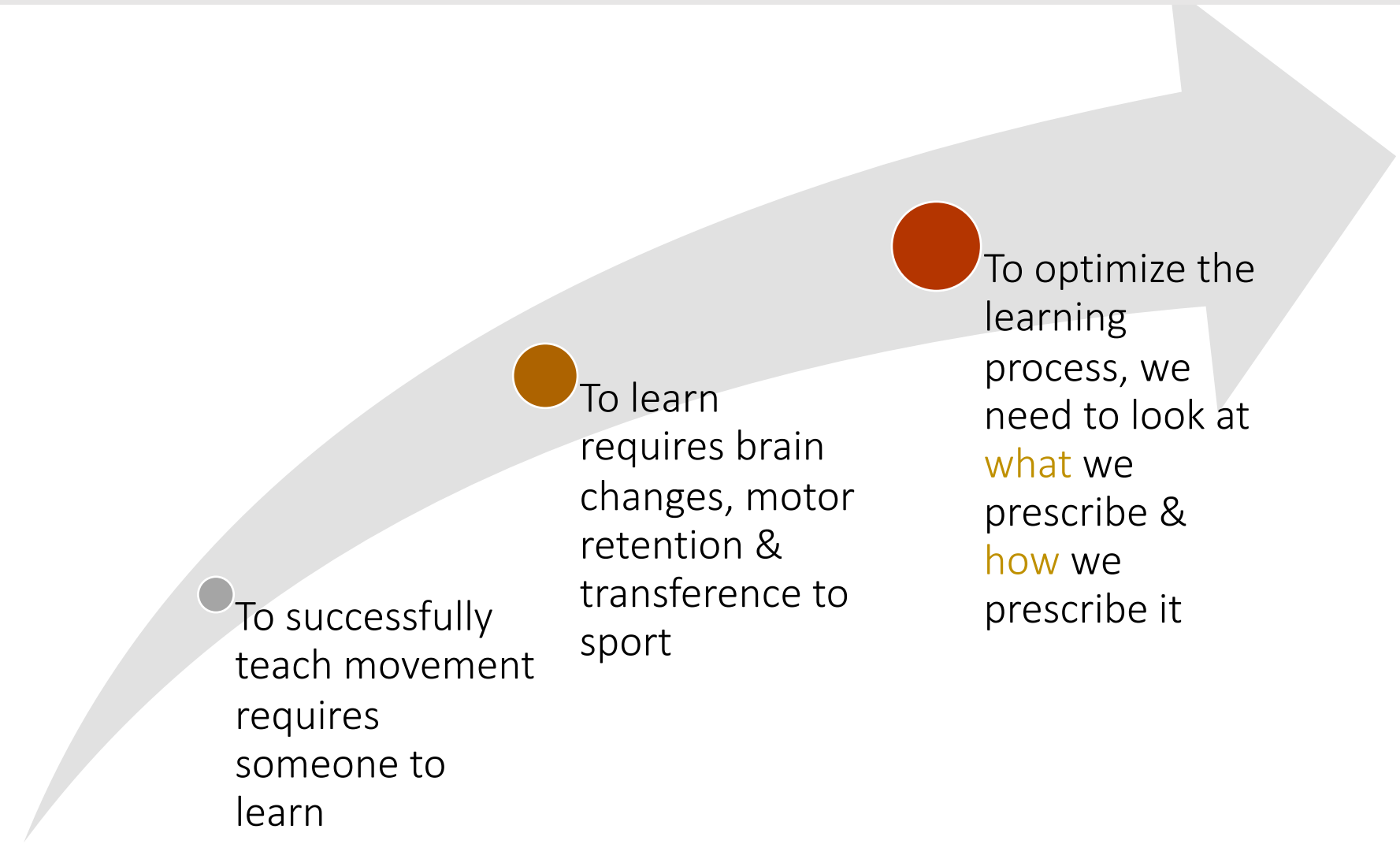
“In virtually all domains, insights and knowledge are steadily accumulating and the criteria for eminent as well as expert performance undergo continuous change.“

- Ericsson et al., 1993, p. 366

“Effective coaches adapt their means to achieve their athlete's end.”

- Nick Winkelman

The Science of Exercise Prescription



"It's Not What We Teach; It's What They Learn."

- Alfie Kohn

Implementing Motor Learning Principles

- The common denominator between coaches, therapists & trainers is that we *ALL TEACH MOVEMENT* – whether that is a new movement or movement after an injury.
- Therefore, it is important for *ALL* of us to have a base level of understanding of motor learning & skill acquisition.

"Learn to *teach* movement, not to *chase* movement."
- Alex McKechnie

Evidence-Based Practice

Spencer et al., 2012

What is Motor Learning / Skill Acquisition?

- Motor learning involves learning novel sensing & moving methods.

- “Thus, motor learning, like motor control, emerges from a complex of perception/cognition/action processes. Previous views of motor learning have focused primarily on changes in the individual. But the process of motor learning can be described as the search for a task solution that emerges from an interaction of the individual with the task and the environment."

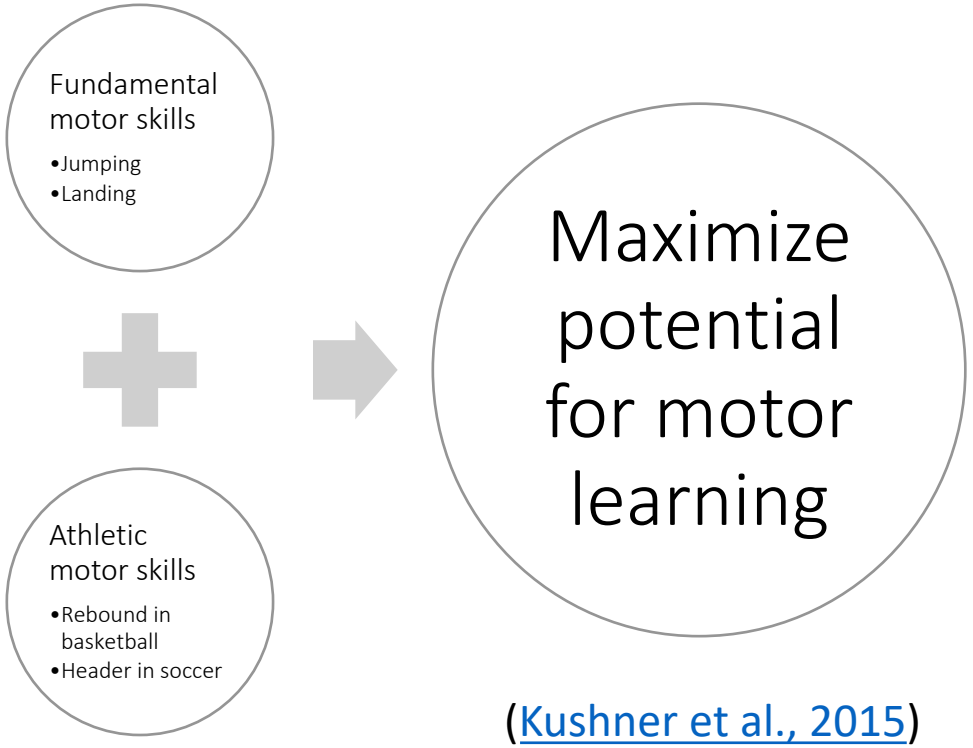
  - Shumway-Cook & Wollacott, 2007, p.22

Biological changes with learning:

- Learning increases myelin in the brain. (Lakhani et al., 2016)
- Mental AND physical training help – physical for neurogenesis and mental for neural survival.
- “[…]Learning increases the survival of newly generated cells in the hippocampus as long as the learning experience is new, effortful, and successful.”

  - Shors, 2014, p. 311

Implementing Motor Learning Principles



(Kushner et al., 2015)

Core A.I.M.™ believes that supporting & stimulating the integration of practitioners, coaches & athletes ensures consistency in youth athlete development.

Embedding motor learning within grassroot sport is key.

Timing also matters.

- Learning something new is easier than re-learning
- With knowledge regarding cues & teaching strategies, we can maximize potential for learning early on

“Knowing is not enough; we must apply.
Willing is not enough; we must do.”

- Johann Wolfgang von Goethe

Connecting Research & Clinic

EDITOR'S CHOICE

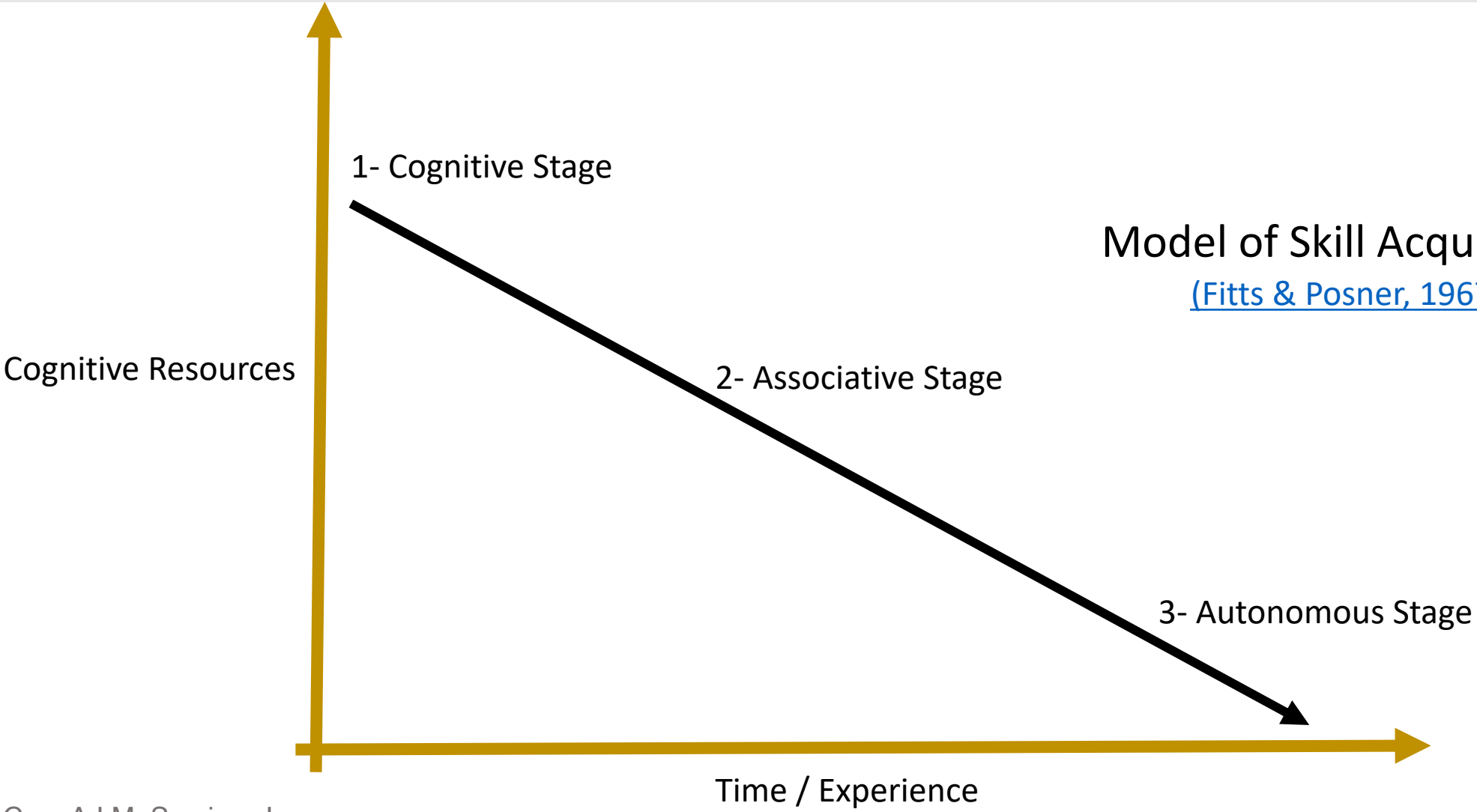
From Motor Learning Theory to Practice: A Scoping Review of Conceptual Frameworks for Applying Knowledge in Motor Learning to Physical Therapist Practice FREE

Michal Kafri ✉, Osnat Atun-Einy

Physical Therapy, Volume 99, Issue 12, December 2019, Pages 1628–1643,
https://doi.org/10.1093/ptj/pzz118

(Kafri & Atun-Einy, 2019)

Original Motor Learning Models



Model of Skill Acquisition

(Fitts & Posner, 1967)

Identify Your Audience

Cognitive – Novice:

- Lots of errors
- Single task focus
- Inconsistent movement patterning
- Movement is not smooth
- Following step by step information

Associative – Learner:

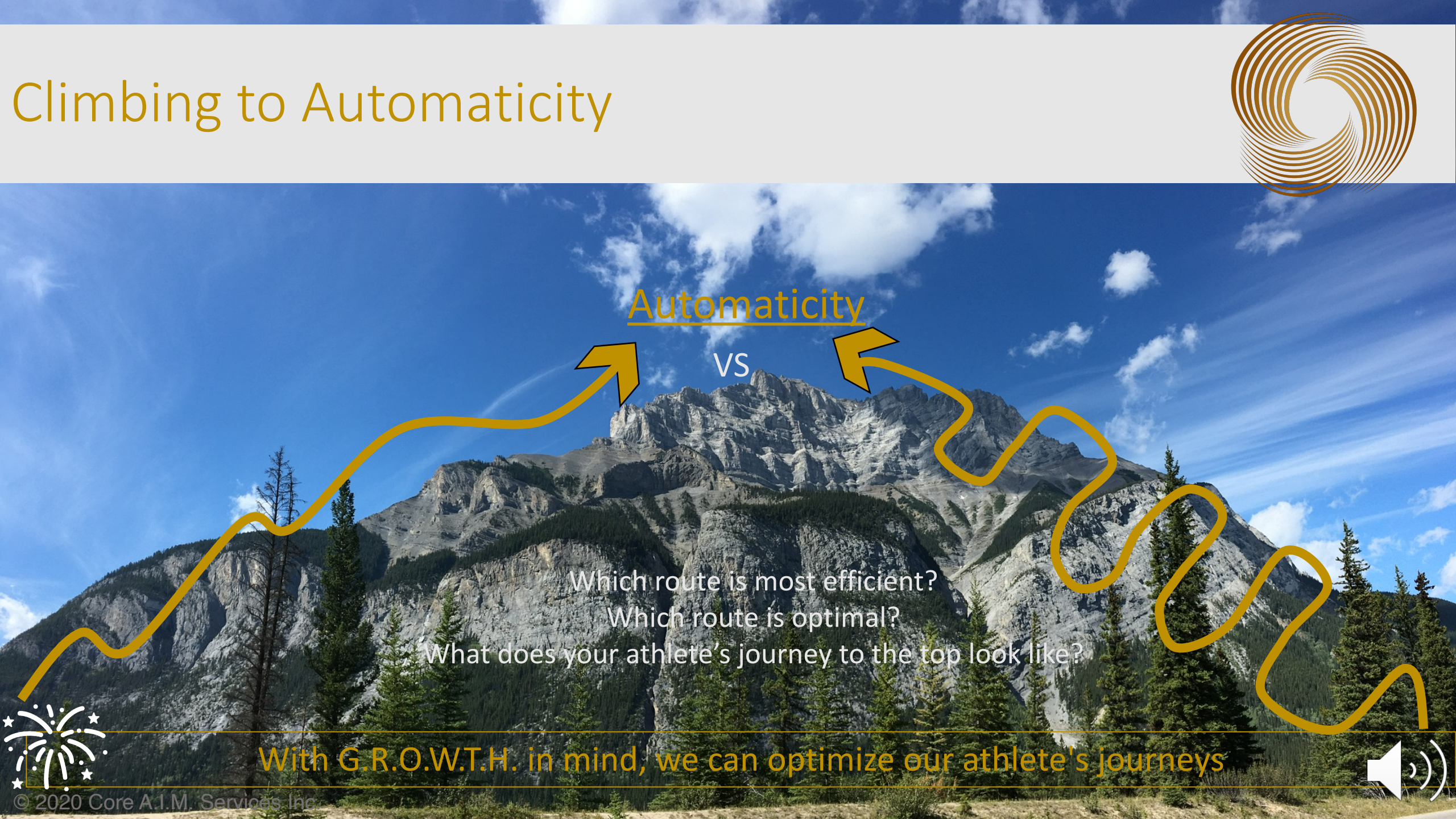
- Few errors
- Can manage some verbal cues
- Some early patterning consistency
- Establishing some declarative knowledge
- Some information chunking
- Execution memory but poor context (cannot pay attention to environment)

Automaticity – Expert:

- Few to no errors
- Smooth, consistent movement patterning
- Able to attend to other things
- Has procedural knowledge
- Encapsulating information
- Good contextual memory (is able to pay attention to environment)

(Fitts & Posner, 1967)

Climbing to Automaticity



With G.R.O.W.T.H. in mind, we can optimize our athlete's journeys

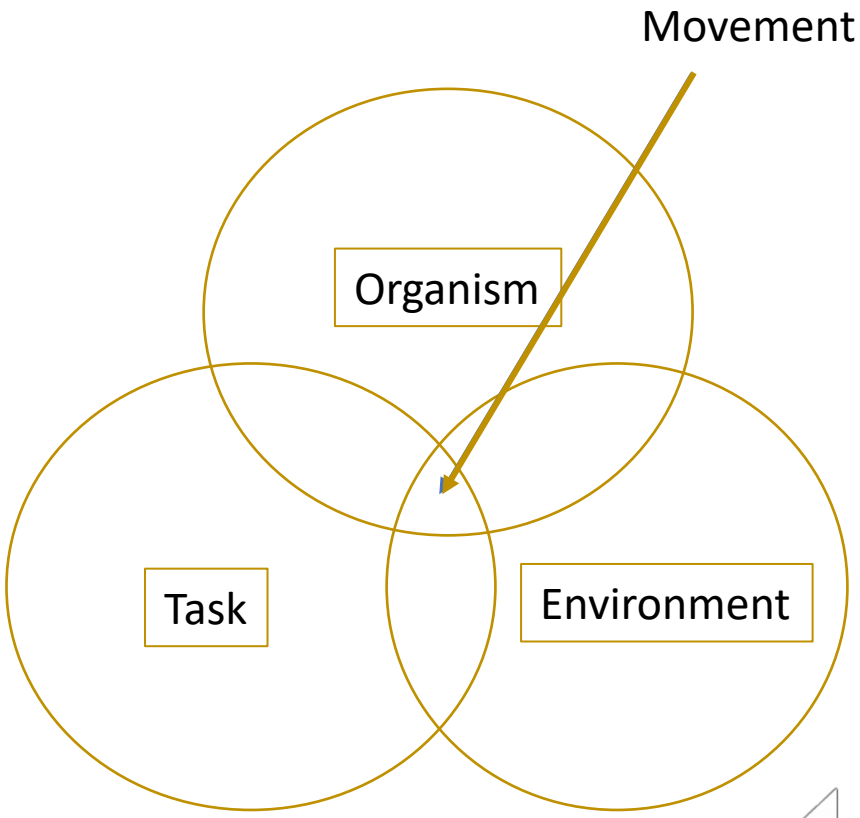
"Athleticism is sport specific, as each sport requires varying demands and key components of emphasis based on the sport specific demands. Athleticism is the ability to perform a range of movements and skills with *physiological and cognitive ease and fluidity*, thus allowing performance to be *efficient, adaptable and resilient* to external forces, in addition to *transferable* into a variety of pressure filled environments and contexts. Athleticism encompasses the ability to seamlessly transition between the appropriate precision and power required for any given task at any given time."

- Core A.I.M.™

Modern Motor Learning Models

The Dynamic Systems Theory by Newell, 1991 (Thelen & Smith, 1994):

- Self-organization by interacting constraints
  - NOT hierarchical
- All constraints are equally reliant on each other
  - No central point of control
- Constant goal of this system is stability
  - Each constraint works together to stabilize system



What the ATHLETE can do:

- Visual-Imitation
- Auditory-Tempo
- Sensory Re-Weighting
- Aerobic Priming
- Positive Priming
- Self-Controlled Learning
- Mental Practice
- Dual Tasks

Optimizing Motor Learning 👍

What the THERAPIST/COACH can do:

- Use of Analogies
- Differential Learning
- External Attentional Focus
- Meaningful Task
- Novel Task
- Sensory Manipulation/ Feedback: visual verbal, tactile
- Variability
- Contextual Interference
- Implicit Feedback

Types of Learning

Explicit Learning	*Implicit Learning*	*Errorless Learning*	*Differential Learning*
• List of cues • Verbal instructions • Declarative knowledge • Higher rate of learning • "Choking effect" decreased performance • Used most often in society	• Trial & error • Little declarative knowledge • Procedural knowledge based • Encourages self-organization • Slower rate of learning • More resilient & better performance under pressure • Easier to implement with kids as they have less knowledge of results	• Trial & error • Environmental constraints used to ensure success • Little declarative knowledge • Early success with small tasks • Progresses from easy to hard • High rate of learning • High resilience to pressure	• Manipulations of variables within the tasks, context, environment • Does not use repetition • Goal is to change elements every 1-3 reps • Promotes self-organization • Slower immediate learning • High resilience to pressure

(Capio et al., 2012; Masters, 1992; Maxwell et al., 2001; Maxwell et al., 2017; Schöllhorn et al., 2010)

Implicit Learning in Youth

Implicit learning has been shown to be beneficial for children

(Capio et al., 2012; De Giorgio et al., 2018; Maxwell et al., 2017)

- Children's cognitive resources are developing
- Children use visual codes to learn – they benefit from demonstration & imitation
- Verbal cues & declarative knowledge (as in explicit learning) are more challenging than visual observation for motor learning in children
- Youth benefit from external cues vs internal cues with novel tasks (Wulf, 2013)
- Imitation - watching & learning (Masterson, 2015)

Linear vs Non-Linear Structured Learning

Linear (Traditional)	*Non-Linear (Differential)*
• Repetition = learning • Easy → hard • Simple → complex • Ideal movement pattern • Repetitive practice • Declarative instructions	• Differential learning = greater resiliency • Fluctuations promote opportunity for self-organized learning • Individualized movement patterns • Variable practice

(Bozkurt, 2018; Schöllhorn et al., 2010; Schöllhorn et al., 2012)

Differential Learning

DL features:

- 3 variables – environment/context & task
- Modification occurs every 1-3 reps
- Athletes are encouraged to adapt & self-organize their movement solutions (Schöllhorn et al., 2012)

**Creating vulnerability will promote learning to calibrate the system,
ie consider altering *one variable at a time* for task, context or environmental constraints.

DL has been shown successful in:

- Producing motor skill learning, retention & transfer (Shoenfelt et al., 2002)
- Reducing the 'choking effect'/empty gym syndrome in free throw shooting (Lattwein et al., 2014, as cited in Henz & Schöllhorn, 2016)

Variability in the Dynamic Systems Theory

- Fundamental to the DST is that the system is always dynamic & interactive
- Remember that with learning, the organism changes as well
- Good coaches bring this to life!
  - Keep a pulse on the temperature
  - Systematically tune, tap & manipulate all these moving parts
  - That's the ART
  - Supported by SCIENCE

"Repetition without repetition."

- Nikolai Bernstein (as cited in Singh, 2018, para. 27)

"No two movement patterns will ever be the same. Therefore, it is imperative not to engage in rote, repetitive practice when the idea of transfer engages variable, complex, and cognitive situations – this is done through varying parameters."

- Singh, 2018, para. 27

Variation + Novelty = Play!

- What about achieving variability through play & games?
  - With children especially, but also adults!

- This can promote:
  - Adaptability
  - Problem solving
  - Plus it has high real-life transference!

- “It is better to try to move to a point in space […] at 100 different speeds or [in] 100 different ways […] to get to that point in space than to move […] 200 times in exactly the same way.“

  - Michael Merzenich (as cited in Feldenkrais Guild, 2012, 2:54)

Athlete can OWN it.

Analogy Learning

Analogy learning may be an effective method for teaching skills implicitly in sport (Liao & Masters, 2001)

- Encourages athletes to send focus externally
- Develops self-organization
- Produces more resilient, pressure-tested learning
- Great for kids - can use it to catch their attention

Examples:

- If you want kids to get lower, tell them to imagine that they are in a building with a low ceiling.
- If you want quickness off of the floor, have the kids imagine that they are jumping off of lily pads – too much time on the ground will cause the lily pad to sink.

Aerobic Exercise as Cognitive Primer

- Exercise for as little as 5 minutes in children can prime the brain to learn (Angulo-Barroso et al., 2019)
- Further studies have shown the positive impact of aerobic exercise in relation to motor learning (Moriarty et al., 2019;

Athlete can OWN it.

Technological Developments

1. *Contextual interference*

- Contextual interference via random practice = increased retention & transfer compared to blocked practice (Porter & Magill, 2010)
- *Virtual reality* as contextual interference in ACL rehab = improved motor learning (Gokeler et al., 2016)

2. *Sensory re-weighting*

- *Strobe glasses* = positively impacted visual contribution & increased the demand on the proprioceptive system (Kim et al., 2017)

3. *Dual task focus*

- DT = freed up cognitive resources in balancing tasks (Kiss et al., 2018)

Athlete can OWN it.

1. Contextual Interference

Contextual interference works with the idea of variability & novelty.

- Greater contextual inference (random & variable; Porter & Magill, 2010)
  - = ⬆ problem solving
  - = ⬆ self-organization
  - = ⬆ transference
  - = ⬆ retention of motor skills

Open skills (Gu et al., 2019; Gentile's 1972 Model)

- Life requires a vast array of movement patterns ('open skills')
- As such, variable practice helps learners discover novel movement patterns & fill their toolbox

1. Contextual Interference

Know the final context – what are we preparing the athlete for?

- The parameters around contextual interference manipulation must match the destination.
- Different types of practice will better serve different types of skills.
- We know the research shows that variability & random practice increase learning, but there still must be some specificity to the result.

Where would you place

HOCKEY, GOLF, DANCE, GYMNASTICS, FOOTBALL?

OPEN SKILLS	CLOSED SKILLS
• dynamic environments • people to react to • unpredictable events • variable visual & sensory inputs • weather • multi-tasking • simultaneous opponent performance • externally paced	• individual sport • defined time & space, • single task • alternating opponent performance • constant context • self-paced

(Gu et al., 2019; Knapp, 1967; Gentile's 1972 Model)

high transfer & resiliency
= high self-organization

Blocked / Variable Example: Shooting around the world 5 shots x 5 spots	Random / Variable Example: Playing one on one
Blocked / Constant Example: Shooting free throws	Random / Constant Example: Playing 3 point 3 up

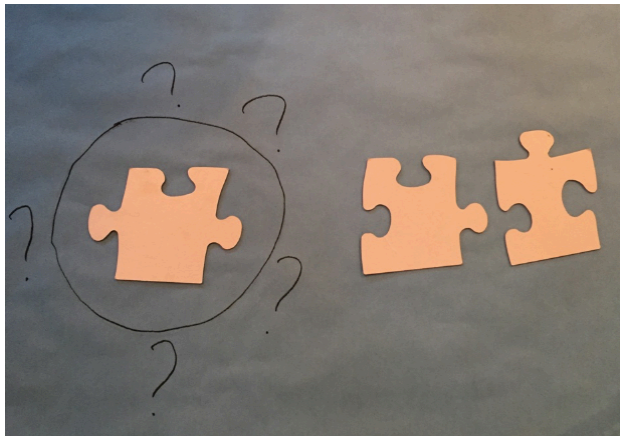
Low transfer & resiliency
= low self-organization

Athlete can OWN it.

2. Sensory Re-Weighting

Sensory re-weighting:

- Take out the variable of sight = makes these somatosensory receptors play larger role



- This also increases the demand *on the other puzzle pieces* for understanding & processing where you are in space (Kim et al., 2017)

Mechano-receptors that are specialized for proprioception:

- Muscle spindles
  - Within the muscle
  - Function to sense *muscle length*
- Joint receptors
  - Within the joints
  - Function to sense *joint position*
- Golgi tendon organs
  - Within the tendon
  - Function to sense *muscle tension*

Athlete can OWN it.

3. Dual Task Focus

On field play requires the ability to maintain optimal A.I.M. whilst...

- Processing the play
- Reading the opposition
- Executing a skill
- Amongst many other cognitive & physical demands

Training your athlete in this ability may involve...

- Holding a conversation
- Doing math problems
- Saying alphabet backwards
- This can be verbal or visual
- This can also be in the form of layering on a ball skill to a movement

Athlete can OWN it.

Tempo Movement

- Metronome use impacts motor patterning in the brain by modulating its inhibiting braking system – meaning it helps reset synergistic smooth movement/coordination (Rio et al., 2016)
- Helps post-injury with loss of motor control
- Acts as an external attentional focus, creating a goal-oriented task
- Promotes self-organization
- Relates to movement outcome

Athlete can OWN it.

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TOSSSS it to your athletes – TEACH them & help them OWN it, then SOLIDIFY that with SPORT-SPECIFIC SKILLS

T

TEACH it to them

Know your audience

Know stages of skill acquisition

Know preferred style of learning

Teach thought processes for initiation & return

O

Make it their OWN

Autonomy

Engagement

Attention

Accountability

Self-organization

Confidence

Implicit learning

SSSS

SOLIDIFY with SPORT SPECIFIC SKILLS

Strive for Automaticity

Dual tasks for cognitive challenge

Multi-sensory modalities

Transference

Manipulate constraints (DL)

Core A.I.M.'s Framework for Integrated Skill Acquisition

Self-Controlled Learning

T.O.SSS - TEACH it to the athlete, & then they OWN it

- Have the athlete identify their 3 most challenging exercises, then YOU pick 1 of them.
- Let the athlete control when they get feedback.
- Teach the athlete to feel their dosages, balancing quality control & effort (fatigue).
- Fatigue + 2.

- *Shared decision-making* encourages autonomy & builds confidence by making the clients part of the process. (Wulf et al., 2010)

- The ASAP program provides case examples for client centered practice. (Winstein at al., 2014)

Athlete can OWN it.

Meaningful Tasks

- For practice to affect motor learning, it must have purpose & goal-directedness
  - “[…] practice is more than mere repetition; it is repetition with a purpose.”

    - Cross, 1967, p. 487

- Active learning requires engagement – the task must mean something to the learner
  - “It is the interdisciplinary teams’ role to help the patient become an active learner and to create an environment that supports this. A passive recipient will never be an active learner and will never get the most out of rehabilitation."

    - Bobath, 1990, as cited in Fraser, 2009, p.184

  - "The active learner needs to be engaged, challenged and involved in meaningful task training.“

    - Fraser, 2009, p.184

"*Boring* means I have failed to teach an athlete the *why* behind the programme."

- Dan Pfaff

Developing the Meaningful Task

- Early success feels good & increases buy-in.
- Motor learning is enhanced if you prime the task with positive emotions. (Masterson, 2015)
- Performance-related why's will often create more buy-in than injury prevention-related why's.
- Athletes will pay attention & feel good about the process *if...*
  - They know the purpose & can see the relevance
  - They have a goal that is meaningful because it relates to their sport/outcome
  - They feel like they have a role in the decision-making

"Practice does not make perfect, practice makes permanent."

- Sarah Kay

Connecting Research & Clinic

Articles to CHECK OUT related to *Mental Practice*:

1. The Vividness of Movement Imagery Questionnaire (Isaac et al., 1986; Roberts et al., 2008)

2. The ability to use motor imagery develops around elementary school age (Spruijt et al., 2015)

3. In sports where equipment is used, imagery is enhanced with concurrent tactile & proprioceptive input (ie racket, ball) (Mizuguchi et al., 2012)

Mental practice can improve:

- Motor skills (Feltz & Landers, 1983)
- Muscle strength (Yue & Cole, 1992)
- Flexibility (Guillot et al., 2010)

Athlete can OWN it.

Implementing Mental Practice

When the athlete is motor fatigued, use *mental practice:*

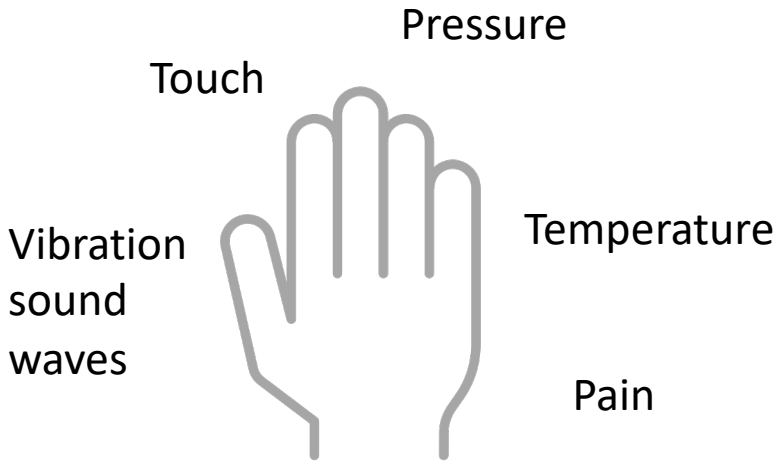
- Request they perform 1 more set mentally
- Prime task with mental trials between reps to productively add to physical rest time

Types:

- First party - often *kinesthetic & visual imagery*
- Third party - just *visual imagery*
- You can enhance the athlete's mental practice even further by using equipment like a ball, a bat & a glove, for example, & possibly even sport-specific positions (Mizuguchi et al., 2012)

Athlete can OWN it.

Somatosensory Information – Touch



Touch is highly involved in posture & positioning

- Tactile cues for balance reduced postural sway (Peterka et al., 2006)
- Most of the information is *processed subconsciously*

Touch as a foundational sense (Hancock et al., 2015)

- Skin is everywhere
- Utilized all over your body for orientation information

Its impact on motor learning is an area of research that requires more investigation

Somatosensory Information – Touch

Layered system of receptors from superficial skin to deeper muscles & bones.

Receptor	Location	Function
Free Nerve Endings	Skin	Pain, temperature, crude touch
Meissner's Corpuscles	Glabrous skin	Touch, pressure (dynamic)
Pacinian Corpuscles	Viscera, interosseous membranes	Deep pressure & vibration
Merkel's Discs	Skin & hair	Touch, pressure (static)
Ruffini's Corpuscles	All skin	Stretching of the skin

(Abraira & Ginty, 2013)

Connecting Research & Clinic

Articles to CHECK OUT related to *Visual Imitation*:

1. Neural mirroring & its role in enhancing motor learning (Masterson, 2015)
2. The action of observational learning is one key for athletic performance enhancement & injury prevention (Benjaminse & Otten, 2011)

Watch & Learn

Athlete can OWN it.

Multi-Sensory Integration (MSI)

We know that sports are multi-sensory, so MSI must be incorporated in our work with athletes, but *how?* And equally as important, *when?*

MSI cues in teaching & training – the *how?*

- Literature is unclear as to the role of MSI in enhancing learning – we must be aware of this
- Sensory input can be manipulated in an organized & progressive way
  - Adding input to support the system
    - Sounds helping visual learning (Seitz et al., 2006)
  - Subtracting input to challenge the system
    - Sensory re-weighting (Kim et al., 2017)
- Evaluation of impact is important to see if your manipulations optimize or hinder the desired outcome

MSI cues in teaching & training – the *when*?

- Some theories propose early childhood (Early Integration Approach; Robinson & Sloutsky, 2010)
- Others believe it is a long-term process that progressively integrates independent systems over time, & well into adolescence (Paus, 2005)

Therapist Key Focuses

1. INCORPORATE IMPLICIT LEARNING / ANALOGIES – Encourages self-organization, linked to implicit learning = more resiliency & transferable learning
2. BE PURPOSEFUL IN MAKING A TASK MEANINGFUL – Empower athletes with knowledge & involve them in the process = optimizes learning
3. POSITIVE EMOTIONS – Create a positive environment & use positive reinforcement = solidifies & optimizes learning
4. UTILIZE MULTIPLE SENSES – Provide fewer words & more externally-directed sensory input (visual, tactile, verbal), be purposeful, know your audience – age & stage
5. VARIABILITY / DL – Mix it up but be systematic about it; target a constraint, manipulate one variable at a time, & as always, know your audience – age & stage
6. CONTEXTUAL INTERFERENCE – Plan your practice schedule & variability levels to match your desired outcome

Athlete Key Focuses

1. PLAY & HAVE FUN – An organized way to create exposure to novel tasks, develop problem solving, foster self-organization & build pleasure with variability
2. DUAL TASKS – Prepares athlete's brain for multi-tasking environments & works on freeing up cognitive resources for in-game scenarios
3. ENGAGE IN MENTAL PRACTICE – Use this tool for priming or when fatigued
4. AEROBIC WARM-UP – Get the heart pumping before learning something new
5. TEMPO (METRONOME) – An external focus via auditory stimulus = reboots the motor coordination for movement
6. IMITATION – Watching & observing encourages implicit learning & self-organization
7. SELF-CONTROLLED LEARNING – Give the athlete autonomy & build confidence in the process

Athlete can OWN it.

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Which Modality is Best?

Each athlete is unique & will require different tools:

- FILL UP YOUR TOOLBOX!
- Educate & empower your athletes so they can OWN their piece of the puzzle

Keys to enhancing your efficiency in movement training:

- Understand the advantages & disadvantages of each modality
- Know your target audience
- Appreciate the context for each type of learning

Know your process & what stage the athlete is in:

- Establishing an understanding of A.I.M.
- Establishing resiliency & transfer of A.I.M.

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Research Setting	Motor learning deemed successful dependent on outcome of task	Example: ball goes in, target is hit	Pressure test: learned task holds up against cognitive dual task challenges
Clinical Setting	Motor learning deemed successful dependent on quality of task performance	Key A.I.M. movement principles	Pressure test: learned motor skill holds up to external forces, cognitive demands & fatigue related to sport

Connecting Research & Clinic

Articles to CHECK OUT related to *Motor Learning in Return to Play Preparation:*

1. Key motor learning concepts that should be incorporated in ACL return to play rehabilitation (Gokeler et al., 2019)

2. The differences between traditional & augmented, multimodal ACL rehabilitation (Haggerty et al., 2020)

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"Purposeful coaching can empower purposeful practice.”

- Dani Langford

Feedback – What is it?

"Feedback describes the information that an athlete receives from numerous sources *concerning the performance* of a particular motor task, and it can occur either during task performance or afterwards."

- (Magill, 2001 as cited in Sharma et al., 2016, p. 1483)

Practice and feedback are 2 key elements to motor learning that need to be understood & applied with purpose. (Winstein, 1991)

It is important to also *get* feedback from your athletes. Often people focus solely on giving feedback, but requesting this of your athletes gives you access to the most valuable information in the teaching/learning process.

Feedback – Types

Intrinsic	*Augmented – Extrinsic*	
	Knowledge of Performance	*Knowledge of Results*
• Feedback is from body's sensory perceptual system • Feedback comes *from within* the body • Feedback happens during task execution • Feedback contributes to the development of kinaesthetic awareness	• Feedback is from *external source* • Feedback is related to specific movement components • Feedback is often provided visually (video, lab testing, etc) or verbally (coach)	• Feedback is from *external source* • Feedback based on outcomes: distances, times, ratios, etc. (Sharma et al., 2016)

Feedback can affect learners' performance, motivation & learning (Wulf et al., 2010 & Wulf, 2013)

Feedback – The Power of Asking Questions

We can extract more useful information, as well as guide the athlete's experience & perceptions with the right questions.

This brings out key information for the athlete & coach.

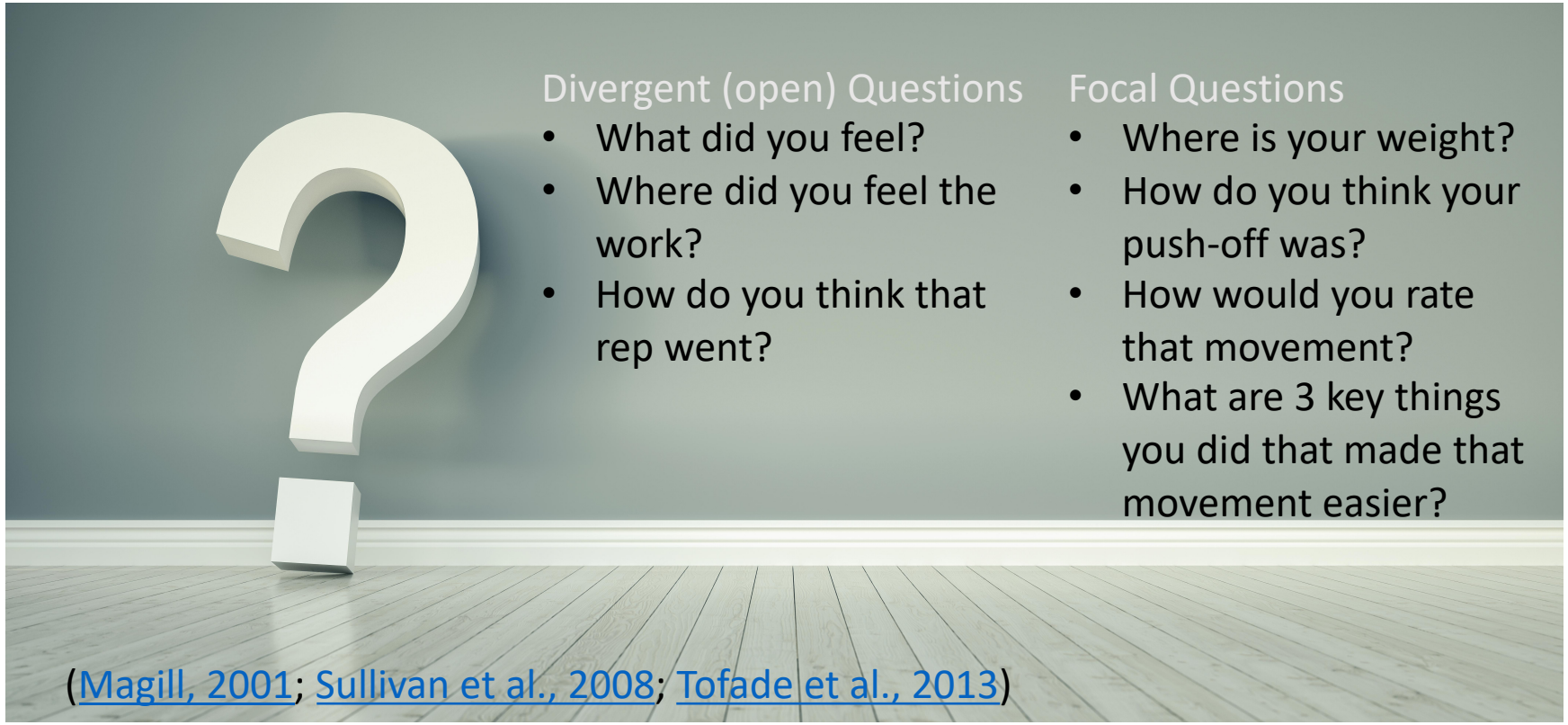
It makes them think – self-reflection.

It increases shared internal feedback.

You can direct the focus of the athlete with questions.

Feedback – Effective Questioning

- Divergent or open question = cannot be answered with just Y / N
- Focal question = directs the topic & gets the athlete to state & justify their position



(Magill, 2001; Sullivan et al., 2008; Tofade et al., 2013)

"In my experience[,] many athletes are used to being questioned[,] less are used to being *asked* a question."

" When you ask your athlete a question 2 things happen. You learn about them and they learn about themselves. "

- Nick Winkelman

Provide Multi-Sensory Mediums of Feedback Delivery

Auditory

- Verbal
- Tempo

Visual

- Video
- Mirror
- Observation
- Imitation of demonstratio

Somatosensory

- Touch
- Pressure – compression bands to bring attention to centre
- Vibration
- Tension / Stretch
- Balls, dowels, unstable surfaces, support, resistance...

Feedback – Visual

Visual:

- Mirror - as a support early or as a regression (need to progress away though as it can feed overthinking & reliance)
- Video
- Observational learning (Benjaminse & Otten, 2011)
- Imitation of demonstration - neuronal mirroring (Masterson, 2015)

Males benefit from visual feedback ++ (Benjaminse et al., 2017)

"[V]isual feedback of one's own performance or one's own performance plus an expert model should be used in the implementation of instructional programs aimed at reducing the risk of jump-landing ACL injuries." P 623

- Benjaminse & Otten, 2011, p. 623

Feedback – Auditory

Verbal feedback tips based on current literature (Benjaminse et al., 2017)

- Present your athletes with information implicitly
- Focus on external focal attention
- **Don't** give them a big long list of decelerative information

Tempo – metronome use

- Connection between auditory rhythmical stimuli & the impact of motor learning & motor coordination (Rio et al., 2016)

Feedback – Somatosensory

- Mechanoreceptors are a highly specialized system developed to detect & discriminate touch
- This system works intimately with the other sensory systems to enable movement by providing your body with the necessary environmental inputs & combining them with body information
- This enables you to create motor output
- These types of questions will direct athletes attention to it:

What do you feel?

Where is your weight?

Feedback – Benefits of Somatosensory Touch

Somatosensory Touch

- Intrinsic feedback is from the athletes' sensory system
- Vital system for athletes as real-life movement requires integration of all senses
- Spatial awareness, orientation & balance

Hands-on Touch & Perturbations

- Perturbations enhance local motor system drive & contribute to intrinsic kinesthetic awareness (Kim et al., 2013).
- Using hands & equipment can provide salient information & decrease the amount of verbal declarative information
- Using surfaces as touch can help alignment
- The *how* of using hands-on touch & perturbations with athletes is important

Feedback – Amount & Stage of Learning

Less is *more:*

- Results show the reduced feedback group demonstrated improved motor learning (Sullivan et al., 2008)

Stage of learning impacts provision of feedback

- Children use feedback differently than adults
- Children may require greater practice volume, as well as a more gradual reduction in the provision of feedback (Sullivan et al., 2008)

Often children are in Fitts & Posner's *cognitive* stage of learning (Fitts & Posner, 1967)

- Recall that this means they have less ability to pay attention to instructions compared to later stages
- Key then is how to keep their attention *without over-cueing* them (De Giorgio et al., 2018)

Feedback – Manipulations

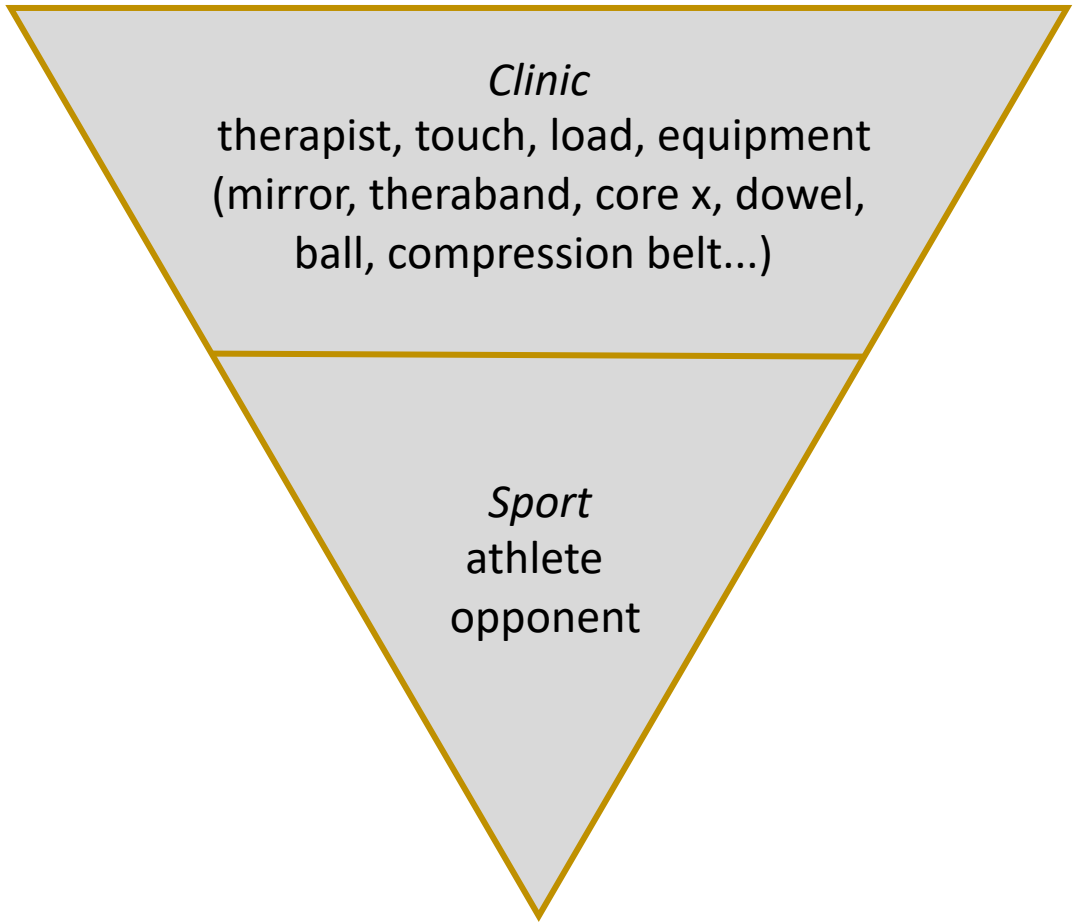
Manipulating sensory feedback can be used to support & augment the learning process

- This makes the task 'easier'

Manipulating context/environment can function to increase the difficulty of the training environment

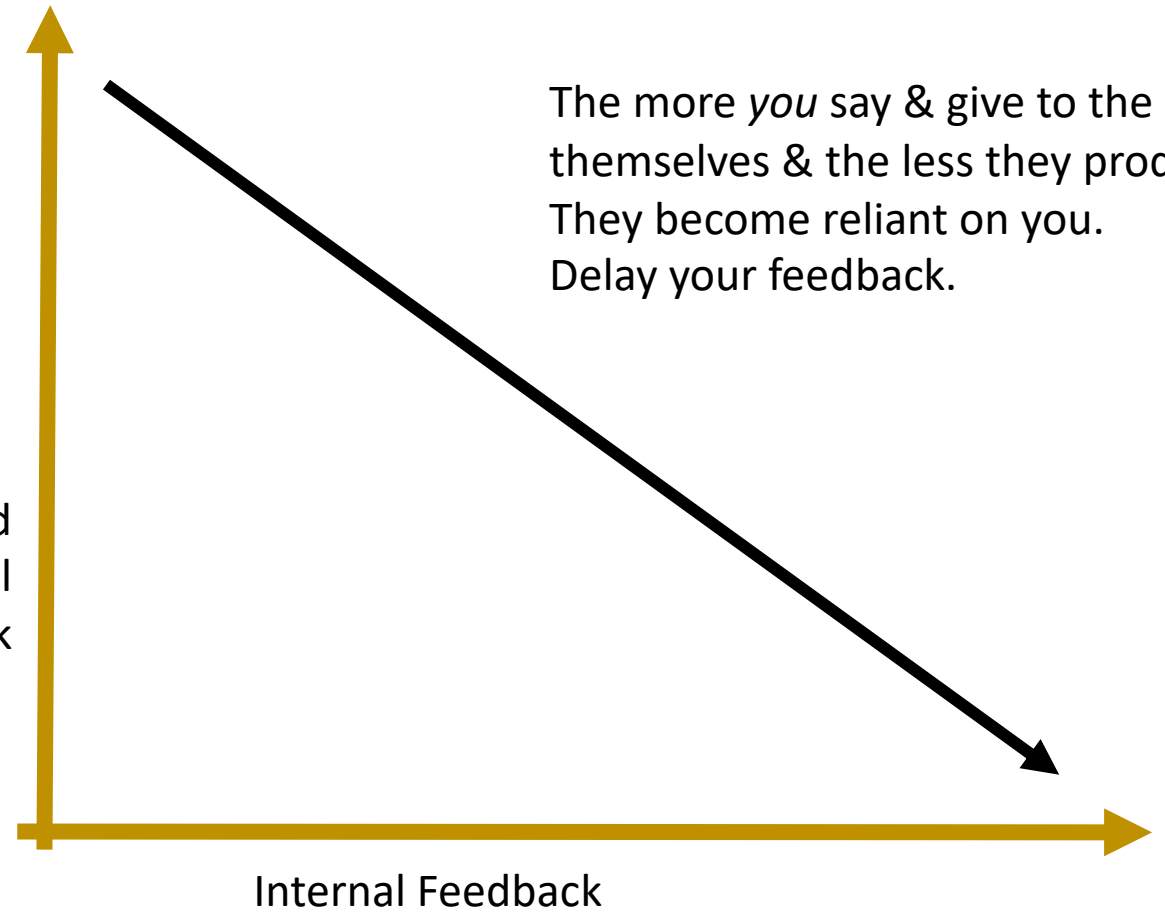
- This makes the task 'harder'

All planning must lead to the final goal of sport performance, where it's only the athlete plus teammates & opponents in a sporting context.



Feedback – Relationships

- Low athlete engagement
- High dependence
- Poor under pressure
- Passive involvement
- Low sense of control



The more *you* say & give to the athlete, the less they give to themselves & the less they produce for internal feedback.
They become reliant on you.
Delay your feedback.

- High athlete engagement
- High empowerment
- High self-control & self-organization
- High autonomy of motor learning

Feedback – Delivery

The Sandwich Method: Do you use it? Does feedback get lost?

Your effort is fantastic.
Work on being more powerful – like a rocket being launched from the ground.
You did a great job of keeping your shape.

Self-Control Feedback:
- Athlete requests feedback
- Increases autonomy & engagement

Stop to Highlight the "GOOD":
- Don't only stop to point out the 'bad'
- Highlighting successful performance & ignoring unsuccessful attempts proved beneficial to learning (Wulf & Lewthwaite, 2016)

A Framework for Athlete Management

G – Gather knowledge.
R – Relay & relate it.
O – Outline the process.
W – Work with purpose.
T – Teach & train together.
H – Highlight successes.

Cueing – Attentional Focus in Coaching

"Coaching cues are snippets of information, or task-orientated information, used to teach the athlete how to perform the task/skill[…]"

- Walker & Bartholomew, 2017

Words have *power*!

- What you say can promote resiliency & *open* motor systems for your athlete
- Or your words can *constrain* motor systems

Choose your words *purposefully &* make your words *impactful*!

Types of Cueing		
Internal Focus	*External Focus*	*Default Cueing*
• Cues are made about the *body* • *Example: "*keep your knee out" • *Freezes* the degrees of freedom • *Constrains* motor systems • Attention is inward • Overthinking • Loses automaticity	• Cues are made about the *outcome* of movement • *Example: "*drive down into the floor" • *Frees* the degrees of freedom • *Opens* motor systems • Attention is outward to the result/outcome • Fast, unconscious, reflexive processing • Automaticity • Encourages self-organization • Divided up into elements (ie distance, time, etc)	• No instruction • Where the athlete based on experience tends to put their focus if they don't get feedback. Can be internal or external. • Athlete-directed can either open or constrain their motor systems • Affected by experience & what they have learned from getting feedback over time

(Wulf et al., 2001; Benz et al., 2016)

”Youth athletes are not miniature versions of their adult counterparts; rather due to the maturation process, they learn and develop motor skills differently, requiring greater movement variety and simpler feedback during training… “

- Barillas et al. 2020, p. 4

Cueing in Youth

- More research is needed with regards to the most efficient & impactful way to cue youth.
    - "How cueing, movement variability, athletic performance and maturation interact."

      - Barillas et al. 2020, p. 3
- External cueing research exists that recommends its use for adult populations, as the body of literature of for adults is strong but that for youth is very limited.
- Evidence-based recommendations exist for
    - Jumping (Chow et al., 2014, Oliver et al., 2019).
    - Landing (Prapavessis et al., 2003).

Cueing – Types

Goal is to direct attention *away f*rom athlete's body & *towards t*he intended movement goal.

- This has been consistently found to improve motor learning & performance
- When a learner adopts an external (rather than an internal) locus of attention, movement kinematics start to resemble those seen in later stages of learning (Wulf et al., 2001; Wulf & Lewthwaite, 2016)
- As an external feedback provider, the key is to avoid directing the athlete's focus towards a single body part during movement
    - For example: avoid using cues like 'bend your knee', 'keep your foot forward facing'

Cueing – External Focus & Performance

- Wulf & Lewthwaite's (2016) Summary on the findings relating performance gains with *external focus* demonstrated improvements in:
  - Running speed
  - Balance
  - Max force production, etc...

- The same researchers state that overall:
  - The performer's attentional focus fundamentally affects movement coordination
  - An external focus on the intended movement effect *enhances all aspects* of performance, independent of skill level, task, age, or (dis)ability

Cueing – Attentional Focus in Rehabilitation

Physiotherapists cueing during rehab sessions (Durham et al., 2009)

- Often, the physiotherapists' instructions were directing clients to their body movement (internal cueing) rather than to the movement's effect on the environment (external cueing).
  - For example: 'straighten your elbow' vs 'get closer to the object'
- Also, these researchers found that the *therapists believed* that they were giving externally focused feedback but were shown via video that in actuality, most of their feedback was focused on the body parts (internal).
- In rehabilitation, our goal should be to make our closed environment (the clinic) into as much of an open environment as we can, which will better prepare our athletes for their final destination of returning to play.

"A cue is to movement what an address is to a GPS.”

- Nick Winkelman

A Framework for Athlete Management

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Unit 6 – The Research "Science" Summary

Step 1 – Understand the literature on learning, feedback & cueing:

What can you do? What can the athlete be taught to do?

Step 2 – Review your tendencies:

Are you promoting motor learning or inhibiting it?

Step 3 – Do some critical thinking:

What evidence could you apply to *your* practice on a case-by-case basis?

Step 4 – Progress through the G.R.O.W.T.H. framework:

This is a cyclical process that adapts and re-calibrates as the goal posts are either adapted or pushed forward with athlete progression.

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