Skill acquisition and Transfer

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When I was a child and budding rugby player many of my early skills were learned in the park playing scratch games of rugby with the kids in the neighbourhood. On Saturday’s after playing my junior game in the morning we would stay at the club all day, watching games, playing tackle rugby in the ‘in goal area’ (our own mini game with field size constraints and made up modified rules to change things up, make it fairer for both sides or even to negate the dominance of the best player in the team), all the time having to keep an eye on the senior game in progress to evacuate our playing arena if play came toward us. In the absence of coaching or referees, an ‘errorless’ implicit acquisition of a base skill set was developed and with it the perceptive and decision-making skills associated with performance environment. There were the formal training sessions with drills, set piece and team runs which gave us some reference during ‘our rugby games’. This opportunity is seldom realised today, pressures on time, security concerns or other distractions have stolen this vital part of our skill development. I remember more of the ‘park’ and ‘in goal area’ rugby than the games because it was so much fine. Our sessions need to incorporate those elements of exploration, self-expression and fun.

This paper looks at skill acquisition and the transfer of that skill into a performance environment. As coaches, how to assist an athlete along the development continuum from novice to expert. It is important to understand that on field performances are a complex series of fine and gross movement skills combining as a reaction to ever changing scenarios. The perception, decision making and selection of those movements at any moment in a game is definition of Skilled Behaviour. The athlete’s consistency, effectiveness and efficiency in performing these skills in competitive environments is a measure of that individual’s development.

Movement/motor skill development is critical for coordination of movements but should be developed in a manner that allows the player to thrive in dynamic performance environments. They must be exposed to a broad range of performance contexts that give them the ability to multitask and continuously adapt their actions. The movement skills and the performance-environment relationship are critical in underpinning the connection between information and movement/action. This provides the link between a player with motor skills and a player who consistently demonstrates skilled behaviour.

In rugby we have a ‘core skill’ element. A set of fundament skills that are specific to the game and allow the player to function in an effective manner in a safe environment. A player can be exposed to many variations of the same movement/motor skill during his development. This may come from changing coaches, law changes, the picture your wanting to present to the referee and with the advances in sports science, a biomechanical advantage. Once we decide on movement components that make up a simple or complex skill we must account for variances in execution due to individual differences that are inherent among the playing group. This is also apparent while the athlete develops coordination patterns through exposure to different types of performance contexts where they collect information, explore solutions and functional coordination develops during the acquisition of skilled behaviour.

Skill acquisition can be considered the acquiring, developing and enhancing skilled performance. A Movement/Motor Skill is an activity that involves voluntary muscular movement with the correct degree of muscular control. A Skill is a learned coordinated activity which achieves a goal.
Movement/Motor skills

Movement/Motor skills are classified in many ways;

Fine or Gross based on the amount of movement required to complete the skill. Fine requiring greater precision in control of small muscles like the action on a ball by the fingers and wrists in a pass. Gross involves the movement of a large part or the whole body as in tackling. A skill can have a combination of both such as passing a ball on the run.

Closed or Open relates to a constant or changing environment. Closed is a highly predictive environment where the athlete initiates the movement when ready and has full control of the movement. There are no adaptive movements. In rugby even, the isolated movement of the lineout throw must respond to a call and adapt player movements. Open is an unpredictable environment that requires adaptive movements.

A Discrete skill has a beginning and an end as with kicking a ball. A continuous skill is repetitive like running. Both occur in rugby but the essence of the game involves Serials skills. The linking together of a combination of skills in a movement sequence or pattern where the order is important. The sequence varying each time due the unpredictability of the game.

Self-paced or Externally paced relates to the amount of control the performer has on timing and the rate of the skill as well as the speed the skill is performed at. In rugby most, activities are done in an environment the athlete has little or no control over.

Simple or High Complexity relates to the amount of information to be processed and the number of decisions to be made. A small amount of information to be processed means few decisions to be made. Where there is a large amount of information a number of decisions need to be made quickly and a high number of sub routines need to be coordinated and performed quickly and accurately.

Movement/Motor skills are not neatly classified but rather fall on a continuum between the two extremes. Rugby players are required to perform combinations of fine and gross motor skills in serial combinations in a complex performance environment that continually provides movement and temporal information that they must perceive, evaluate and relevant motor skills called upon as a result of their decision making.

Stages of Skill Acquisition

Learners pass through three stages of skill learning on the journey from novice to expert. The ability of individuals to learn, refine and build experience greatly affects their ability to perform any physical activity. These stages have unique characteristics relevant to the athletes’ performance level including demonstration, instruction, feedback, decision making, practise variations and assessment.

Cognitive

The Cognitive stage is the athletes’ introduction to the skill and is likely clouded in errors, awkwardness, confusion and discomfort. Coaches need to provide clear demonstrations and instruction. Continuous feedback of an informative and positive nature to reassure, build confidence, understanding and keep motivation high. Video also offers the player the opportunity to be more aware of their own movement and build their kinaesthetic awareness. Structure the
activities for high success and breakdown complex skills. Incorporating a variety of modified activities or rotating through a few subskills that can later be combined into a more complex skill may help maintain focus and motivation. Some players move through this stage quickly and for others it’s more challenging. Once a player starts to demonstrate understanding and execution of a skill without the obvious conscious thought they are progressing to the next level.

**Associative**

Here the athlete has reduced reliance on cognitive effort and moves from ‘how to do the skill’ to ‘what can I do with it’. This is a stage of ‘Deliberate practice’ where the practice is effortful and working towards improving performance. Now that the performer has an understanding of the skill it needs to be repeated to enhance the synchronisation of mind and muscle. This concept of Myelination is one indicator pointing to those who excel and those who do not. The more times and the more purposeful an action is repeated the more the impulse is reinforced and the faster the signal travels (Coyle 2009). Errors become less frequent and the skill more refined and fluent. These errors now provide valuable feedback, reflection and adjustment. The constant attention to detail and correction is critical. The ‘Deliberate Practice’ frame work suggests it is not enough to simply practice but that it must be done with effort and attention for the purpose of improving performance (Farrow, Baker and MacMohen 2008). The further a player moves through the associative stage the depth and detail of the feedback and the technical nature and complexity of the practice must keep pace with the athlete’s development.

**Autonomous Stage**

The athlete has now refined all the inherent subroutines and building blocks and can combine the simple elements learned in the cognitive stage into complex sequences under game situations. Highly specific technical points are unconsciously executed. The focus and attention is now concerned with perception and decision making. Sensory cues are processed and decisions made proactively. Tactics and game strategies are constantly implemented, reviewed and adjusted. At this stage the athlete exhibits, kinaesthetic sense, good anticipation, sound technique and consistent decision making. To ensure skill and performance levels continue to develop the athlete must be consistently challenged by coaches. It is at this point that effortless completion of skills and demonstrations of talent are almost a negative. ‘Deep Practice’ (The Talent Code-Dan Coyle) has athletes operating at the edge of their ability,’ where you make mistakes – makes you smarter’. “We think of effortless performance as desirable, but it’s really a terrible way to learn”.

**Movement/motor skill Acquisition**

**Motivation**

Fundamental psychological needs related to perceptions of competence, autonomy, and social relatedness may govern many of these motivational effects. Just which and how many conventional “conditions of practice” in the motor learning literature may owe some or all of their impacts to motivation is one of the most interesting and potentially important lines of inquiry in future research on motor learning. Instructions and feedback that convey positive messages regarding the learner and the value of effort and practice, or portray abilities and skills as acquirable, can help increase individuals’ feelings of competence and optimize the conditions for motor learning. It is worth noting that both animal and human studies have found positive learning impacts with more positive reinforcement or augmented feedback.
The Nature of Feedback

There are two types of feedback, Task-intrinsic comes from the learner’s sensory systems as a natural part of performing the skill. These include proprioceptive (stimuli produced and perceived connected to the body’s position and movement) and tactile feedback from the sensory receptors in the muscles, joints, vestibular apparatus (motion, equilibrium and spatial awareness) and skin, visual feedback from the eyes and auditory feedback from the middle and inner ears. Augmented feedback comes from external sources, such as coach, trainer or training devise in the manner of auditory, visual or tactile.

Augmented feedback

Augmented feedback will function to provide information for and athlete to determine what to continue doing or not, provide information that allows the learner to determine how to improve in specific contexts and situations, and motivate them to continue to practice and participate.

Verbal

Researches have established that humans can process or remember a limited amount of information at any one time, since this information must be remembered and used, the amount of feedback should be limited for effective use. The general rule is to provide information about one specific error observed in the performance of the activity. This is especially critical in beginners.

The content of the augmented feedback needs careful consideration. Following the rule of specifying only one error at a time the coach needs to determine which error? The coach should give the errors priority in terms of how critical each is to correct to perform the task. The most critical should be the basis for the verbal feedback. These lists are best organised prior to training, this will help the coach understand what the critical components are and the order of priority.

The feedback must be in a meaningful to the athlete. Children will more easily remember a position on a clock-face than an angle of an arm position.

Consideration must be given to how the feedback corrects the observed error. For beginners with no experience or reference the error should be identified along with movement-specific information about how it should be corrected. Once the athlete has some background in the activity or for more experienced athletes the error should be identified through enquiry and the correction information should be less specific so that the learner is encouraged to search actively for ways to correct the error. This will also encourage better awareness and utilisation of the Task-intrinsic sensory feedback as a source of information and can be further integrated with questions like: ‘how did that feel’, ‘what did your right hand do’ ‘what did you see’.

Non-Verbal

Technology is available in many forms, visual, tracking, movement analysis software and sensors giving measures force and speed etc. All of which can be available to the athlete to examine, comprehend and utilise through independent thought.
Timing of Delivery of Augmented feedback

Augmented feedback plays a vital role in aiding an athlete to discover solutions in the acquisition of skills. However, a dependence on this feedback can divert the learner away from self-discovery and the processing of Task-intrinsic sensory information. It is suggested that dependence occurs if (1) if the feedback is to quick after an attempt, (2) if it occurs during the attempt or (3) is to frequent and of a simple corrective nature. Instead try delaying the feedback over a number of attempts, use the critical rating of the components to suggest appropriate timing. Letting the athlete select the trial to which they would like feedback or estimate any errors prior to feedback. Augmented feedback is most effective when it facilitates the learner’s discovery of the critical sources of task-intrinsic feedback that are essential for controlling performance in the absence of augmented feedback. In the case where the skill level is low and the task complexity high the learner may need guidance through augmented feedback. The dependence can be countered by breaking the task into simpler components. Dependence on augmented feedback is also a function of time with performance becoming increasingly reliant to the source of the information to improve performance. The longer the athlete relies on augmented feedback the less self-aware and independent they become and their progress to Skilled behaviour retarded.

Observational Practice

The use of demonstrations to relay a strategy or show what motor skill is to be performed and how the components work. It has been shown that mixed practice sessions that combine observational practice with physical practice have benefits in aiding skill learning, promoting retention and the transfer of skill. Further to this, two participants can alternate between observational and physical practice. The retention rates are the same with athletes benefiting from a combination of physical and observational practice and interacting with their partner. The benefits appear to be related to the interaction of doing and watching, the concurrent development of the motor skill, the processing activities between attempts enabling more skilled perception. It has also been found that retention rates were the same with the mixed practice needing only half the physical practice. Implications for training loads, injury prevention and larger groups.

Attention Focus

An internal focus of attention is defined as ‘where attention is directed to the action itself’, while an external focus of attention is described as ‘where the performer’s attention is directed to the effect of the action’. With Internal focus of attention instructions the movement control is more conscious, the upper levels of the central nervous system are more involved and this can lead to undesirable breakdown of the movement. Typically, internal focus of attention instructions that emphasise movement form tend to evoke a more conscious control of movement and thus may lead to less successful learning. In contrast, external focus of attention instructions can evoke a more subconscious control of movement.
and thus encourage the use of self-organisation processes in movement control. In designing successful learning experiences, the use of an external focus of attention on movement effects seems to encourage such processes.

**Contextual Interference.**

Contextual Interference concerns how the practice of multiple skills in short bursts frequently switching between skills for the duration of the practice session. There are arguments of slower learning vs better retention. Regardless of the on-going research, it provides a variation to training and allowing the players to select the order can be empowering and motivating.

**Ecological Dynamics**

The acquisition of skill is enhanced through the coupling of perception and action in a environment designed to simulate the constraints of a performance environment. The training of motor skills should be based on organising practice conditions that promote the development of expertise, even in non-experts. Ecological dynamics is the relationship between Perceptive systems and Movement systems in humans ‘So we must perceive in order to move, but we must also move in order to perceive’ (Gibson, 1979, p. 223 Gibson’s theoretical insights (1979) highlight the importance of carefully structuring practice tasks in sport which maintain relationships between key sources of information and action for performers. In ecological psychology, therefore, perception is considered to be a functional act of picking up information to use for regulating actions, not for enhancing automaticity of an athlete in a performance context. Instead it has been argued that the perception, action and intentions of an individual performer are highly integrated behaviours which underpin performance in sport and should always be considered when designing learning environments.

**Affordances**

Affordances are what the performance environment offers an athlete in terms of opportunities for action. Since an affordance is a relational property between an individual and a performance environment, it has an objective and a subjective characteristic. That is, an affordance exists objectively in a performance environment, independently of an individual’s current abilities and skills and intentions. For example, a gap between two converging defenders in a team game is an affordance to be utilised, whether or not an individual attacker has the speed to run through with the ball before it closes, has the skills to pass the ball through it, or wishes to ignore it. Clearly, affordances can also be subjectively utilised by individuals’ dependent on their action capabilities (e.g. skill levels and states of maturation and development in children and masters athletes) and the presence of other individuals. Therefore, the surrounding environment when perceiving and acting can be
similar, and yet distinct, for each individual performer, due to variations in previous experiences, developmental status, motivations and intentions. Affordances may be available in a performance environment but may not be utilised due to variations in a performer’s capabilities over time. Based on this objective-subjective characteristic, it has been argued that affordances are actually invitations to act that emerge from the continuous interactions of each individual athlete with key features of a performance environment. An individual can reject one invitation to act and utilise another instead. This idea highlights the individual differences between performers and is highly relevant for coaches seeking to design affordances into practice tasks. By manipulating task constraints in specific practice environments, coaches can create affordances, which help learners to couple their movements to information to regulate their performance behaviours. Designing affordances into learning environments can ‘nudge’ individuals towards certain performance outcomes. Representative design implicates the need to ensure that the information present in a practice environment simulates the information present in the performance setting. It is important to understand how the design of informational constraints of a practice task in sport can facilitate skill transfer.

The design of practice tasks is relevant in the coordination of individuals in a team sport. Individual players are conceptualised as the base unit degree of freedom in sports teams, identifying attackers and defenders as components of a self-organising system that continually co-adapt their performance behaviours. These interactions are captured by movements relative to each other in space and time, linked by visual (and other) informational fields. During competitive performance, sophisticated attacking and defending patterns of play emerge from these continuous attacker-defender interactions. Rugby Union players spontaneously adjusted their co-positioning in an attacking formation as they approached a first and second line of defenders, demonstrating how co-adaptive moves of athletes emerged in anticipation of, and response to, changes in informational constraints during performance, such as distances to or between defenders.

**Constraints Led Approach**

Constraints play an important role in channelling to certain functional movement patterns within a simulated practice environment. This generates more affordances in which to develop specific movement pattern responses to a specific scenario. Task constraints include rules, playing area, equipment used, number of players and the information about objectives or outcome. Skilful manipulation of the constraints can afford learners to opportunities to acquire individualised movement patterns that take into account their own individual constraints and how those constraints interact with the environment and the task constraints.

**Summary**

The journey of the novice to skilled performer is one of continuous exploration. As coaches we must provide as many opportunities as possible in task simulated environments to enable
the athlete to perceive information and develop movement pattern to achieve an outcome. Our interaction with the player must be positive and motivational, and our feedback meaningful and questioning. Our practice design must be relevant and player centred.