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Different Perspective on Teaching Motor Skills: A Critical Analysis

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Abstract

An important part of a comprehensive physical education program is instruction in fundamental motor skills. Motor learning is also of great theoretical and experimental interest to psychologists and neuroscientists. New motor patterns are learned through movement, interactions with rich sensory environments, and challenging experiences that challenge a person to solve problems they encounter. The knowledge about motor control and motor learning shape our understanding of how individuals progress from novice to skilled motor performance throughout the lifespan. This page provides an overview about Motor Control and Motor Learning. In this article the various theories and models of motor learning has been critically discussed and appropriate measures has been highlited depending upon various researcher's view.

Keywords: Motor Skill, Cognitive, Associoative, Autonomous and motor learning.

Introduction

At the 2012 London Olympic Games, Ms. Gabby Douglas won an individual all-around Olympic gold medal, Michael Jordon, a basketball legend, enthralls us with his skills, and Bruce Lee's lightning-quick actions knocking down multiple opponents within a second (Picture 1, 2, and 3) have stunned the sports world. How can these athletes perform such fascinating movements so

flawlessly? What kinds of learning processes brought the seath-letes to such levels? Is any human being capable of performing such incredible movements with the proper training?

The role of physical education in the school curriculum is to help students develop the competencies and beliefs necessary for incorporating regular physical activity into their lives. Through involvement in a well-taught physical education program, students can achieve physical and personal benefits which has a long carry over value.

An important part of a comprehensive physical education program is instruction in fundamental motor skills. Fundamental motor skills, such as the run, jump, throw etc, are underpin the learning of more complicated sport and movement skills common to the community. Without fundamental motor skill learning, students are less likely to learn related sport and movement skills. Motor learning is a blanket term that encompasses a huge diversity of phenomena, approaches, and disciplines. It is of enormous practical relevance to physical therapists, musicians, dancers, athletes, pilots, sports coaches, and animal trainers to name but a few. Motor learning is also of great theoretical and experimental interest to psychologists and neuroscientists.

New motor patterns are learned through movement, interactions with rich sensory environments, and challenging experiences that challenge a person to solve problems they encounter. The knowledge about motor control and motor learning shape our understanding of how individuals progress from novice to skilled motor performance throughout the lifespan. This page provides an overview about Motor Control and Motor Learning.

Motor skill learning is an active process, interrelated with cognition. Skill concepts are aspects of cognitive concept learning in physical education that focus on learning the way the body should move while performing motor skills (1).

The development of such a knowledge base facilitates children's motor engagement, decreasing errors in performance both in- and out of the school setting. Children have the potential to learn fundamental movement skills and the respective skill concepts by the age of seven if they receive instruction and encouragement, by the physical education teacher (1).

According Roller et al (2) the production and control of human movement is a process that varies from a simple reflex loop to a complex network of neural patterns that communicate throughout the Central Nervous System (CNS) and Peripheral Nervous System (PNS) (2).

New motor patterns are learned through movement, interactions with rich sensory environments, and challenging experiences that challenge a person to solve problems they encounter. The knowledge about motor control and motor learning shape our understanding of how individuals progress from novice to skilled motor performance throughout the lifespan. This page provides an overview about Motor Control and Motor Learning.

Definition of Motor Learning

1. "The process of acquiring a skill by which the learner, through practice and assimilation, refines and makes automatic the desired movement"(3).

2. "An internal neurologic process that results in the ability to produce a new motor task" (4).

3. “A set of internal processes associated with practice or experience leading to relatively permanent changes in the capability for skilled behavior” (5).

Theories of Motor Learning

Motor learning research considers variables that contribute to motor program formation (i.e., underlying skilled motor behaviour), the sensitivity of error-detection processes, and strength of movement schemas. Motor learning requires practice, feedback and knowledge of results (6).

The Motor learning theories are:

1. Adams Closed Loop Theory (1971)

- Closed Loop - Sensory feedback is used for the ongoing production of skilled movement ,Slow movements, Relies on sensory feedback (Sherrington), Blocked Practice
- Errors = Bad! Needs to be accurate!
- Memory Trace - Initiation of movement
- Perceptual Trace - Built up over a period of practice & is the reference of correctness.
- Improvements = Increased capability of performer to use the reference in closed loop

Clinical Implications

Perform same exact movement repeatedly to one accurate end point

Increase Practice → Increase Learning

Errors produced during learning → Increase strength of incorrect perceptual trace.

2. Schmidt's Schema Theory (1975)

- Open Loop
- Schema - Abstract memory representation for events → RULE
- Generalized Motor Program - Rules that allow for the generation of novel movements
- Rapid, ballistic movements = recall memory with motor programs and parameters to carry out movement without peripheral feedback Variability of Practice → Improve Motor Learning

Clinical Implications

- Optimal Learning → Task practiced under many different conditions
- Positive benefits for error production (learn from own mistakes)
- The schema has rules for all stored elements, not just correct elements

3. Newell's (1991) Ecological Theory

- Based on Systems & Ecological Motor Control Theories
- Motor Learnining = Increases coordination between perception and action thru task & environmental constraints.
- Perceptual-motor workspace - Identifies movemts and perceptual cues most relevant to performance of task
- Optimal task-relevant mapping of perception & action → NO Rules!

Clinical Implications

- The patient learns to distinguish relevant perceptual cues important to action.

Stages of Motor Learning

According to Fitts and Posner Model (7):

Stages of Learning	Characteristics	Attentional Demands	Activities	Description
Cognitive	• Movements are slow, inconsistent and inefficient. • Considerable cognitive activity is required.	• Attend to understand what must move to produce a specific result. • Large parts of the movement are controlled consciously	Practice sessions are: • Performance focused • On less variable incorporate a clear mental image (technical & visual).	Early Cognitive; Essential Elements were not observed or not present
				Late Cognitive; Essential elements are starting to appear
Associative	• The movements are more fluid, reliable and efficient • Less cognitive activity is required	• Some parts of the movements are controlled consciously, some automatically.	• Practice sessions link performance and results, conditions can be varied. • Clear Mental Image = Accurate Performance	Early Associative; Essential elements appear, but not with consistency.
				Late Associative; Essential elements appear regularly at a satisfactory level.
Autonomous	• Movements are accurate, consistent and efficient. • Little or no cognitive activity is required.	• Movement is largely controlled automatically • Attention can be focused on tactical choices	• Practice sessions are more results orientated • The focus is on a greater range of movement, speed, acceleration and use of skill in a novel situation.	Early Autonomous; Essential elements appear frequently above the required level.
				Late Autonomous; Essential elements appear continuously at a superior level.

According to Bernstein's Model:

Underlines degrees of freedom (the number of independent movements needed to complete an action, as a central component of learning a new motor skill). It has 3 stages. They are (8).

Stage	Description
Initial	Individual simplifies movements by reducing the degrees of freedom
Advanced	The individual gains a few degrees of freedom, which permits movement in more of the articulations involved in the task
Expert	Possesses all the degrees of freedom to carry out the task in an effective and coordinated manner.

Systems Involved in Motor Control

Sensory/ Perceptual System	Action Systems
Somato-sensory	Motor Cortex
Visual	Basal Ganglia
Vestibular	Cerebellum
	Central Pattern generators

Principles of Learning Motor Skills

1. Principle of Interest

A student's attitude toward learning a skill determines for the most part the amount and kind of learning that takes place.

2. Principle of Practice

Practicing the motor skill correctly is essential for learning to take place.

3. Principle of Distributed Pract

In general short periods of intense practice will result in more learning than longer, massed practice sessions.

4. Principle of Skill Specificity

A student's ability to perform one motor skill effectively is independent of his/her ability to perform other motor skills.

5. Principle of Whole-Part Learning

The complexity of the skill to be learned and the leaner's ability determine whether it is more efficient to teach the whole skil or break the skill into component parts.

6. Principle of Transfer

The more indentical two tasks are the greater the possibility that positive transfer will occur. Practice conditions should match the conditions in which the motor skill is going to be used.

7. Principle of Skill Improvement

The development of motor skills progresses along a continuum from least mature to most mature. The rate of progression and the amount of progress within an individual depends upon the interaction of nature and nurture.

8. Principle of Feedback

Internal and external sources of information about motor performance is essential for learning to take place.

9. Principle of Variable Practice

Block practice aids in performance while variable practice aids in learning. Variable practice causes an increase in attention. (10).

Role of Implicite Learning in Motor Learning

Learning is a key cognitive function of the human brain. It is a process of acquiring or modifying knowledge, behaviours, skills, values, or preferences (11-13). Learning takes place when neurons transmit sensory information through synapses and store it temporarily in a volatile region of the brain: the short-term memory. Once information processed it goes via neural pathways to the long-term memory. A comparison with existing memories follows and storage in the long-term memory ensues (11, 13-14).

A common assumption about sequence-learning paradigms is that learning takes place in the motor domain; that is, that sequence learning is in large part about creating a single, implicit motor representation that encompasses the entires to factions to be executed. Thus, sequences are assumed to be executed as if they were a continuous, sequential action, supporting the argument for a parallel between the generation of motor sequences and the control of muscle activations that occur during a single action. Moreover, this has led to the general assumption that the order of the individual elements is implicitly represented, and not necessarily explicitly known. The logic, therefore is that, if motors kill learning is largely implicit (or at least has a significant implicit component; see the discussion in the introduction to this review), and if motor-sequence-learning paradigms are a reasonable model of motor skill learning, then sequence learning must be implicit (or at least have a significant implicit component). To that end, much effort has been invested in trying to verify this assumption, seeking evidence that sequence learning is not simply cognitive learning of order combined with non-specific practice effects on individual elements (15,16).

There are two main sub-categories of the long-term memory: the implicit memory and the explicit memory (Figure 1). They differ in terms of memory content, content retrieval mode and what part of the brain structure they make use of. Implicit memory is an unconscious memory that is acquired

and put to use without awareness. It can affect thoughts and behaviours. Explicit memory is a conscious memory whose prime function is the intentional recollection of factual information as well as previous experiences and concepts (Curran and Schacter, 2001 Therefore, explicit memory is often referred to as declarative memory and being described as having episodic and semantic aspects (16).

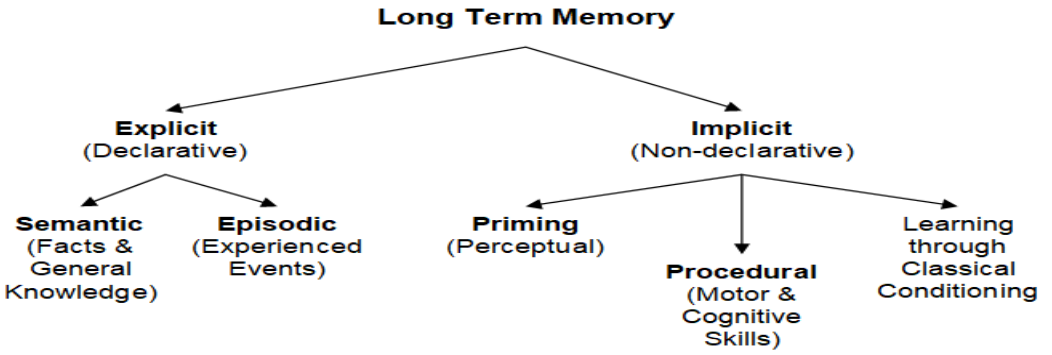


Figure 1: Implicit and Explicit Memory

Adapted from: Stangor and Walinga (2014, p.366)

In our society, people attempt to learn many different motor skills for a variety of purposes. Some skills are very complex and difficult to perform while others are easily learned. Sport scientists are always searching for the most effective training approaches to help learners efficiently master the required motor skills in the minimal time. The following are the five characteristics of the motor learning process (Figure2;17).

Characteristics of Motor Learning

Motor learning is an internal process that cannot be observed from an external perspective. This means that how much an athlete has learned is an unknown factor from an outsider's perspective because motor learning takes place inside the learner's brain and the muscular movements are only a reflection of brain activities. Observing motor performance provides only an indirect assessment of the learning progress of a learner.

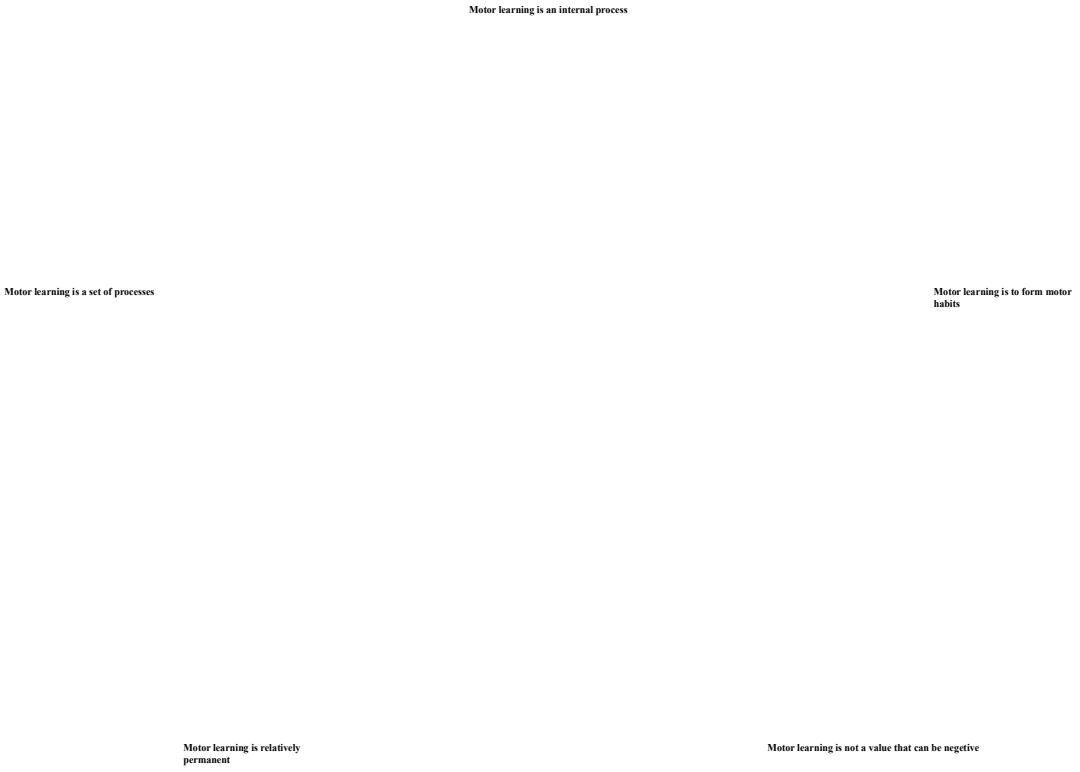
1. Motor learning is a set of processes for the purpose of reaching specific learning objectives. Obviously, different types of learning will produce different results and sports scientists continuously search for the best motor learning processes for particular motor skills based on individual differences.

2. The goal of motor learning is to form the designated motor behavioral habits through proper training.

3. Once a motor skill is learned, it becomes relatively permanent and will not be easily forgotten. For example, once an individual has learned how to ride a bike, he/she will never forget how to do it (17).

4. According to (18), motor learning is not value free and it can be negative to form a bad habit that is extremely hard to be changed once it is formed.

Characteristics of Motor Learning



Motor Learning is an i Figure2. Five Characteristics of Motor Learning

Motor control is the study of postures and movements and the mechanisms that under - lie them. Also, motor control can be defined as the study of how an individual can execute designated motor skills through the neuromuscular control process in response to external environmental demands.

Motor Control

Table -1. Three Components of Motor Control Areas of Human Movements

Neuromuscular control mechanism of responding to external stimuli	Neuromuscular mechanism of decision-making in advancefor takingactions	Unconscious control mechanism for controlling reflex movements

Table 2. Three components contribute to motor performance factor contribute to Motor Performance

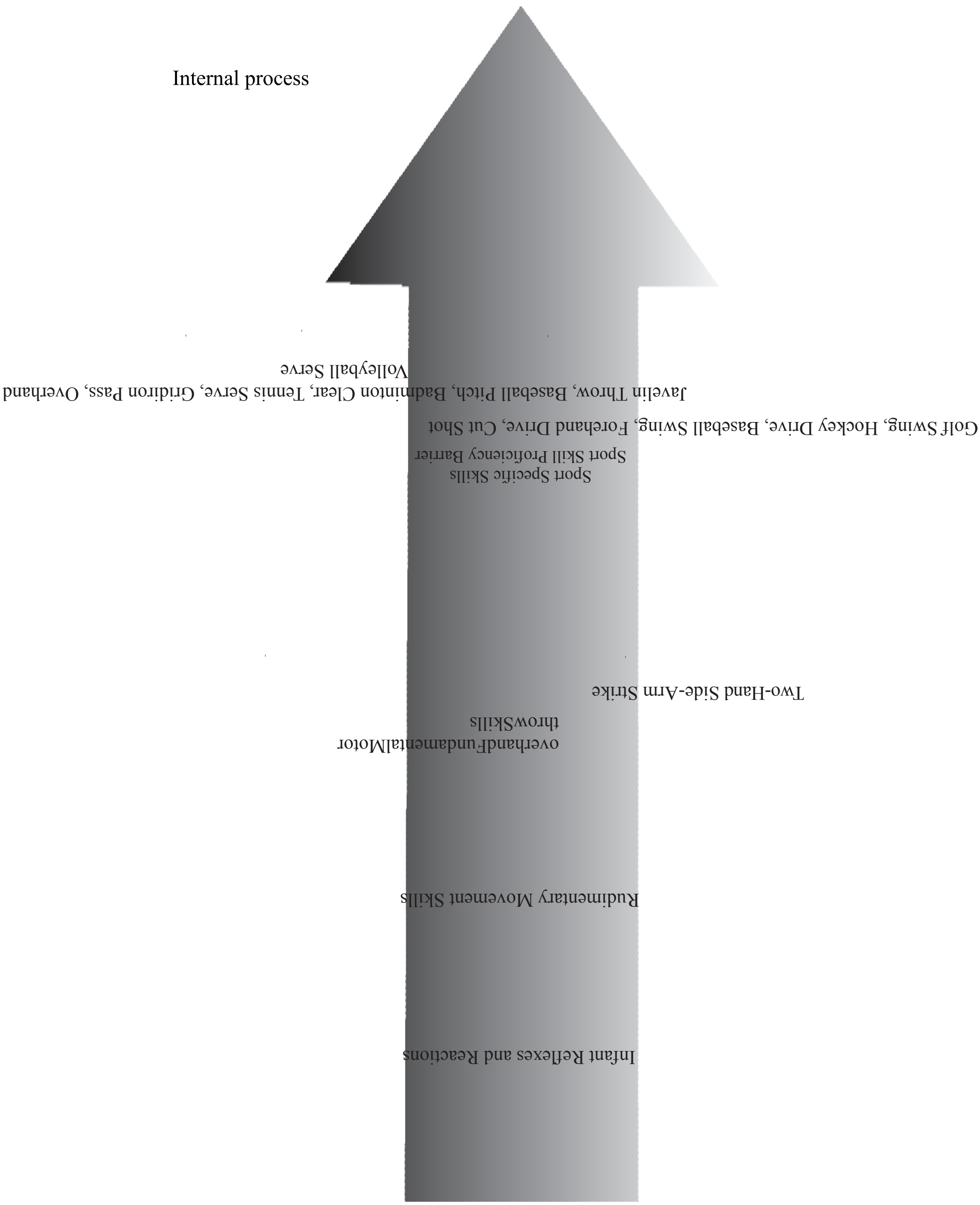
Learner's characteristics (age, gender, experience, cognitive ability, genetic traits, psychological characteristics, etc.	Instructor's competence (sports science background, athletic experience, knowledge of sport, administration and communication skill, human relation skills, etc.)	Learning environment and conditions (Undistractive learning environment, facility and equipment, sports field and settings, organization of training)

Diagram 3. Effects of Fundamental Motor Skills Instruction on the Performance of Sport Specific Skills

The acquisition of fundamental motor skills during childhood are the basis for developing the skills to participate in sports and leisure activities (19). The success of developing these skills at a young age can have a positive effect on health throughout the lifespan by increasing the participation in physical activity and therefore reducing obesity (20). Research commissioned by the Victorian Department of Education recognised the following skills should be taught during a child's formative years (21):

Locomotor skills such as running, jumping, hopping, galloping, rolling, leaping and dodging, horizontal jump, slide.

Manipulative skills such as throwing, catching, kicking, striking and trapping, dribble, overhand throw, and underhand roll, Stability skills such as balance, twisting, turning and bending.


Internal process
Volleyball Serve
Javelin Throw, Baseball Pitch, Badminton Clear, Tennis Serve, Gridiron Pass, Overhand
Golf Swing, Hockey Drive, Baseball Swing, Forehand Drive, Cut Shot
Sport Skill Proficiency Barrier
Sport Specific Skills
Two-Hand Side-Arm Strike
throwSkills
overhandFundamentalMotor
Rudimentary Movement Skills
Infant Reflexes and Reactions

Mastery of these skills by children is necessary if optimum development of higher-level skills is to occur. Children who do not master these skills are less able and often less willing to persist with the difficult task of learning more complex motor skills, and will avoid activities which expose them to “public failure”. Ultimately, such children encounter a sport skill proficiency barrier and reject participation in physical activity as part of their lifestyle. activities which expose them to “public failure”. Ultimately, such children encounter a sport skill proficiency barrier and reject participation in physical activity as part of their lifestyle.

Neural Mechanism of Motor Learning

In the cerebral cortex there is a motor centre in charge of motor functions. Moreover, the left and the right hemispheres do not function symmetrically, as each of them has its own specialized functions. Learning is most efficient when the two hemispheres function in synchronisation.

Communication between them is made possible by the neural bridge – the corpus callosum. The right hemisphere of most people controls movements and sensations of the left half of the body, and vice versa. There is no symmetrical division of functions and it is a known fact that 90% of all people are right-handed. Research conducted by Sperry (22) established two ways of thinking, one manifesting itself through speech and the other not. The left hemisphere is "talkative"; the right is "silent".

The educational system and the Western civilisation both give primacy to the functions controlled by the left hemisphere, at the same time neglecting those controlled by the right hemisphere. The functioning of the left hemisphere is connected with analytical thinking, logic, reading, writing, speaking, counting, and calculating. The functioning of the right hemisphere is connected with intuition, spatial processing, overall comprehension, movement, drawing, rhythm, feelings, creativity and dreams. In motor learning, both hemispheres jointly control movement; however, cognitively and rationally mediated functions originate more from the right one. The right hemisphere is responsible for overall spatial cognition, visual presentation of spatial depth, rhythm, recognition of movement patterns, and for concurrent processing of many pieces of incoming information (Bouchard et al., 23).

The left hemisphere is "smart", while the right one is "adept". The theory of the hemispheres' functions has not been altogether confirmed, yet it still offers interesting considerations regarding motor learning.

The optimal years for motor learning are around the age of 6 (24-25). During this period the two hemispheres are intertwined. The older we get, the more our brain hemispheres specialise. The educational system gives explicit priority to logical inference, learning by heart, mathematics, reading and language learning.

At the same time there is less and less intuition, playing, rhythm, music and motor expression. Moulds, patterns and rules increasingly gain ground. In the opinion of Abraham (26), elite sports creativity in any sport is a domain of the right hemisphere. According to some elite athletes, their top performance was characterised by a unique mood, almost like a trance. Their achievement was a result of serenity, absence of effort, a feeling of easiness and a crystal-clear mind.

To make use of these abilities in the process of motor learning, one has to activate the right hemisphere and thus facilitate and accelerate one's own learning. Only by activating the right hemisphere can one make full use of one's intellectual abilities and exploit their potentials. To increase the participation of the right hemisphere Abraham (26) recommends the following:

• It is possible to achieve optimal results in motor learning as soon as the right hemisphere is activated in addition to the left one. Spontaneity and intuitiveness make exercising more fun. If one enjoys movement, one progresses much faster.

• Beginners make a big mistake trying to control their movements by focusing on inner consciousness. This way they activate their left i.e. analytical hemisphere, which triggers a series of commands in the body, generally disrupting the overall coordination of movement. That is the primary function of the right hemisphere.

• Too many commands will activate only the left half of the brain, resulting in the inhibition of the centre for movement analysis. Therefore, it is necessary to focus one's thoughts on the set goals.The overall comprehension of movement is the function of the right hemisphere of the brain. Learning a movement is easier if it is considered as a whole, not a jigsaw of many pieces.

• Mistakes are integral parts of learning, so allow yourself to make them. It is a normal part of the process and one should not harbour resentment towards it. Do not allow them to diminish your self-confidence and self-assurance. Immediate evaluation and analysis of the mistakes occupies the left half of the brain to a great extent, which in turn has a destructive effect on the execution of movement.

• Visualisation of movement and the notion of movement are prerequisites for efficient motor learning. A mental notion helps in the execution of a motor task. One has to learn how to observe a movement, its rhythm and coordination. A special type of such practice is the "observation" of one's own movement. In your mind, repeat the relevant movement several times (ideomotor training). Visualisation is not useful only as part of one's mental preparation, but also activates those muscles and muscular nerves that take part in real movement. Visualisation of exercises awakens the right hemisphere, reduces fear and increases self-confidence.

The following tips may be use fulinteaching fundamental motor skills.

Don’t be putoff by the length of the list! Select one or two strategies and practise them ina lesson. In following lessons, attempt another strategy. After a while, many strategies become a habit.

1. Above all, teach! Help children to learn a fundamental motor skill rather than just participate in the activity involving it. Do not passively standby and observe. Circulate among students when teaching.

2. Use demonstrations to help communicate the key components of a fundamental motor skill to be learned. Demonstrations can be improved by using words or phrases that highlight the important parton which the demonstration is focusing. Ask the student to demonstrate the skill to ensure the instructions have been understood before commencing practise.

3. Keep the time to an absolute minimum between giving an instruction and allowing a student to practise. If possible, have the student begin practice immediately after viewing a demonstration. Avoid giving any new information until the student has had the opportunity to practise.

4. Be patient : teach one component of the skill at a time. Do not provide more than one or two pieces of new information at a time. Use words and phrases that can be easily understood.

5. Provide ample opportunities to practise each fundamental motor skill. Repeated practice will be necessary before a student will master the skill.

6. Ensure that the student achieves success. Plan practice, drills and games so that the student has many successful experiences and minimal negative experiences. Success breeds success: praise in public; remedy in private. Call attention to correct performance rather than to mistakes.

7. Provide appropriate, positive feedback, and praise often. Feedback on student's performance works best when it is specific and given immediately. In addition, ensure that the feedback highlights what is good about the student's performance as well as what can be improved.

8. Link a key word or phrase to a component of a fundamental motor skill while that component of the fundamental motor skill is being demonstrated. For example, link the word "step" to the action of stepping forward during an over hand throw. By hearing or saying the word "step", the student is reminded to step correctly when throwing.

9. Be brief when explaining or introducing a fundamental motor skill or game. Teacher talk should be restricted to less than 60 seconds whenever possible.

10. Keep the purpose of the lesson clear. What fundamental motor skill component will be learned in the lesson? Continually emphasise the focus of the lesson to students.

11. Break down the fundamental motor skill to be learned into small parts. The components of the skill can then be taught in a progressive manner. Teach the first component of the fundamental motor skill, then the second, and then combine the first and second components into a sequence. Continue teaching components and incorporating them into the sequence until the entire skill is being performed.

12. All people make mistakes. Help students to understand that learning most fundamental motor skills is difficult. Noon e should be ridiculed for their efforts.

13. Accept that children will be active in physical education. Involve children in vigorous activity early in the less on to use up some of their energy.

14. Teach a signal for attention. Some teachers us e a whistle, others a hand clap, still others their voice. Whatever method is used, inform students early of its meaning.

15. Set group sizes that are as small as is practical. Mis behaviour often occurs when students are forced to wait their turn.

16. Remind students of safety considerations associated with a fundamental motors killorgame.

Taken from Walkley, J. & Baldock, R.(27)

Skill Learning

Primary Level of Skill Learning

- Proper implicite motor learning
- Focus on the skill technique not the result
- Provide immediate, precise and positive feedback
- If possible compare the new skill to others that the student may be familiar with
- Provide plenty of opportunity for exploration of the skill and self discovery of the general principles
- Let the learner to try out the skill
- Provide a demonstration of the skill the help form a mental picture
- Introduce major aspects of skill only

Immediate Level of Skill Learning

- Practice for relative longer period of times
- Practice at the rate and in the manner that the skill will be used during "real life" performance
- Allow for individual differences in the rate of skill learning
- Be able to analyse skills and provide constructive feedback
- Devise practice opportunities that progressively focus on greater skill refinement
- Provide numerous opportunities for practice and skill application
- Minimize the time of execution of motor skills.

Advanced Level of Skill Learning

- Result oriented skillful activities

- Focus on outcomes rather than process
- Allow for individual differences in technique
- Provide feedback that focuses on specific aspects of the skill
- Offer tips on strategy and tactics
- Provide encouragement, motivation and positive support
- Structure practice sessions that promote intensity
- Structure practise sessions that duplicate game like situations
- Provide ample opportunities for maintaining the mnastery over motor skill (28).

Suggested Assessment Procedures

1. A friendly enthusiastic approach to students will often act as a strong motivating force.

2. Examine the components of the skill and the layout of the score sheet so that you understand what is being assessed.

3. Avoid long waiting periods between activities for each student. Keep the group being assessed small (6–8 students).

4. The performance of girls has been shown to be negatively influenced by peer pressure from boys. Where possible, separate boys and girls into different groups.

5. Minimise distractions. When giving instructions, face students away from the sun or any other distractions which may make it difficult for them to concentrate.

6. Where possible, combine a demonstration with a brief explanation.

7. Keep instructions and demonstration brief, clear and appropriate to the capacities of the students.

8. Ask students to wait until you have completed a demonstration or explanation before asking questions. This may avoid a student asking an unnecessary question.

9. Be sure everyone can see the demonstration.

10. Avoid giving feedback to the student until you have finished your observation of performance.

Conclusion

Motor learning is a complex and continuous process consisting of several phases. The basis of motor learning is a specific motor programme, which is created by the motor cortex based on external and internal information. The essence of efficient motor learning in sport is a correct notion of movement. The use of motor learning methods depends on the athlete's biological and

calendar age, foreknowledge, motor experience, and the information he has on movement. Attention has to be focused primarily on the causes of incorrect movement, and not their consequences. To get mastery over motor skill one has to develop the insights through motor learning.

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