e-swim coach

LEARNING SKILLS

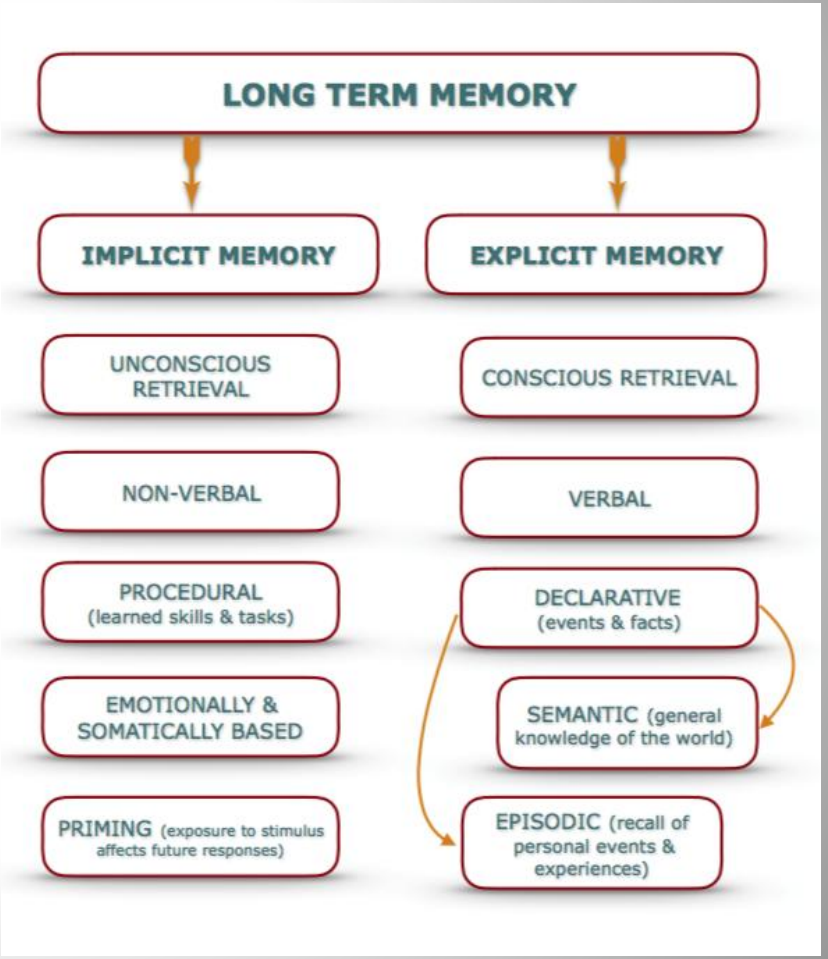
Research overview

LEARNING AND MEMORY

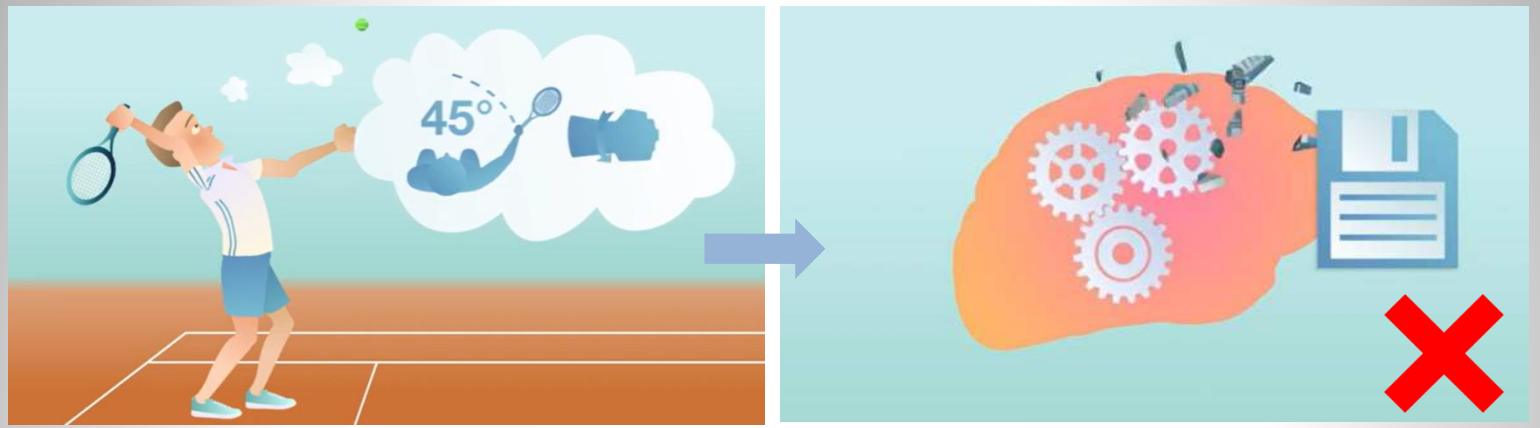
There are 2 types of long term memory involved in motor learning.

Explicit memory involves recalling previously learned information that requires conscious effort to receive, while implicit memory is unconscious and effortless.

Which memory is used will depend on the level of expertise as well as the learning approach that is used.



MEMORY AND REINVESTMENT



- Reinvestment is the tendency to consciously attend to the rules and knowledge that underpin the skill in an attempt to control the quality of performance.
- Reinvestment in competition can reduce the performance of an expert performer to the standard of a relative beginner. A term known as “choking under pressure”
- Autonomous/implicit learners are better equipped to solve the unexpected problems and challenges they encounter in competitions.

LEARNING METHODS

Several theories and instructional models have been proposed over the years to improve motor learning.

The main ones are :

•The Direct Approach (based on traditional theory)
•The Constraints Led Approach (based on the contemporary theories of “Action-Perception Coupling” & “Differential learning”)

Other tools include :

• Action observation
• Action imagery
• Metaphoric analogy
• Dual tasking

THE DIRECT APPROACH

- The traditional method of coaching.
- Instructor centered. The learner is a passive receiver of information.
- Explicit : learning takes place as a result of direct instruction, the performer is told what to do and when to do it.
- External cueing seems to be more efficient than internal cueing : Experts focus on the environment not their own bodies.
- The underlying theory is that repeating the same movement pattern “over and over” is the best way of memorizing skills (10,000 hour rule).
- Learning goals are often based on “ideal textbook technique” models.
- Sports are broken down into technical skill components which are mastered in isolation before being integrated to the activity as a whole.
- Facilitates early-stage skill learning (improvements are rapid).
- Practical for coaching large groups.
- Too much conscious control of skills in training can lead to “choking” under pressure (reinvestment).

e-swim coach

Fitts & Posner, 1967

Traditional models describe 3 stages to learning :

Cognitive stage (beginner)
-Conscious control
-Movement broken into sequences
-Movements completed step by step
-Large amount of variation and error in skill

Associative stage (intermediate)
-Decreased reliance on working memory
-Movement becomes more fluent
-Requires deliberate practice

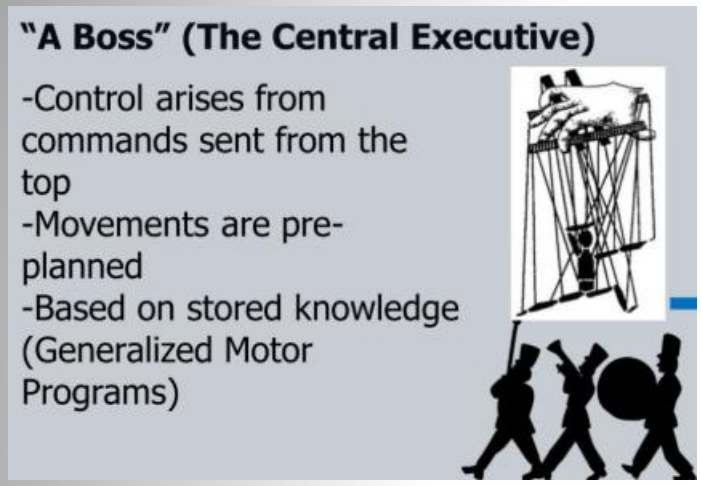
Autonomous stage (expert)
-Minimal cognitive effort required
-Improved anticipation and decision making
-Greater ability to detect errors in skill

Learning rate is individual and non-linear in nature. Patience is the key!

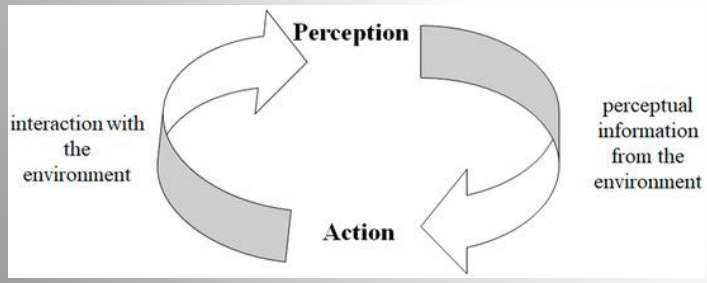
Although learning can be schematized into stages it is a continuum.

It is important to use appropriate learning methods for each stage.

ACTION-PERCEPTION COUPLING



•Traditional models present skill execution as a "top-down" system where commands are sent from the cognitive areas of the brain to the muscles.

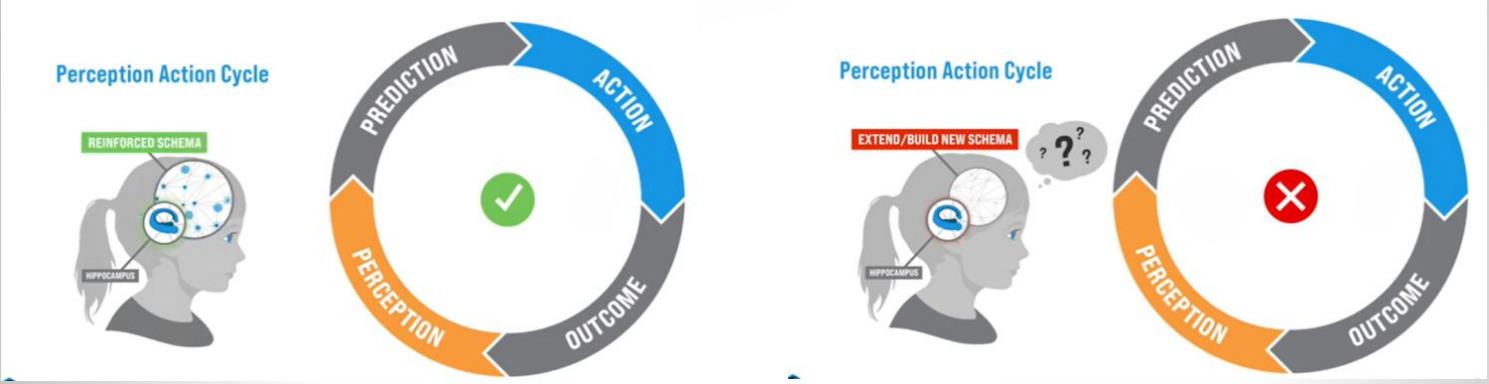


•Perception–action coupling is a reciprocal relationship between what the performers sees/feels and the actions they take.

• ***In this model actions are directly controlled by what we perceive without any need for processing and analysis.***

ACTION-PERCEPTION COUPLING

When we perform the brain automatically compares the outcome to the prediction.



- If the outcome is good the schema is reinforced
- If the outcome is not good the existing schema is de-prioritized and the brain becomes receptive to learning.

"We must perceive in order to move, but we must move in order to perceive!"

ACTION-PERCEPTION COUPLING

5 senses help us to perceive :

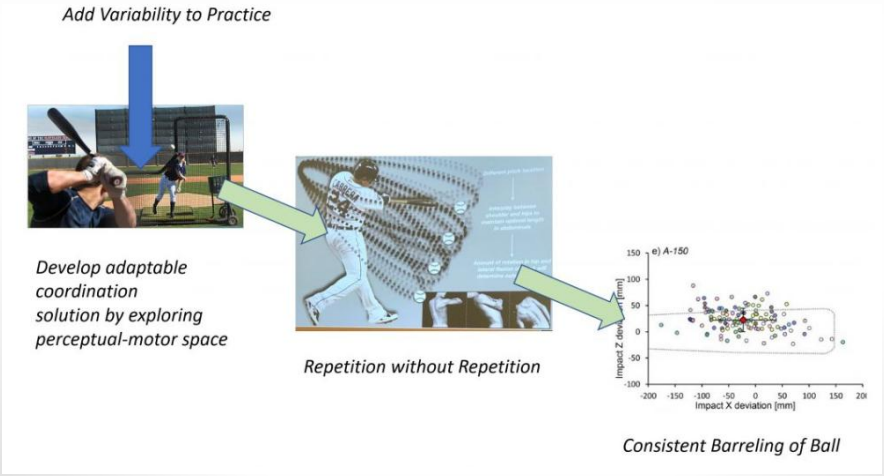
- Visual sense
- Auditory sense
- Tactile sense
- Vestibular system
- Proprioceptive system

The vestibular system is the movement and balance sense, which gives us information about where our head and body are in space. It helps us stay upright when we sit, stand and walk.

Proprioception is body awareness. It tells us where our body parts are relative to each other. It also gives us information about how much force to use, allowing us to do something like crack an egg while not crushing the egg in our hands.

DIFFERENTIAL LEARNING

• Differential learning is a theory that opposes the traditional theory of "repetition of movement based on an ideal movement pattern".
• It stems from the action-perception coupling theory of self-organization.
• Exploring a broad range of movement solutions for a specific task will increase awareness of ones individual capacities and enhance perception.
• "Repetition without repetition" : means repeating outcomes NOT movements.

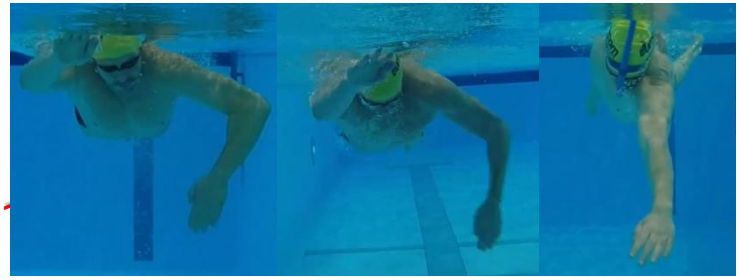


• The goal of variability is to develop ***adaptability in being able to solve movement problems*** (NOT to develop adjustability of an already developed technique).

DIFFERENTIAL LEARNING

Beginners naturally have a lot of movement variability during learning so it is not necessary to add more. Experienced swimmers can benefit from **"non-systematic"** variability early on in the training cycle to destabilize established patterns and to explore other movement options :

E.g. 3 x 100m : 1- "very shallow" pull, 2- "normal" pull, 3- "very deep pull" (checking stroke count to evaluate the effectiveness of the different options)

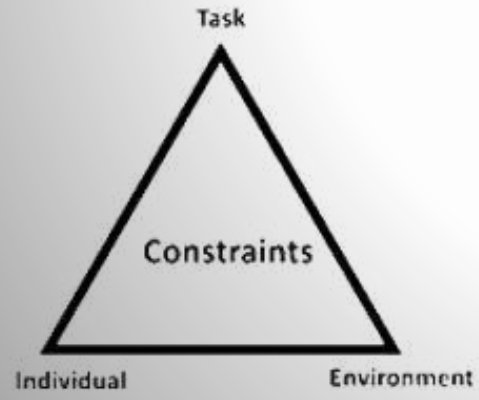


"Systematic variability" using constraints can be used to steer the swimmer towards a specific outcome :

E.g. 3 x 100m with closed fists, reducing the number of strokes taken from the first to the third 100m (to learn how to use the forearm to generate propulsion)

THE CONSTRAINTS LED APPROACH

- Learner oriented.
- Movement solutions are found through self organization
- Implicit learning through doing and feeling (Action-Perception Coupling).
- Skill is NOT movement memorization.
- Skill comes from problem solving ability (enhanced through Differential Learning)
- Skills become more fluid and robust in a competition setting
- No “ideal movement”. Solutions will vary according to individual traits.
- Emphasis on repeating outcomes not movements.
- Constraints serve to exclude actions.
- There are 3 types of constraints :



Environmental
The type of environment in which the performance takes place
E.g. 50m pool / 25m pool / Open water / Altitude/ Temperature

Individual
The physical and psychological traits of the performer
E.g. Height / Weight / Strength / Endurance / Fiber type

Task
The defining characteristics of the sport/game
E.g. Competition event / training set

THE CONSTRAINTS LED APPROACH

- ***Individual constraints*** such as strength, endurance and mobility can be improved through conditioning but body type is difficult to change.
- ***Environmental constraints*** used in swimming are mainly pool size, open water and altitude training.
- ***Task constraints*** are the principle type of constraints used by swimming coaches. Tasks can be manipulated using drills or equipment to achieve desired learning outcomes. However constraints are even more effective when the outcomes can be measured Eg. Pace / Tempo / Stroke count

DRILL CONSTRAINTS

General goal	Constraints	Effect	Desired outcome
Streamlining	Finger trail	Forces the arm to bend during the recovery phase (increasing economy)	High elbow recovery
Streamlining	1 arm with board	Creates an obstacle in front of the head	Hand entry without crossing the midline
Streamlining	Side kick	No arms, no board creates instability	Focusing on core stability
Streamlining	Arrow kick	No arms, no board creates instability	Focusing on core stability
Streamlining	6363	Instability after each arm pull	Focusing on horizontal and lateral streamlining
Streamlining	Kick and roll	No arms, no board creates instability	Minimize frontal resistance, maintaining rhythm and balance
Streamlining	Underwater recovery	Increased drag during the arm recovery	Using the body roll to reduce drag
Propulsion	1 arm swimming	Loss of speed after each arm pull	Overcoming inertia, focusing on acceleration
Propulsion	Hip catch-up	Loss of speed after each arm pull	Overcoming inertia, focusing on acceleration
Propulsion	Catch-up	Loss of speed after each arm pull	Overcoming inertia, focusing on acceleration
Propulsion	6363	Loss of speed after each arm pull	Overcoming inertia, focusing on acceleration & opposition timing
Propulsion	Sculling	Increased sensory awareness of the water	Generating vortices to create propulsion
Propulsion	Doggy paddle	Instant visual feedback of the skill	Focusing on the catch phase
Propulsion	Waterpolo	Instant visual feedback of the skill	Focusing on the catch phase and opposition timing
Breathing	Side kick with breathing	Task simplification	Focus on head rotation and ventilation
Breathing	6 beat kick with breathing	Task simplification	Focus on body and head coordination
Breathing	1 arm breathing active side	Task simplification	Focus on arm and head coordination
Breathing	1 arm breathing inactive side	Task simplification	Focus on arm and head coordination
Breathing	Breathing every stroke	Reduces the time available to breath	Minimizing the time spent with the face out of the water
Breathing	6363 with 2 breaths per side	Reduces the time available to breath	Minimizing the time spent with the face out of the water
Breathing	Hip catch-up with breathing	Reduces the time available to breath	Minimizing the time spent with the face out of the water

THE CONSTRAINTS LED APPROACH

EQUIPMENT CONSTRAINTS

General goal	Constraints	Effect	Desired outcome
Streamlining	Ankle weights	Reduces rear end buoyancy	Maintaining horizontal alinement
Streamlining	Weighted belt	Reduces general buoyancy	Maintaining horizontal alinement
Streamlining	Wrist weights	Reduces front end buoyancy	Maintaining horizontal and lateral alinement
Streamlining	1 wrist and 1 ankle weight	Assymetric momentum of the limbs	Maintaining lateral alinement
Streamlining	Band only	Eliminates the balancing action of the legs	Maintaining horizontal alinement
Streamlining	Pull with band	Eliminates the balancing action of the legs	Maintaining lateral alinement
Streamlining	1 fist + 1 paddle + 1 fin	Asymetric propulsion	Maintaining lateral alinement
Streamlining	Head paddle	Restricts head movement	Keeping the head on the longitudinal axis
Streamlining	Head cup (backstroke)	Restricts head movement	Keeping the head on the longitudinal axis
Streamlining	Kick with pull buoy and paddle on hea	Restricts head movement and kick amplitude	Horizontal and lateral alinement
Streamlining	Swim with pull buoy and 6 beat kick	Restricts the degree of kick amplitude	Horizontal alinement
Streamlining	Assisted sprint with rubber tubing	Overspeed increases drag above normal	Horizontal and lateral alinement
Streamlining	Assisted sprint with fins	Overspeed increases drag above normal	Horizontal and lateral alinement
Propulsion	Parachute	Resistance heightens the sensory awareness of the limbs / Reveals changes in speed	Eliminating pauses within the stroke cycle
Propulsion	Tethered swimming	Resistance heightens the sensory awareness of the limbs / Reveals changes in speed	Eliminating pauses within the stroke cycle
Propulsion	Band only	Eliminates any leg propulsion	Eliminating pauses between stroking actions
Propulsion	Pull with band	Eliminates any leg propulsion	Eliminating pauses between stroking actions
Propulsion	Opposition timing with a band	Band shortening highlights incorrect hand timing	Keeping the arms in opposite positions throughout the stroke cycle
Propulsion	Fists / Tennis balls	Eliminates hand propulsion	Using the forearms to generate propulsion
Propulsion	Forearm paddles	Eliminates wrist flexion	Using both hands and forearms to generate propulsion
Propulsion	Paddles	Increasing the surface area available for propulsion	Effective arm positioning to create propulsion in the right direction
Propulsion	Fins	Increasing the surface area available for propulsion	Effective leg positioning to create propulsion in the right direction
Propulsion	Paddles and fins	Increasing the surface area available for propulsion	Mastering arm and leg coordintation
Propulsion	Wrist weights	Increasing the momentum of the limbs	Efficient arm recovery, inter-arm and arm-body coordination
Propulsion	Ankle weights	Increasing the momentum of the limbs	Mastering kick amplitude, efficient change in foot direction
Propulsion	1 wrist and 1 ankle weight	Increasing the momentum of the limbs	Mastering arm and leg coordintation
Propulsion	Kicking	Eliminates arm propulsion	Generate propulsion with the kick
Propulsion	Vertical kicking with a weighted belt	Resistance heightens the sensory awareness of the limbs / Reveals changes in speed	Eliminating pauses within the kick cycle
Propulsion	Vertical board kicking	Resistance heightens the sensory awareness of the limbs / Reveals changes in speed	Eliminating pauses within the kick cycle
Breathing	Tuba breathing every 2 strokes	Task simplification	Focus on ventilation timing without head timing
Streamlining/Propulsion	Tuba	Task simplification	Focus on streamlining and propulsion only

MEASURABLE OUTCOME TASK CONSTRAINTS

Constraints	Desired outcome	Possible strategies
Pace per length	Holding pace to improve precision	Improving streamlining / propulsion / breathing / all 3
Stroke count per length	Holding or reducing stroke count at a given pace to improve efficiency	Improving streamlining / propulsion / breathing / all 3
Tempo	Holding tempo to eliminate pauses in the stroke cycle and to maintain a constant speed	Improving streamlining / propulsion / breathing / all 3

INSTRUCTIONAL MODELS COMPARED

Direct approach (Traditional)	Constraint led approach
•Coach oriented •Explicit learning (coach instructions) •Skill comes from repeating and memorizing “Ideal textbook movement patterns” (10,000 hour principle) •Simple skill components are mastered in isolation before being integrated to the main activity •Better suited to beginners, and for managing large groups •Too much conscious control of skills in training can lead to “choking” under pressure	•Learner oriented •Implicit learning through doing and feeling (Action-Perception Coupling) •Skill comes from problem solving ability •No “ideal movement”. Solutions will vary according to individual traits •Repeating outcomes not movements •Constraints serve to exclude actions •Movement solutions are found through self organization •Skills are more fluid and robust in a competition setting

INSTRUCTIONAL MODELS COMPARED

A recent study aimed to explore the experiential knowledge and preferred training approaches of 20 elite Australian swimming coaches in regards to general skill development .

The study revealed that the most common training practices employed to improve skill learning included :

- Task decomposition techniques (direct approach).
- Practices and tasks that are specific/representative to the intended performance outcomes.
- Use of constraints manipulation in the practice design.

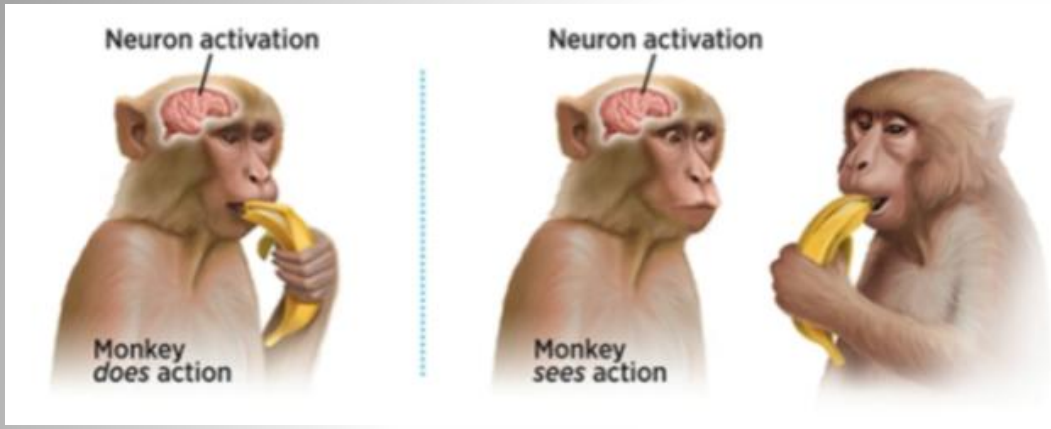
The best swimming coaches seem to mix both traditional and contemporary skill acquisition theories in their training prescriptions.

OTHER SKILL ACQUISITION TOOLS

In addition to the direct approach and the constraints led approach other skill acquisition tools include :

- Action observation
- Action imagery
- Metaphoric analogy
- Dual tasking

ACTION OBSERVATION



- Action observation is the process of watching movement.
- Humans naturally learn how to perform movements by watching the movements of other people.

  E.g. Children learn important skills such as walking by seeing their parents perform those actions.
- Research has shown that ***watching*** movements activates "mirror neurons" in the brain which are also involved in ***performing*** movement.
- Watching sports performance helps athletes improve by strengthening the brain areas used when actions are performed.
- Virtual reality equipment can enhance the experience.

ACTION IMAGERY

- Action Imagery is also called visualization or mental rehearsal and has been used successfully by sports psychologists for many years.
- Imagery means using all of your senses (e.g., see, feel, hear, taste, smell) to rehearse actions in your mind and has been shown to be an effective way of activating the same neurons that are used when performing.
- Success depends on the capacity of individuals to visualize effectively.
- Some individuals prefer visualizing as a spectator and others prefer seeing the performance through their own eyes.
- Action imagery can be combined with action observation.

METAPHORIC ANALOGY

• The use of a metaphoric analogy is an effective implicit coaching strategy as it gives the learner a simple focus and reduces the technical information they need to process.
• Pre-existing memories are retrieved from the unconscious areas of the brain.
• Analogy cues are superior to detailed, long winded technical instructions which require conscious processing.

E.g.1
Analogy learning : "Stretch out like an arrow"
Vs Explicit instructions : "Lock your head between your arms, stretch and keep your body segments in line!"

E.g.2
Analogy learning : "Jump like a frog"
Vs Explicit instruction : "Crouch down then use your thigh muscles to push off the floor, simultaneously extending your back and swinging your arms forwards.

(In order for metaphoric analogy to work subjects must understand the metaphors and be familiar with the vocabulary that is used.)

DUAL TASKING

- Dual tasking is when two tasks are performed at the same time.
- The idea is that if a cognitive task (such as counting) is performed at the same time as a motor task (such as throwing), the cognitive part of the brain will be “occupied” and motor learning will have to occur in the unconscious areas of the brain.
- Skills will be learned, implicitly leading to improved performance under pressure.

E.g. In swimming counting strokes is a form of dual tasking

- If the 2 tasks are similar in nature this creates interference and performance is compromised.

LEARNING SKILLS

The e-swimcoach approach

e-swim coach

IMPROVING SKILLS

BASIC PRINCIPLES
Take ownership of your learning process!
Understand the end goal of your actions!
Increase intent!

ACTION-PERCEPTION
''Do & feel''
Let the nervous system compare predictions to outcomes automatically

ACTION
PERCEPTION

IMPROVE GENERAL BODY AWARENESS
Using elementary dryland & water drills

GOALS
Clear & Precise
Challenging but attainable
Measurable outcomes whenever possible

CONSTRAINTS
Simplify tasks in the early stages
Exclude certain actions to highlight other ones
Increase difficulty at the right time

DIFERENTIAL LEARNING
Introduce variability to destabilize established, potentially inefficient habits Discover other movement options!

ACTION OBSERVATION
Implicit learning (using the unconscious areas of the brain)

METAPHORIC ANALOGY
Implicit learning (using the unconscious areas of the brain)

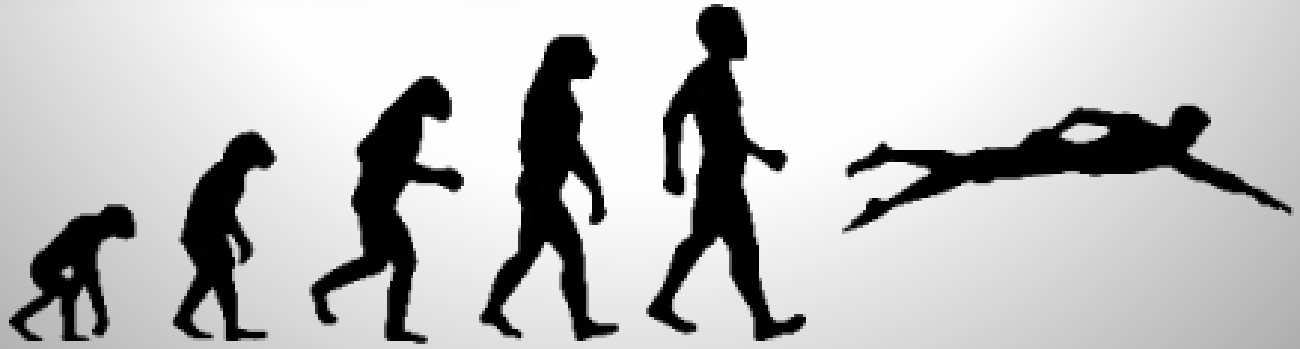
Analogies

The e-swimcoach approach

Water is not our natural environment!

On land we use our lower limbs for locomotion, we stand upright and we look forwards. Breathing in an aquatic environment is also very challenging and can be stressful. We have few if any transferable motor skills when we begin our learning journey in swimming.

Children who have been lucky enough to experience regular spontaneous free playing in the water from an early age have a definite advantage. They will bring to the table several rudimentary aquatic skills including floating, breath control, propulsive abilities and postural control. Unfortunately most adults have not been sufficiently exposed to the aquatic environment.



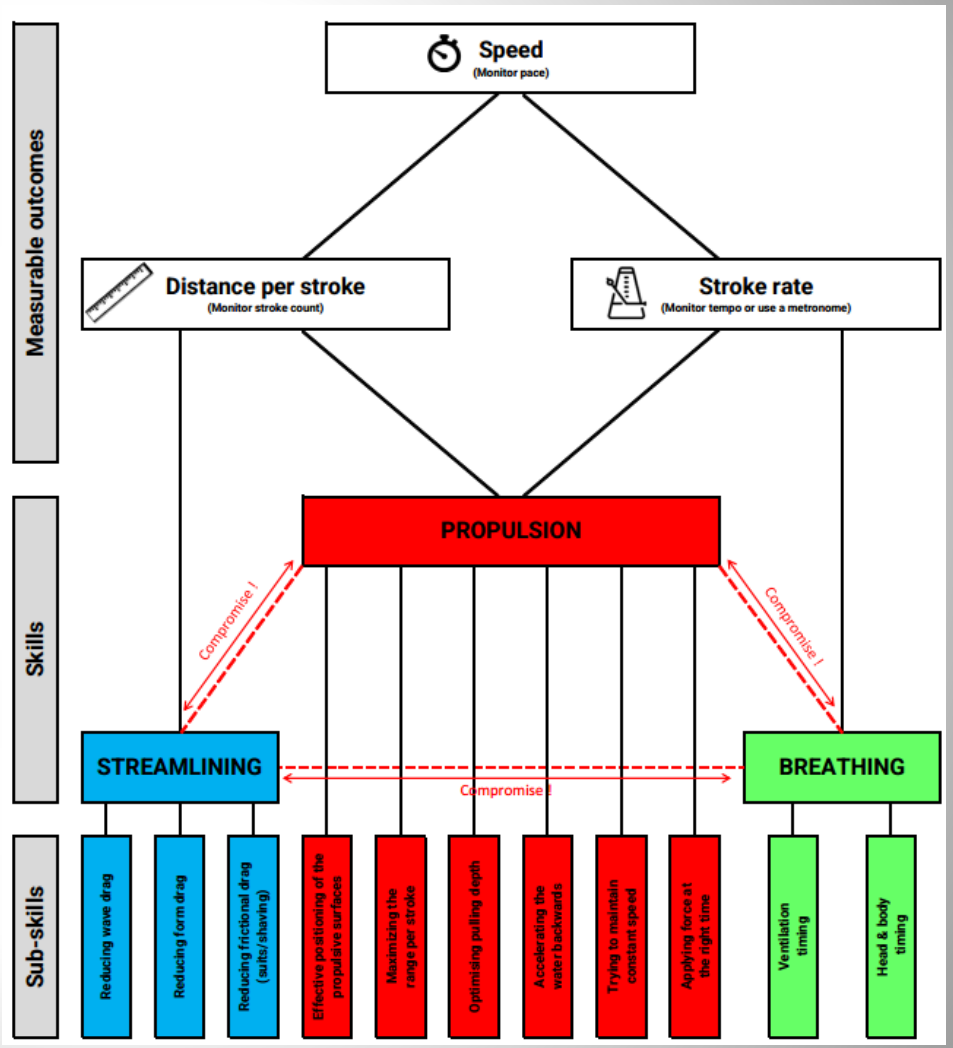
The e-swimcoach approach

Swimming is a very complex activity, requiring several skills and sub-skills!

It would be very ambitious to ask someone with little experience to tackle so many skills at the same time!

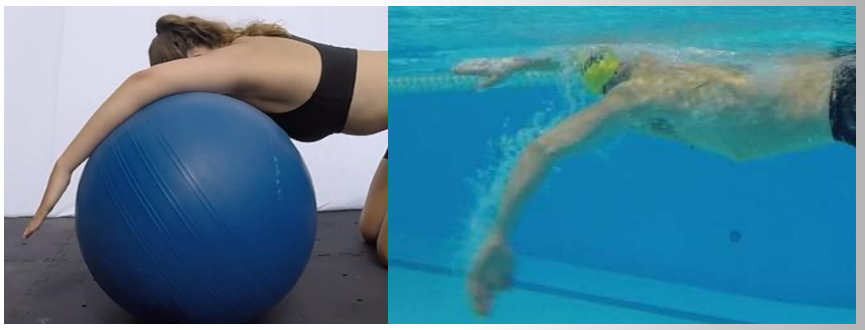
The **direct approach** to learning is integrated in the initial stages of the program in order to :

- Understand the theoretical principles of streamlining, propulsion and breathing.
- To put these principles into practice using simplified drills which improve body awareness in the aquatic environment.



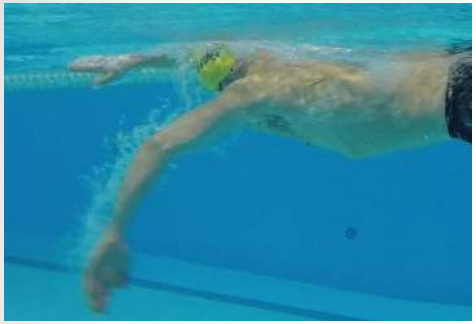
The e-swimcoach approach

Elementary dry land and water drills are used to improve body awareness. This sensory information is essential and can be recalled implicitly in the latter stages of the program.



The e-swimcoach approach

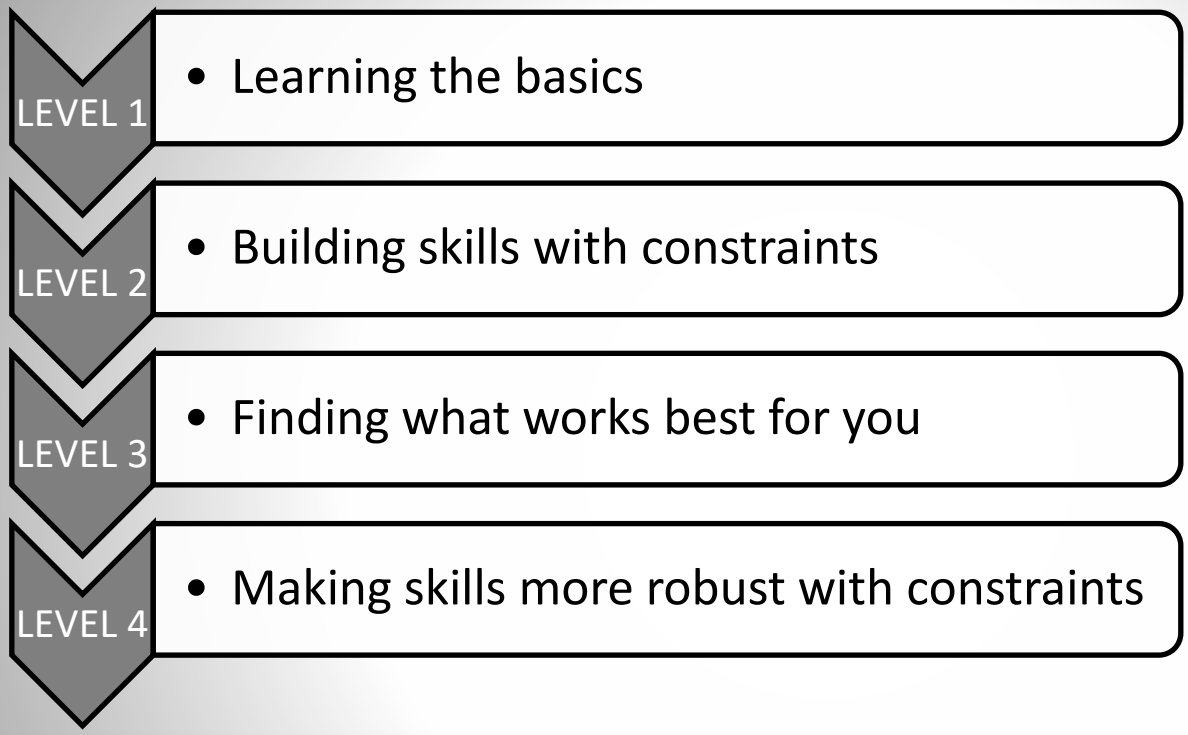
Tools such as action observation videos and analogies are used in order to stimulate learning implicitly (without conscious awareness).

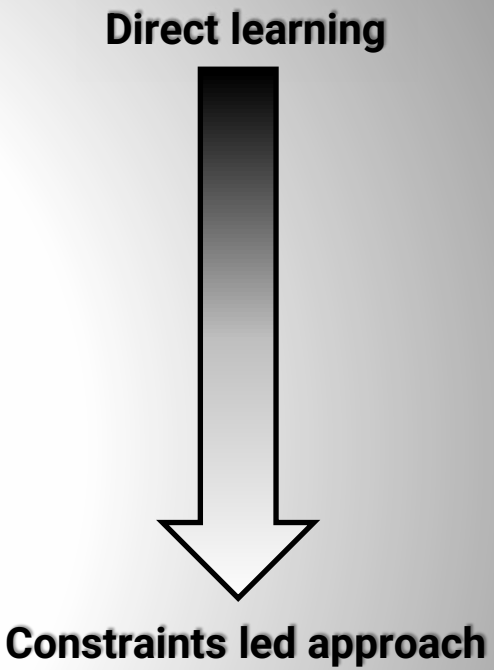


(The guidance that is provided does not aim to reproduce "ideal movement patterns" but rather to "get learners into the ball park".)

Once the rudimentary movement patterns are understood and acquired it is time to use the **constraints led approach** to develop functional and robust swimming skills!

Learning progression





We recommend starting the program from scratch whatever your level to make sure you don't miss any fundamental principles which could be limiting you.

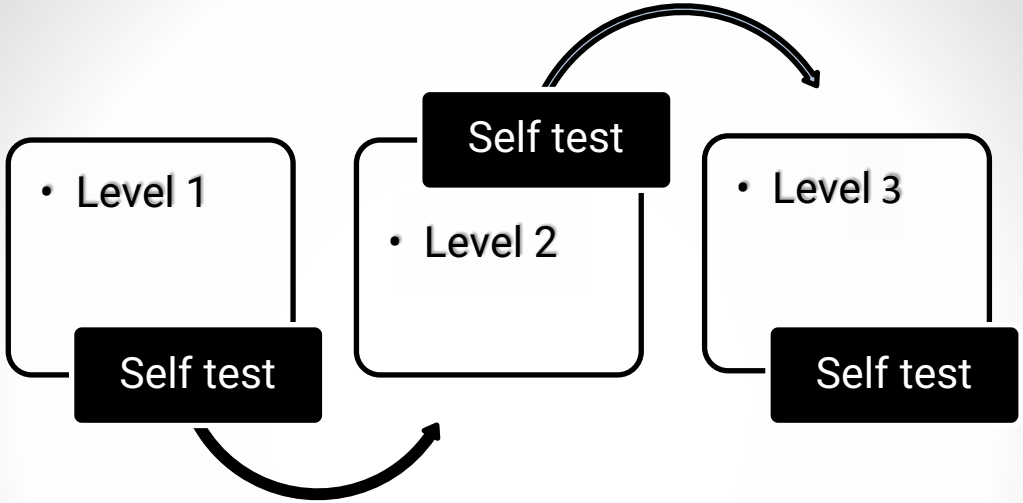
Even national standard swimmers may have technical weaknesses which are masked by their strengths! What will vary from one person to another is the time spent at each stage.

e-swim coach

Learning progression

	Goals	Instruction methods	Session format
Level 1 "Learning the basics"	Putting theoretical principles into practice Developing body awareness Learning rudimentary swimming skills	>Mainly direct learning with cues (internal & external) >Understanding the theory (PPT/PDF) >Implicit tools (action observation, analogy) >Exercises designed to heighten sensory information & to improve body awareness >Mostly elementary drills (targetting sub-skills) linked to fullstroke to facilitate transfer >Equipment is used mainly to facilitate tasks	>Duration aprox.50min (volume measured in time instead of distance covered) >Focusing on 1 basic principle per session (propulsion or breathing or streamlining) >1 dryland drill before getting in the water (at home or on the pool deck) >3 swimming drills focusing on specific sub-skills >Mainly slow paces, some medium & fast pace work >No measurable outcomes
Level 2 "Building skills with constraints"	To continue improving body awareness To start encouraging self organization To test skills using one measurable outcome at a time	>A balance between the constraints led approach & direct learning >To challenge skills using tasks & equipment >To evaluate results using 1 measurable outcome at a time (stroke count/pace/stroke rate) >Implicit tools (action observation, analogy) >Less direct cues	>Duration aprox. 60min (volume measured in time instead of distance covered) >Focus on all basic principles every session (propulsion, streamlining & breathing) >Warm up with elementary drills to revise the basics >1 speed set every session >1 stroke count set every session >1 pace set or 1 tempo set every session >Mainly slow paces, some medium & fast pace work
Level 3 "Finding what works best for you"	Exploring a broad variety of movement options to further enhance body awareness and to discover individual preferences To continue challenging skills with constraints To test skills using one measurable outcome at a time	>Exploring a broad variety of movement options for each skill (To test different movement options using stroke count) >To continue challenging all skills with the constraints led approach >To evaluate results using 1 measurable outcome at a time (stroke count/pace/stroke rate) >Analogies still included	>Duration aprox. 60min (volume measured in time instead of distance covered) >Focus on all basic principles every session (propulsion, streamlining & breathing) >Warm up with elementary drills to revise the basics >1 speed set every session >1 stroke count set with exploratory drills every session >1 pace set or 1 tempo set every session >Mainly slow paces, some medium & fast pace work
Level 4 "Making skills more robust with constraints"	Stabilizing skills Increasing the difficulty of the constraints To test skills with 2 measurable outcomes at the same time	>Constraints led approach >To challenge skills using multiple tasks at the same time >To evaluate results using more than 1 measurable outcome per exercise >Implicit tools (action observation, analogy) >Some general analogies >Little if any cues	>Duration aprox. 60min (volume measured in time instead of distance covered) >Warm up with exploratory drills & stroke count >1 speed set every session >Main set either : Pace + stroke count / Tempo + stroke count / Pace + tempo >Kick set (pace) >More medium and fast pace work

Self tests and prerequisites



A system of self-tests and prerequisites determines if you are ready to move from one level to the next. If you have difficulties achieving the tests we recommend repeating sessions which focus on your weaknesses or even repeating the pack of sessions till you acquire the necessary skills.

Learning rate is individual and non-linear in nature. Patience is the key!

References

Brymer, Eric & Renshaw, Ian (2010) An introduction to the constraints-led approach to learning in outdoor education. Australian Journal of Outdoor Education, 14(2), pp. 33-41.

Bruton AM and Wright DJ (2022) Watch and Learn: Athletes Can Improve by Observing the Actions of Others. Front. Young Minds. 10:702784. doi: 10.3389/frym.2022.702784

Davids, K., Button, C., and Bennett, S, (2008) Dynamics of skill acquisition. A constraints led approach. Human Kinetics

Gray, R. (2021). How We Learn to Move: A Revolution in the Way We Coach & Practice Sports Skills. United States: Rob Gray.

Hardwick, R. M., Caspers, S., Eickhoff, S. B., and Swinnen, S. P. 2018. Neural correlates of action: comparing meta-analyses of imagery, observation, and execution. Neurosci. Biobehav. Rev. 94:31–44. doi: 10.1016/j.neubiorev.2018.08.003

Nelson, S., Walsh, K., Stockdale, P., Hamilton, A., Guthrie, J., Millar, S., Live It Up 2. VCE Physical Education Units 3 & 4. 5th edition. learnON. Jacaranda

Neuman, B., and Gray, R. 2013. A direct comparison of the effects of imagery and action observation on hitting performance. Mov. Sport Sci. Sci. Motricité 79:11–21. doi: 10.1051/sm/2012034

Renshaw, I., Davids, K., Newcombe, D., Roberts, W. (2019). The Constraints-Led Approach: Principles for Sports Coaching and Practice Design. United Kingdom: Taylor & Francis.

References

Seifert, Ludovic & Papet, Valentin & Strafford, Ben & Coughlan, Edward & Davids, Keith. (2019). Skill transfer, expertise and talent development: An ecological dynamics perspective. Movement and Sports Sciences - Science et Motricité. 10.1051/sm/2019010.

Sheaff, A. (2023). A Constraints-Led Approach to Swim Coaching. United Kingdom: Taylor & Francis.

Silva, Ana & Seifert, Ludovic & Fernandes, Ricardo & Vilas-Boas, J. Paulo & Figueiredo, Pedro. (2022). Front crawl swimming coordination: a systematic review. Sports Biomechanics. 10.1080/14763141.2022.2125428.

Ste-Marie, D. M., Law, B., Rymal, A. M., O. J., Hall, C., and McCullagh, P. 2012. Observation interventions for motor skill learning and performance: an applied model for the use of observation. Int. Rev. Sport Exerc. Psychol. 5:145–76. doi: 10.1080/1750984X.2012.665076

Victoria Brackley, Sian Barris, Elaine Tor & Damian Farrow (2020) Coaches' perspective towards skill acquisition in swimming: What practice approaches are typically applied in training?, Journal of Sports Sciences, 38:22, 2532-2542, DOI: 10.1080/02640414.2020.1792703