ACHPER Brisbane Conference 2018
Motor Learning Theory for Senior Physical Education
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Evolution of Motor Learning Theories

	Behaviourism	Cognitive Systems Approach	Dynamic (ecological) Systems Approach
Developed from	Behavioural Psychology	Cognitive Psychology	Ecological Psychology
When?	Pavlov (1897) Watson (1913) B. F. Skinner (1930)	Plato (428 BC—348 BC), Descartes (1596-1650).	Bernstein (1967) action Gibson (1979) perception
Theory (model) to explain learning of motor skills	**Stimulus - Response** ("programmed animals" respond to a stimulus)	**Information Processing Model (Cognitive Model)**	**Ecological Dynamics** (Motor Learning Theory) • Ecological psychology • Dynamical systems theory
Learning (movement) occurs as a result of:	• instruction and reinforcement/ punishment produces a response or behaviour (conditioning) • no thinking	• brain processes information (like a computer), selects a response and programs movement • thinks then acts	• Movement emerges from the interaction between the individual, the task and the environment
Movement is controlled by	**External Environment (training)** • brain not recognised	**Brain** • environment and subconscious control mechanisms of body not recognised	**Entire Body** (brain, subconscious control mechanisms of the body, i.e. nervous system, musculo- skeletal system) **and the Environment**

Cognitive Systems Approach v Dynamic Systems Approach

Key difference is how movement is controlled

Cognitive Systems Approach (conscious control)

- **Brain**

Dynamic Systems Approach (subconscious control)

- **Entire body** (brain, subconscious control mechanisms of the body, i.e. nervous system, musculo-skeletal system)
- **Environment**

Our Body Thinks

How do actors memorise their lines? Michael Boyd

We worked with about 30 actors over nearly three years on the Royal Shakespeare Company's last complete cycle of the history plays. All the actors were in at least seven of those plays and learnt a huge number of roles. Halfway through the project, we left the first four plays behind for nearly a year. And we had to revive them. The actors began to get anxious about whether they would remember them: not only their principal roles, but the roles they understudied - thousands of lines, hundreds of states of emotions. An extraordinary feat of spatial memory was required, too: they had to remember where to go. Where am I? Backstage or front of house?

This process started with actors on their own going through their lines. They didn't remember them. We then moved on to working together in a room, sitting down doing a line-run. It wasn't very good. Then we decided to cut to the chase and just fling all four plays onto the stage - without costume, without décor, without all the effects. And the actors were very nearly word-perfect straightaway. It was clear that what they were trying to retrieve was no more than a broken bit of memory, only complete when the actions of their bodies and the emotions were combined with the recall of the line. And there was a further improvement when they were not only together on stage, but also together with an audience. Then they became absolutely pitch-perfect and word-perfect, with an urgent need to communicate. I think that says something about where we keep our memory. Maybe our memory is in our body as well as in our cranium. Source: The Sunday Times, November 23, 2008

"It seems that the cognitive task of remembering is more effective when the brain, body and environment are involved".

Cognitive Systems Approach v Dynamic Systems Approach

Problem: During practice, your shot putter consistently fouls when practicing by just touching the top of the stop board while following through

Cognitive Systems Approach (Information Processing Model)
Brain controls movement, therefore the solution is aimed at forcing the individual to consciously think about what their specific body segments should be doing using their brain and then act

Explicit Instructions

- After release, come off the heel of the foot not the ball

Problem: During practice, your shot putter consistently fouls when practicing by just touching the top of the stop board while following through

Dynamic Systems Approach (ecological dynamics)
The solution will come from the individual engaging with the environment at a subconscious level

No instructions (let the body think)

- Make shot put circle smaller (constraint)

Q. Predict what behaviour might emerge.

Problem: Your backstroke swimmer's hand enters the water wide of the shoulder line, causing the arm pull to lack power.

Cognitive Systems Approach (Information Processing Model)
Brain controls movement, therefore the solution is aimed at forcing the individual to consciously think about what their specific body segments should be doing using their brain and then act

Explicit Instructions

- Your arm must be straight
- Hand must enter the water in line with the shoulder

Problem: Your backstroke swimmer's hand enters the water wide of the shoulder line, causing the arm pull to lack power.

Dynamic Systems Approach (ecological dynamics)

Q. How can we manipulate the environment to enable the swimmer to learn the correct hand entry subconsciously (i.e. without consciously engaging the brain)?

What does research say about the conscious v subconscious control of movement?

- Learning is possible without the instructions and feedback provided by a coach, teacher or parent.
- Typically, motor skills are not controlled at a conscious level, they are controlled subconsciously (implicitly without thought).
- Forcing you to consciously think about what your body segments are doing can interfere with the natural learning process, which can harm your performance.

- Therefore, try to distract or quieten the mind not fill it with specific information about what your body segments are doing (i.e. slight forward rotation of the hip).

Quietening the mind

Sport psychologists have recognised that one of the main reasons athletes choke under pressure is because they overthink skill execution which interferes with their action. Professor Sian Beilock of the University of Chicago is a leading expert on this phenomenon and calls it "paralysis by analysis". Thus, many elite sportsmen and sportswomen use the theory of distracting or 'quietening' their mind to prevent overthinking and allow movements to flow automatically, without conscious thought.

What type of instructions compliment implicit learning?

Many studies have demonstrated that focusing attention on the **outcome of an action** produces superior performance and learning compared with focusing on the **mechanics of an action.** This is because focusing on the result of a movement prevents conscious control, and allows your body to explore and find its own way to achieve the outcome. For example, instructing a sprinter to run in a straight line or instructing a golfer to hit the ball so that its flight is like the shape of a rainbow or instructing a hurdler to get three steps in between each hurdle.

Advantages of Learning Implicitly

Your skills are:

- less likely to break down under competitive pressure (choking)
- retained more permanently over time.

Dynamic Systems Approach is based on the Motor Learning Theory of Ecological Dynamics

Ecological Psychology + Dynamical Systems Theory

Ecological psychology

Learning (behaviour) is shaped by the interactions between an individual's body and the environment.

Ecological Psychology: Learning through Interacting with the Environment

As a 13 year old I used to play unstructured soccer in the front yard of my house with my 6 year old brother. A rose garden bed surrounded half of our yard. This made us both learn to kick the ball with control as we did not want to damage the ball or the roses. Playing against a 6 year old in a small yard was harder than it sounds too- we had 1 goal and a 3 m x 5 m yard to play on. We developed technical skills in one on one situations (learning to beat opponent in many ways) and I personally developed defensive skills as well because I had to keep my brother interested so gave him the ball more often. Mitch 2013

Identify an example of a constraint (boundary that shapes behaviour) in this account?

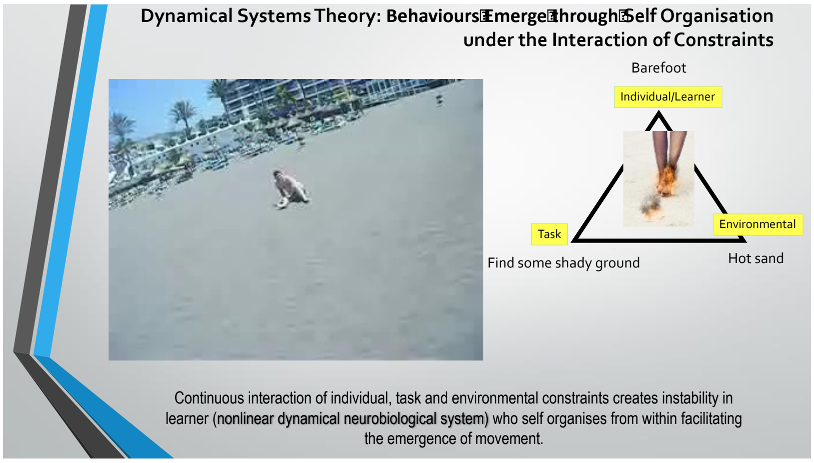
What behaviour was emergent (not explicitly prescribed) because of this constraint?

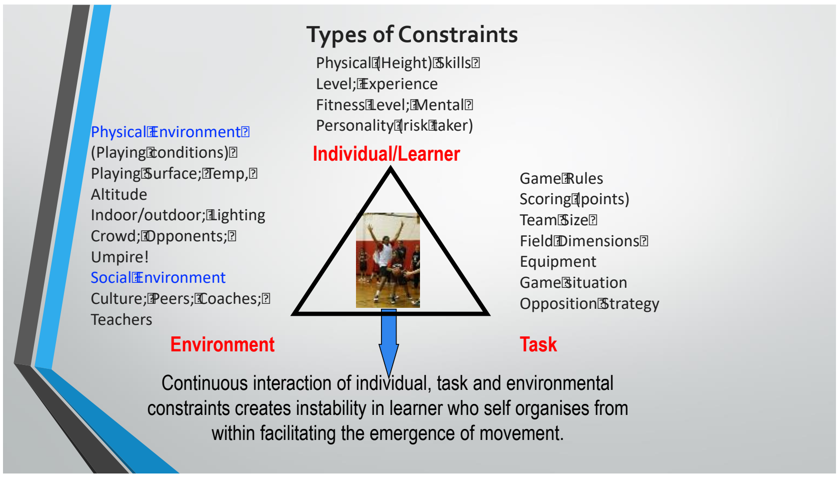
Is this learning explicit (conscious) or implicit (subconscious)?

Dynamical Systems Theory:

According to dynamical systems theory, we are a complex, dynamic system composed of many interacting parts such as the senses, nerves and muscles, and many unique individual characteristics such as height and fitness. When this complex dynamic system interacts with a task and the environment, instability is created, resulting in the system reorganising itself and movement emerging.

Dynamical Systems Theory: Behaviours Emerge through Self Organisation under the Interaction of Constraints





Dynamical Systems Theory: Behaviours Emerge through Self Organisation under the Interaction of Constraints

Growing up, my next door neighbours and I used to play backyard cricket. However, the pitch was a narrow driveway to the side of the house. On my leg side the man next door would confiscate our ball if it was hit into his yard . This fear prevented me playing the pull shot, but space on the offside allowed me to play shots such as the straight drive and cut shot. This shaped how I played club cricket as I was able to work any delivery onto the offside and my most successful scoring shot was the cut shot (QUT Student)

Identify examples of constraints (boundary that shapes behaviour) in this account?What behaviour was emergent (not explicitly prescribed) because of this constraint?

Is this learning explicit (conscious, explained by cognitive theory) or implicit (subconscious, explained by ecological theory)?

Growing up, my next door neighbours and I used to play backyard cricket. However the pitch was a narrow driveway to the side of the house (task constraint). On my leg side the man next door would confiscate our ball if it was hit into his yard (environmental constraint). This fear (individual constraint) prevented me playing the pull shot, but space on the offside (task constraint) allowed me to play shots such as the straight drive and cut shot. This shaped how I played club cricket as I was able to work any delivery onto the offside and my most successful scoring shot was the cut shot (Emergent Behaviour).

Linear v Nonlinear Learning

When learning to ride a bike, ski or surf etc.
Was your learning journey:

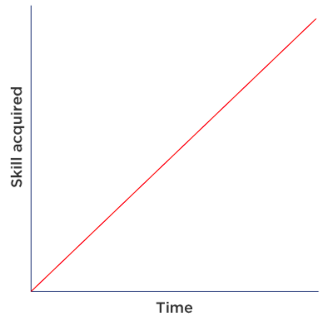
Linear

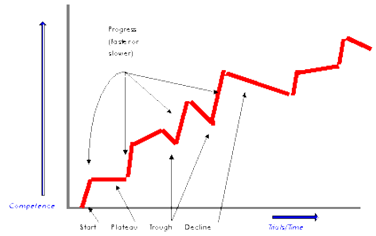
- proportional (if you spent twice as long you got twice as good)
- practice resulted in single, sequential predictable learning outcomes

Or

Nonlinear

- erratic (sudden progressions and regressions in performance level accompanied by periods of an absence of change)
- practice resulted in multiple, unpredictable learning outcomes





A Learning "Curve" is far from a straight progression

Nonlinear Teaching Approach Grounded in Ecological Dynamics

The Constraints Led Approach (CLA)

The practice design and delivery of feedback and instruction of the CLA is grounded in the contemporary motor learning theory of ecological dynamics within a nonlinear pedagogy framework

The CLA challenges learners to solve common tactical, technical problems through active exploration of representative practice environments, shaped by practice task constraints (boundaries) that facilitate the emergence of functional movement solutions.

The Constraints Led Approach v TGfU

- similar operational principles to TGfU (looks same in practice)
- motor learning theory of ecological dynamics can also underpin (explain) learning in student centred approaches like TGfU, Game Sense
- TGfU was designed by *practitioners for practitioners* as a *practical approach* aimed at improving the learning experiences of children (Thorpe, 2015). When can we play a game? Why do we need to learn skills?
- The CLA approach is grounded in/grew from Motor Learning Theory
- The CLA can be used to develop technical and tactical ability
- CLA can be applied outside games (track and field, swimming, sailing)
- Unlike TGfU and GS, understanding (cognition) and questioning is not an essential part of the learning process in CLA

The Constraints Led Approach in HPE

Q. How may each of these task constraints shape the emergence of a player's behaviour during a game/performance?

Game Rules (track and field)

- 6 lap race on circular track that is 150m
- Eliminate last runner after each lap

Game Rules (basketball)

- If tagged lose possession

Game Rules (badminton)

- Double points if receiver can win the rally within 4 shots

Scoring Procedures (basketball)

- 3 points if score from inside key

Team Size/ Number of Players (volleyball)

- 6 v 6 (3 players from each team have a red bib and they cannot have first touch after serve)

Field Dimensions, Equipment, Game situation, Opposition Strategy

Representative Practice Design

Why is this key information important to include in practice?

Allows learners to:

- coordinate their movements (action) in response to what they see (perception)
- perceive and detect affordances for action (i.e. information in the environment that supports an opportunity for action such as an unmarked teammate for a pass or a gap between defenders for dribbling through). In other words, 'read' the play

Representative Practice Design: Affordance

Q. Give an example of an affordance for action in rock climbing (i.e. information in the environment that supports an opportunity for action).

Q. Give an example of an affordance for the action of driving to the basketball hoop. (i.e. information in the environment that supports an opportunity for action).

Rate Limiters

Rate Limiters are factors that influence how you learn and may potentially restrict your performance. For example, research in child development has found that muscle strength is a key rate limiter that restricts an infants' ability to walk. Rate limiters are many and varied but can be classified into 3 main categories:

- individual (technique, coordination, perceptual ability, decision making ability, tactical knowledge, height, limb length, strength, confidence, motivation, speed, flexibility, experience),
- task (weight, size, or height of equipment, playing area dimensions, rules)
- environmental (running surface, coach/teacher instruction, weather, umpire/referee, cultural, teammates ability)

Q. What is an affordance for an acting half to run in a game of touch football

Q. If a player in your team does not run from acting half when afforded the opportunity what are possible rate limiters?

How to teach Motor Learning Concepts using the Inquiry Approach

The following is an example that I used in the Senior PE Textbook

Macmillan Physical Education QCE Units 1 & 2 Student Book
Glenn Amezdroz, Geoff Hosford, Angela Kelso, Brendan Moy, Robert Sweeper, Tania Stewart

Constant and Varied Practice and Performance
Concept: To enable the best transfer of skills, practice environments should prepare players for the variability of the performance environment

Stage 1: Engage and Understand

Use secondary data to explain the motor learning concept and how it can influence performance

A drill is a constant practice environment in which you repetitively practice one variation of a movement prescribed by your teacher or coach, for example, chest passing a ball over 5 metres around a triangle. However, techniques fail to effectively transfer from a constant practice environment to the actual performance environment This is because the two environments are significantly different (Handford, Davids, Bennett, & Button, 1997). For example, a study of futsal players by Bruno Travassos and colleagues (2012) found that when they practiced passing in a constant practice environment, they passed at a constant speed. In contrast, in a competitive game passing speeds were found to be variable, not constant. Thus, constant practice did not prepare players for the variability of the game. To enable the best transfer of skills, practice conditions should match the variations experienced during a match. This allows you to learn to adapt to changing conditions in the performance environment (Renshaw and Moy 2018).

Gather primary data

Investigating variability of passing within a constant practice environment (primary data)
A group of 5 students participate in the constant practice environment (passing square soccer drill). The remaining students observe and gather primary data about passing within the drill. Record the passing data using table 3.1.
Investigating variability of passing within the performance environment (primary data)
A group of 22 students play a full game of soccer (10 minutes). The remaining students observe and gather primary data about passing within the game. Record the passing data using table 3.1. To make easier, observe the passing of one team only. Note: If not enough students available play a 6 v 6 game on a half size field.

Table 3.1 Passing data in a constant practice environment (drill) and the performance environment (game)

How variable is passing?	Constant Practice Environment (passing square drill)			Performance Environment (game)		
1. Passing Distances (distance between passer & receiver)	0-10 m	11-20 m	>20 m	0-10 m	11-20 m	>20 m
2. Ball Trajectory	Along ground	Between Ground & Head Height	Above head height	Along ground	Between Ground & Head Height	Above head height
3. Ball Speed	Slow	Medium	Fast	Slow	Medium	Fast
4. Foot Contact with Ball	Inside Foot	Toe	Outside Foot	Inside Foot	Toe	Outside Foot
5. Passing Recipients	Same	Few	Many	Same	Few	Many

Stage 2: Apply and Analyse

Analyse primary data

How variable is passing?	Constant Practice Environment (passing square drill)			Performance Environment (game)		
6. Passing Distances (distance between passer & receiver)	0-10 m	11-20 m	>20 m	0-10 m	11-20 m	>20 m
	100%			**30%**	**50%**	**20%**
7. Ball Trajectory	Along ground	Between Ground & Head Height	Above head height	Along ground	Between Ground & Head Height	Above head height
	100%			**50%**	**30%**	**20%**
8. Ball Speed	Slow	Medium	Fast	Slow	Medium	Fast
	90%	**10%**		**20%**	**40%**	**40%**
9. Foot Contact with Ball	Inside Foot	Toe	Outside Foot	Inside Foot	Toe	Outside Foot
	100%			**60%**	**10%**	**30%**
10. Passing Recipients	Same	Few	Many	Same	Few	Many
	100%					**100%**

a. How variable was the passing in the constant practice environment (passing drill)? Give a rating from 1-5 (**1 = repetitive**; 2 = little variability; 3 = some variability; 4 = much variability; 5 = highly variable). Justify your rating using the primary data gathered.

b. How variable was the passing in the performance environment (game)? Give a rating from 1-5 (1 = repetitive; 2 = little variability; 3 = some variability; 4 = much variability; **5 = highly variable**). Justify your rating using the primary data gathered.

Devise and justify a strategy to increase variability of constant practice

In groups of 4, modify the passing drill to better prepare the novice learner's passing skills for the variability that exists in the performance environment. The aim will be to achieve a higher score of 2 or 3 on each of the 5 variability criteria. Simply put, turn the drill into a type of game which incorporates passing variability. To ensure that the practice task is not too complex for the novice learner, you must use a game that involves 3 or 4 students with no defenders. Justify your strategy using

Implement strategy to gather primary data

How variable is passing?	Modified Passing Game		
1. Passing Distances (distance between passer and receiver)	0-10 m	11-20 m	>20 m
2. Ball Trajectory	Along ground	Between Ground & Head Height	Above head height
3. Ball Speed	Slow	Medium	Fast
4. Foot Contact with Ball	Inside Foot	Toe	Outside Foot
5. Passing Recipients	Same	Few	Many

Analyse primary data

How variable is passing?	Modified Passing Game		
6. **Passing Distances (distance between passer and receiver)**	0-10 m	11-20 m	>20 m
	50%	**30%**	**20%**
7. **Ball Trajectory**	Along ground	Between Ground & Head Height	Above head height
	60%	**30%**	**10%**
8. **Ball Speed**	Slow	Medium	Fast
	10%	**70%**	**20%**
9. **Foot Contact with Ball**	Inside Foot	Toe	Outside Foot
	60%	**20%**	**20%**
10. **Passing Recipients**	Same	Few	Many
			100%

a. How variable is the practice environment (modified game)?

(1 = repetitive, 2 = very little variety, 3 = some variety, **4 = mostly variable**, 5 = highly variable)

Note: A graph to compare each activity could be used here

Stage 3: Evaluate & Justify

Evaluate (predict) and justify effectiveness of strategy

a. Predict the effectiveness of your modified passing activity in preparing a novice player for the variability of passing within the performance environment.
b. Justify your prediction using primary and secondary data.