Athlete Learning and Decision Making

Resource: How Athletes Learn and Make Decisions

Learning is a complex process that is not directly observable. Performance is observable and can look like learning, but learning can only be determined after many attempts that demonstrate consistency. One of a coach's goals is to provide an environment that will enable athlete learning.

This resource provides information about how athletes learn and make decisions. It offers suggestions about how a coach can provide optimum practice conditions to enhance student learning and what may occur during the learning process. The resource includes sections titled 'Practical Help' which give hints for coaches to consider how to enhance athlete learning in real life training or competitive settings.

Introduction

How do athletes learn?

This section provides an overall summary of factors which influence athlete learning. A broader explanation of each point is provided later in the resource.

Motivation:
Athletes learn when they are motivated – when they have a reason for learning. (Hence, coaches should try to make activities relevant and meaningful for the athlete).

Athletes learn when they are challenged. Maximum learning occurs when athletes are required to perform within an optimal 'zone of learning' at the upper end of their capability. With the coach's facilitation and their understanding of an individual's 'zone of learning', an athlete is able to overcome the most challenging aspects to take him or her to the next level.

Practical contexts (real situations):
Athletes improve with meaningful practice. Athletes need to recognise the purpose of a practice activity – they need to have a goal or outcome in their mind.

Athletes learn by doing - and they learn best by doing in real contexts. Although mental rehearsal is a vital part of learning, actual practice in real or authentic game/event like situations is most important.

Athletes learn to make the best decisions when they practise in real contexts and solve situational problems for themselves, with guided assistance. Reading the game/event, or developing game/event 'nous' is essential. Real sport or game contexts allow athletes to make connections between the skill and game/event context requirements.

Construction of knowledge and skills:
Athletes learn from watching and modelling others. Athletes will try to copy respected role models. Therefore good demonstrations of skill that are within the realm of the athletes' possibility, are most valuable.

Athletes make decisions based on their perception of the most socially acceptable responses or outcomes of their responses. Athletes will respond to what they think is appropriate behaviour to gain the most acknowledgement from coaches, peers and significant others.

Athletes learn through coordinating their neuromuscular systems. They make decisions intuitively (based on socialisation and environmental influences), not innately (based on genetic and natural acquisitions) because of a co-relation between real environments and the individual's ability of coordinated neuromuscular response. Intuitive responses develop over time because to learn, an athlete is influenced by environmental factors about their actions and the outcomes of the actions. If athletes are successful, they get reinforcement and try again on successive occasions. With experience, they develop a natural connection between the cue for a particular response and the response itself.

Athletes learn by constructing knowledge and skills using previous knowledge and skills. All skill is learned (we are not born with skill) and develops progressively. Each skill attempt requires the athlete to call on his or her prior knowledge about the task which helps to inform the next attempt. In this way the athlete constructs new knowledge about a task using his or her previous knowledge about the task requirements.

Athletes learn by developing motor schema and using them in real contexts. They make decisions using an established motor-schema and applying it when they are presented with realistic situations. Motor-schemas are abstract blue-prints or mental representations of particular actions. Because they are mental blue-prints, mental rehearsal of appropriate actions can help establish strong mental representation and enable an athlete to recall appropriate responses when under pressure in a real game context (e.g. it's a bit like mentally rehearsing a speech).

Motivation for Learning

Athletes feel highly motivated when they see the relevance of the learning activity to their lives!

A necessary first step in learning is the motivation to learn. Current learning theories emphasise the importance of creating realistic learning environments for athletes. Motivation comes from athletes' desire to learn a particular task. Therefore coaches need to create a learning environment based on the athletes' motivation for the task, at the particular moment, in the particular situation (readiness).

Achievement Motivation:
As long as athletes feel they are competent or successful, they will continue to be motivated. An athlete's motivation is closely related to his or her perception of ***success in achieving their desired goal.*** Athletes make judgements about their success with respect to *the task itself* (i.e., task-referenced judgements) or with respect to *their performance as it compares with the performance of others* (i.e., norm-referenced judgements).

Practical Help 1
Creating meaningful practice environments is essential for learning. ***Tasks and contexts that provide real challenges that are relevant to the athlete are most motivating. Real game-like situations are more meaningful and result in better learning than static drill like activities.*** Research shows that although they may result in poorer performance on the day of practice, random and variable practice conditions similar to those found in most game situations provide better recall of knowledge, ultimately resulting in improved learning and performance (Schmidt and Wrisberg, 2004). ***Athletes should be encouraged to measure their own success in relation to a given task rather than comparison to the capability of others.***

Goal-Setting:
Every athlete approaches a new skill-learning situation with some idea of what he or she wants to accomplish. An important part of learning is a clear understanding of each athlete's intended goal. Where does the athlete want to go? What skills does she or he want to master? Under what conditions does the athlete want to perform those skills?

Coaches should encourage all athletes to identify the specific skills and behaviours they want to achieve and to have a reference point for assessing their progress. It is important to remember that they are the athlete's own goals and not the coach's broader team or collective outcome goals.

Skill Acquisition, Motor Learning

Traditionally, our knowledge about and how we acquire skill came from the internationally recognised field of motor learning. Most motor learning theories were based on knowledge drawn from cognitive psychology (explanations about the way we think and therefore act). Advancing technology neurological studies (involving studies of the neural pathways, brain and central nervous system functions) have advanced our understanding about the nature of coordinated movement. The fields of education and sociology have more recently contributed to our knowledge about learning motor skills. Skill acquisition recognises the contribution of all these fields.

Theories about Motor Learning – The Learning of Physical Skills

Motor learning involves 'changes in the internal processes that determine a person's capability for producing a motor task' (Schmidt & Wrisberg, 2004:186).

There are two different, but complementary, schools of thought about how athletes learn and perform motors skills. The first involves *information processing* which generally involves being able to understand and acquire skill at a conscious level, even though some movement occurs at a subconscious level. The second involves a sub-conscious, *dynamical systems' perspective* that suggests motor-learning involves each athlete subconsciously performing a task due to an environmental cue that triggers the performance. It is likely that both information processing and dynamical systems' perspective have their place in explaining how athletes learn and make decisions. Both are useful 'tools' for helping coaches understand the process of learning and performing.

Information Processing – (Motor Programme or Schema)
This school of thought comes from cognitive theory and provides a processing model of how athletes learn and memorise how to do things including physical skills.

Information processing is a way of explaining how humans think and perform deliberate and conscious actions. In the context of motor learning the term is used to explain how athletes *'consciously'* interpret, understand and control movement. The most useful tool for coaches that comes from the information processing model is the ***motor programme or motor schema*** (schematic representation), which can be viewed as being an abstract set of rules, a pattern or a blueprint of how to perform an action or series of actions. The more an athlete performs an action or series of associated actions the more developed the motor schema (blue print) becomes; the more variables of a particular schema an athlete practises the broader the schema becomes. Therefore a coach should try to introduce as many variations of skill as possible during practice sessions (e.g. when practising the golf swing, practice with different clubs, in different lies). When the athlete is called on to perform familiar and even new but similar tasks they recall this schema and adapt it to the context at the moment.

Practical Help 2:
The schema concept can be a useful 'coaching tool'. ***Coaches should set up practices that require the athlete to use a particular motor schema (like using a tool) in real and variable contexts*** and thus further develop and broaden it with each practice. (e.g. catching is represented by a motor-schema [a mental picture of how to catch] so when coaching and improving catching skills, set up practice situations that are as realistic as possible and that include as many different catching variables as possible). Given that using the schema requires 'conscious' recalling and application, ***authentic (real to the situation) problem-solving practice situations, in which the athlete has to interpret the environment and then build and apply an appropriate response, are most useful***. Over time, as the schema develops, the athlete is able to readily recognise and respond to particular environmental cues and the motor response then appears to be intuitive or a natural response for the athlete. The athlete has learned to respond in particular ways. ***A variety of practices and problems (becoming more and more complex) are useful because they help to develop the motor schema*** and it is this process of building the schema that is most important for skill learning. When an athlete learns his or her "existing knowledge serves as the foundation for all future learning" (Cullen, 2001:65).

One can think about motor schema development as a similar way to building schema to solve mathematic problems. For example, let's say we have a generalized schema for multiplying (a set of rules or blue print of how to multiply, which we learn and develop over time). We begin with relatively simple problems and as we develop we progress to more complicated ones. We need the challenge of these more complicated problems to develop our understanding and in this way recall, utilize and develop our schema of knowledge about how

to multiply. However, if the problems are too hard for us in the initial learning stages we can give up, so we have to tackle problems that are challenging but still within the capability of the learner with some expert help. If we think of motor skills in a similar way we can see how important the coach's role can be in helping to set challenges for athletes which are within their range of possibility. With the coach's assistance athletes can progressively develop their schema. [Note: in common motor learning texts you will most often see motor schema written up as motor programmes as this is a common motor learning term].

Note: If coaches are interested, there is some more theoretical explanation of motor programmes and schema in Appendix 1.

Dynamical Systems' Perspective – A Subconscious Coordination of the Neuromuscular System
Dynamical systems' perspective argues that in acquiring skill discussions, there is too much emphasis on the role of the central nervous system (the brain and conscious thought) in controlling every action. The dynamical systems' perspective suggests that to learn coordinated movements we rely on changeable properties within our body's muscular and associated systems (e.g. vision, inner ear) combined with physical properties of environmental information. According to the dynamical systems' perspective, skilled movements are not represented in motor schema (programmes) but rather *emerge naturally as the result of complex interactions among numerous connected internal body systems*.

Practical Help 3:
The concept of a dynamical system can be a useful 'tool' for coaches as they should recognise the need to ***place athletes in realistic practice situations where they are required to solve actual game/event problems. Learning and applying an appropriate technique and/or tactic to overcome a particular game/event situation systematically develops the coordination of the whole system (including the skeleto-musculature system) to perform in a coordinated way.***

How does this Theory Relate to Coaching in the Real World?

The above motor learning explanations can be applied very well to different practitioners' approaches. For example the Teaching Games for Understanding (TGfU) approach (Bunker and Thorpe, 1982) uses real games' contexts involving problem-solving and questioning approaches to raise athletes' awareness of the reasons and consequences of their game actions. This is a similar approach to that used by a school maths' teacher who often uses problem-solving techniques to teach an understanding of maths problems. The TGfU approach uses game specific problem-solving to teach an understanding of how to play a particular game. Appropriate technical competency develops as a result of the athlete needing to develop it to perform a particular task. Playing in games which are realistic to the sport itself builds the motor schema. This includes the very important and often neglected game specific awareness factors.

A second example of real coaching is based use is the inner game approach (Gallwey, 1981). The inner game approach is the subconscious 'feel for the game'. The inner game approach lessens the reliance of conscious thinking about movement and increase the reliance of the feel of movement (i.e., the NZ CoachApproach). The result of this learning develops intuition so that an athlete builds a schematic understanding of what to do as well as how and when to do it.

The Learning Context - Constructivism, Social Constructivism and Social Learning Theories

A further explanation about how athletes learn and know what to do in particular situations is called constructivism which can be linked to schema learning. Constructivism, as the name suggests, is the construction of knowledge by building new knowledge upon previous knowledge. Constructivism is where learners (athletes) use current/past knowledge to make sense of new situations and continually and progressively build up a body of knowledge (or skills) which is then stored in mental pictures or schemas. A coach's role is very important in providing appropriate learning environments for the athlete to integrate new knowledge with old knowledge and therefore help the athletes learn how to perform new tasks or improve on previous tasks. The coach's role in constructivism is 'scaffolding' (i.e. providing opportunities to develop step by step). The coach plays an important supporting role in enabling the athlete to construct knowledge or skills. A useful analogy, using the building industry, is where construction is often assisted by scaffolding, to enable progressive steps to occur.

Practical Help 4
A problem-based approach in game situations is a recommended method for learning because it enables athletes to learn how to tackle problems in the most effective manner possible. Athletes learn that there is usually no single correct answer to a problem. Effective problem-solving is learned by confronting events, defining problems, puzzling with them, experimenting, trying, and searching for effective solutions. Problem-solving means asking the kinds of questions that are relevant to the situation. Examples are 'what are the requirements of this task?' or 'what is the goal?' The coach should not solve the problems for the athlete but rather assist and guide the athlete to solve (construct) it for themselves.

Social Learning and Social Constructivism:

Two principles of learning are:

- Learning comes from our attempts to reproduce actions we have seen
- The best learning experiences occur when athletes practise in conditions that are as close as possible to the conditions of the required skill in the real sport situation.

Athletes learn from observing one another and experts. Social learning and social constructivism are theories based on the assumption that learners observe and model other people's actions. Learning is optimized when athletes are involved in real game situations; when they learn the appropriate methods and behaviours through the natural game, sport or event environment. Social constructivism is linked to social learning but this theory adds that through the athletes' involvement in the natural game or event they construct mental representations of how to behave and perform in that particular setting.

Coaching Guide 5
Social learning theory provides a basis of understanding which recognises that ***athletes, learn from observing and copying respected (the respect comes from the athlete) role models.*** They also learn consciously and sub-consciously from their social environment. Therefore, ***appropriate performance and behavioural role modeling in real contexts, which may be presented in various forms (eg. live situations or television), are essential for establishing recommended schema development.***

Specificity of learning: the specificity of learning principle holds that ***the best practice is that which approximates most closely the movements of the required skill and the environmental conditions (social construction) of the actual game/event.***

Individual Learning Differences

We all recognise that athletes are different, but it is the task of discovering the possible reasons for these differences that is important and sometimes difficult for a coach. The reasons are many, but we will look at a few in this resource.

One factor that contributes to individual differences in athletes' performance can be caused by differences in their 'stable' and 'enduring' ***abilities***. Stable enduring abilities are **genetically** determined traits (Schmidt and Wrisberg, 2004). These abilities include *body configuration*, *explosive strength, speed of limb movement, stamina, reaction time, kinesthetic sensitivity, multi-limb coordination, response orientation* (i.e., the ability to make decisions quickly given numerous choices) and more. According to much of the motor learning research, these abilities represent the hardware (the foundation of body and mind function) that is essential to perform certain tasks to varying levels. Various combinations of these abilities will influence specific skills.

Research suggests all athletes possess all abilities but each athlete differs in the strength of these. Eyesight (or visual acuity) is an example of a physical ability and almost all people inherently possess eyesight. However, we all vary in the degree of strength of our visual acuity. Some are said to have 20/20 vision, others have to wear glasses to help enhance their vision and others are visually impaired. If one considers how his/her eyesight changes with age, we can appreciate that our motor abilities, like explosive strength and limb speed, also deteriorate, as do our multi-limb co-ordination and reaction time, etc. However, throughout childhood and adolescence many of these abilities continue to develop and contribute to an individual's athletic ability. This is why it is important for coaches to appreciate the differing motor abilities and physical limitations of young athletes.

However, an athlete's innate ability (genetically determined) should not be confused with his or her skill level. Skill is much more than ability and is considered to be the outcome of several factors. Underlying (innate) ability is only one of the factors. Skill is an athlete's proficiency in performing a particular task and it requires a great deal of practice.

Other factors that influence individual differences are gender, age, previous experience, personal fitness, personality, motivation and previous social and cultural backgrounds.

Athletes may also differ in the way they respond to particular coaching styles. This is because there is some research that supports a view that individuals demonstrate a preference for particular ways of learning. The three commonly identified ways are visual, auditory or kinesthetic. This is commonly referred to as the individual's preferred learning style. Identifying learning styles often label an individual as being either a visual, auditory or kinesthetic learner or a combination of these modes of delivery. It is important for a coach to recognise that almost all individuals have **all** these modes of receiving sensory information and **most often use all three in combination in practical learning contexts**.

Self-awareness and self-correction

An intrinsic drive to succeed is most important in all learning situations including sport. When we are intrinsically driven and feel a sense of autonomy and **competence** we are likely to engage in selected activities over a long period of time. For athletes to continue over a long period of time they must believe that **some measure of success** is realistically possible. Even if an athlete values an activity, they will not participate to their full potential if they do not feel that they are competent or successful.

Athletes generally fall into two camps relating to their ability to succeed. The first group views success as an **innate** quality (i.e., they believe people are naturally good or bad at sport, i.e. it's in their genes). These athletes believe any improvement in their capability and their ability to succeed is beyond their control. The second group views success as something that is within their ability to manage. For the second group, success comes with time and practice.

It is important for a coach to foster the second belief, that is, a belief that the athlete is capable of bringing about his or her ongoing improvement and success. In this regard self-awareness and positive self-feedback, which are directly related to an athlete's personal competence on the task being performed, are most useful. Self-efficacy (Bandura, 1986, in Solomon, 2003) is a term that describes an athlete's perception of his or her ability or competence to perform a given task. If an athlete has high self-efficacy they have a positive self-belief and will persist, but if self-efficacy is low they are more likely to become disillusioned and give up.

Appropriately challenging, incremental, progressions that lead to ongoing success can lead to a high self-efficacy and athletic success. Positive self-efficacy requires a positive self-awareness of the athlete's ability to perform a given task. Self-awareness is therefore an important contributor to athlete progress. The most rewarding self-awareness is gained when an athlete assesses his or her own performance in direct relationship to the task itself, rather than against the capability of others to perform the same task. Therefore, task-orientated analysis should be encouraged over comparative assessments between athletes.

Practical Help: 6
It is recommended that coaches should encourage and help athletes to **undertake self-analysis and self-feedback** that is directly related to the athlete's capability to perform a given task. Peer feedback is also valuable, but only if it relates to the task itself and not used to compare an athlete's capability to others.

References:

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Appendix 1: Motor Programme/Schema Theory

Further discussion/background information/optional knowledge.

Motor Programmes

A ***motor programme*** 'is a set of pre-structured movement commands which defines and shapes the action being produced' (Schmidt and Wrisberg, 2004:131). In the initial stages of learning a motor programme, the programme is thought to be capable of controlling only limited actions, but with practice the programme becomes more sophisticated and is able to control larger *chunks* of skilled behaviour. As an analogy, think of numbers and counting 1,2,3,4,5… Initially numbers are quite meaningless but progressively we learn the ***relational properties*** of numbers which allows us to chunk information about them and use them quite meaningfully. [E.g., to an infant the relationship between numbers is unknown until she or he learns to count and then add subtract and multiply them etc. As the relational properties about numbers are learnt the child is able to use them more and more effectively]. In motor-learning the same principle applies. Initially the environmental stimulus, like a ball in the air coming at us may be relatively meaningless. As young children we often tried to avoid it, or got hit by it as we didn't know how to react. However, progressively we learnt the *relational properties* between a ball in flight and the processes required to catch it and we developed a motor programme to enable this to happen. Over time this programme became more and more sophisticated, allowing us to apply it in multiple skilful situations.

Motor programmes are often considered to be executive programmes within the brain that control conscious human movement. The major roles of motor programmes include the following:

- To define and issue the commands that ultimately determines which muscles to contract, when, and how forcefully.
- To organize the many degrees of freedom of the muscles and joints into a single unit to produce an effective and efficient action.
- To specify and initiate preliminary postural adjustments that performers need to support the upcoming action.
- To modulate the many reflex pathways to ensure that the movement goal is achieved.

(From, Schmidt and Wrisberg, 2004:143).

Generalised Motor Programmes

It is common today to think of motor programmes as being general patterns that control broader classes of movement so the notion of a ***generalised motor programme*** is now preferred. The concept of a 'generalised motor programme' explains classes of movements like kicking, passing and bowling rather than single movements. Generalised motor programmes are *stored movement patterns* that have specific parameters. For example, *over-arm bowling* is a class of movement that is abstractly represented as a general motor programme (a specific parameter being that it requires the arm to be straight) as opposed to the different general motor pattern, *throwing,* (which requires the arm to be bent).

A generalised motor programme has the flexibility of allowing the athlete to adjust actual movements within the parameters of the general movement pattern to adapt the movement to meet the environmental demands. For example, not having been born with the skill of walking, with assistance, infants progressively develop a generalised motor programme for walking and over time develop the schematic representation for walking that allows them to do it subconsciously and, when they wish, change their pace or direction to adapt to any environmental demands. Meaningful practice is said to build and broaden a person's general motor programme allowing them to meet a growing number of situational demands.

The characteristics of a generalised motor programme for a class of movements are:

- Common sequencing among the elements of the action
- Common temporal, or rhythmical organisation (i.e., relative timing)
- Variable parameters, or surface features (e.g., speed) that athletes determine before movement attempt, depending on goal requirements.

When people practice a particular class of movement (e.g., bowling), they acquire and progressively develop a set of '*abstract rules'* called the ***motor-schema*** (Schmidt, 1975). When required to perform the task they call upon their schema to determine the parameter values (e.g., fast, spin, or swing parameters) necessary for producing different versions of the action. Another example to consider could be when an athlete is presented with a particular situation (e.g. a ball in flight coming towards him or her) he or she calls upon an

existing general motor programme (e.g. catching) with its inherent schematic representation (e.g., position of hands relative to body, movement of body to meet the ball) that enables the athlete to make a decision about what to do, how to do it and when to do it. With practice athletes broaden their schema parameters and can more readily adapt existing ones to meet new and different situations. As they learn, especially with a coach's help, they develop their schema to respond appropriately to a wide variety of cues or to intuitively respond in set ways to particular cues. Skilful athletes are those with well developed motor schema.

Degrees of freedom

The concept of degrees of freedom is used to demonstrate how *motor control* is attained. All of the components of a motor system (e.g., muscles and joints) and all the ways in which they can function are sometimes referred to as a system's degrees of freedom. The challenge for an athlete is to learn to control the combinations of degrees of freedom to enable them to produce the most effective and efficient movements. Muscles and joints that a performer allows to move during an action are said to be *free* to vary, whereas those the person prevents from moving are the ones she or he *freezes*.