Utilising A Range Of Motor Learning Methods In The Development Of Physical Skills

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The Strength and Conditioning Coach is responsible for the physical preparation of athletes. This preparation involves the development of a wide range of physical variables, with the relative importance of each depending upon the specific sport involved, and the capabilities of the athlete. It must always be remembered that the aim of the athlete is to enhance their levels of sports performance, and this requires the application of these physical capacities directly into the performance of their sport. Additionally, this has to be performed under the pressure of competition. In this way, an important part of the S&C coach's role requires the development of stable physical skills that are able to transfer directly to competition and withstand the pressures of the high performance environment. Given this requirement for skill development, it is useful for the S&C coach to have a basic knowledge of approaches to skill development. This article will outline three common approaches to skill development and suggest advantages and disadvantages of each approach.

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Characteristics of skilled performance

The precise nature of skilled performance will vary from sport to sport. However, there are a few key characteristics of skilled performance that provide a valuable insight into the role of skill in performance. Expert performance depends upon making effective decisions, or the ability to make the best choice between a set of alternatives[4], and this capacity is critical in sport and draws on perceptual and cognitive skills as well as physiological capacities. In this way, while physical capacities will underpin effective performance, they cannot guarantee a higher level of performance unless they can be transferred. This requires that athletes are able to integrate these physical capacities directly into the sport, and develop high levels of movement effectiveness and efficiency. This is reflected by the fact that higher jump performances can be achieved with a lower EMG activity as skill levels develop,[19] (while typical thought would suggest that higher EMG activity should result in a higher jump performance). Indeed, this efficiency of movement is highlighted by the fact that elite performance has often been presented as an autonomous process, where athlete's movements are highly automated and require little conscious effort of explicit attention to perform and control skills.[4]

However, while this state of automated action may be ideal in performance, it may not promote an ideal learning environment. Ericson,[3] found that experts in any fields rarely let their actions become fully automated during practice. Instead, they find ways of improving the cognitive effort utilised in practice. Cognitive effort is the mental work that leads to high levels of decision making, anticipation, planning, regulation and interpretation of motor performance.[11] Permanent gains in skilled performance capacity are only achieved when cognitive and physical training occur in tandem.[17] This is the concept of deliberate practice, which has been presented as a key determinant of elite performance. Much of the reasoning behind these strategies depends upon the nature of brain function. The brain is fundamentally a pattern forming self-organised system governed by potentially discoverable non-linear dynamical laws.[10] Within the brain the areas responsible for pattern recognition and those responsible for the automation of action are different.[13] This requires the development of synaptic linkages between these areas. These synaptic linkages are best developed

where a rich learning environment is provided[2] and where the challenges of cognition and physical actions are combined,[9] helping develop key synaptic linkages required for high level performance. This combination of physical and cognitive effort ensures that the athlete lays down the required neural networks, which underpin improvements in motor performance.[17] Therefore, effective physical development programmes need to encourage and foster cognitive effort, in addition to physical performance. Exercise modalities and coaching interventions that encourage this combination are therefore a key tool for any coach.

Approaches to skill development

A number of approaches to skill development are available to the coach. The most common ones utilised in skill development, and which have been applied to physical training are:

1. The behavioural approach
2. The dynamic systems approach
3. The constraints based approach

Behavioural approach

Behaviourism has evolved out of the work of Skinner[15] and Thorndike,[16] and plays a large role in many strength and conditioning practices. This approach assumes that a response will become a habit as a consequence of the number of times it is associated with a given stimulus.[11] These methods have been typically utilised in strength and conditioning where development of skills have occurred in closed conditions for a given number of repetitions in a blocked and repetitive manner.[6] Behavioural methods can elicit impressive gains in performance in the short term, and athletes achieve a high level of performance in these initial stages.[17] However, they are not as effective for the retaining of skills in the longer term,[11] and particularly in open performance environments. This is especially the case when unusual, difficult or stressful conditions are encountered.[18] Athletes trained in a behavioural fashion do not develop the higher order cognitive skills needed to understand their own performance, and to be able to explain good or poor performances.[17] The behavioural approach can have advantages in terms of developing initial skills (especially when utilising the key coaching tools outlined later), but distinct disadvantages in developing these beyond the initial stages of learning.[6] This lack of cognitive effort during many closed skill exercises is abundantly clear when watching many training sessions, where athletes perform their exercises with little thought required.

However, there are methods by which some of the disadvantages of the behavioural approach can be minimised, and these all involve adding a level of cognitive requirements to the exercises. These involve modifications to the way exercises are structured, as well as through modifications of coaching inputs which can increase the cognitive requirements. The exercise modifications include the addition of variable and random practice to the exercises. Variable practice refers to the practicing of a single class of skills in a range of environments.[6] For example the same agility movements can be practiced over a range of different distances and/or directions. Random practice on the other hand refers to where different classes of movements are combined within the same practice element.[6] For example, where three different speed drills are performed, they are performed in a random order, rather than where each exercise is performed successively for the required repetitions before moving on to the next.

In terms of coaching input, the use of questioning techniques is a very useful tool for the coach. Rather than giving the athlete details on their performance, the use of an effective question requires the athlete to reflect upon their own performance and try to come up with the answer. However, this approach does require a great deal of skill and knowledge on behalf of the coach to be optimally effective. The use of questioning should not be restricted to enhancing the behavioural approach and should be seen as a key tool to develop for effective coaching.

Dynamic systems approach

The dynamic systems approach to motor learning asserts that movement patterns arise from the organisation of the neuromuscular system in response to biomechanical factors, morphological factors, environmental factors, and task constraints.[1] Skill is thought to emerge when the individual is able to control the degrees of freedom of a movement.[10] This method has been proposed as an effective method of developing agility[5] and may also have application in other areas of performance. The dynamic systems approach requires the application of a progressive series of exercises, that sequentially add to movement complexity via freezing, freeing and then exploiting degrees of freedom, as required in sports performance.[17] This approach fits in with the self organising nature of the human brain, and is often used to explain the locomotor development of humans from crawling to toddling to walking and finally running, with the self organisation occurring as a spontaneous pattern formation.[10] This approach can have great potential in developing effective skill learning environments. For example, in terms of agility development, the freeing of degrees of freedom is an excellent method of movement progression, developing basic movements through increasingly open challenges.[6,7,15] However, dynamical systems models tend to neglect, or minimise, the role of cognitions and attention in human learning and the performance of complex movement patterns and skills, which are now recognised as important elements of skill development.[14] Therefore, used in isolation, this method may not allow performance to be maximised in sports where decision making, and the associated perceptive and cognitive requirements, are important.

Constraints based approach

This approach to skill development attempts to combine a number of approaches, and remove some of the disadvantages associated with the two earlier systems.[12] Here three key constraints (organismic, task and environment) interact to determine the optimal patterns of co-ordination and control for any activity.[12] Organismic constraints are those that reside within the athlete, and are the traditional focus of strength and conditioning and include elements such as force capacities, speed capacities etc. However, the application of skill will ultimately also depend upon the environment in which it is performed, and the precise task that the athlete has to perform.[9,12] The environmental constraints will include elements such as playing surface, temperature, wind, gravity etc, all of which interact to determine the nature of skill application.[9] The task constraints include the goal of the task (what the athlete is trying to achieve), the

rules that govern the task itself and any specific equipment used in the completion of the task.[9,12] An important benefit if using this approach to look at performance levels is that it highlights the fact that organismic constraints alone will not totally dictate the level of performance. This focus on a specific activity is crucial to effective skill development and emphasises the importance of moving towards a task-based approach.[9] Another important aspect to consider is that this approach involves a perception-action cycle that seeks information from the external environment and processes this to elicit the appropriate response.[12] This model lends itself ideally to agility exercises, as the perception-action requirements are naturally present and developed, and the response specific to the required task, but can also be applied when looking to ensure transfer of other fitness parameters into performance. However, effective use of this approach does have a number of essential pre-requisites. Firstly it requires the athlete possesses the ability to be able to make effective decisions, and this may require a base level of performance prior to it being optimally effective. Secondly it requires high order coaching skills, which can facilitate the athlete making effective decisions, and this must be based upon the coach possessing an intricate knowledge of performance related aspects on which to draw during a session. Similarly, it requires the ability to effectively analyse performance and effectively direct athlete's attention to the key elements that will allow them to make effective performance decisions.

The integration of methods

It is important to remember that each of the above methods have both strengths and weaknesses. These will very much depend upon the training age and capacity of the athlete and upon the skill to be developed. One of the key roles of the strength and conditioning coach is to provide an appropriate learning environment commensurate with the precise requirements of the athlete. As coaches it is all too easy to take an either/or approach, with discussion focussing on which method to use, rather than on how best to combine methods. This either/or mentality also pervades research where, due to the nature of research designs, the focus has largely been on the comparisons between methods, and decision made based upon the sole application of a single approach. In all likelihood the most efficacious approach will be one of integration. Understanding the advantages and disadvantages of all learning approaches can allow the S&C coach to effectively integrate all methods effectively to provide a level of stimulus that maximises skill level performance. This integration can occur through both long term and short term planning. For example, the behaviourist approach can facilitate short term learning, and while this can be the basis of introductory approaches, it can also be supplemented by the other methods, to remove some of the key disadvantages associated with this approach. This combination of approaches can occur within a single session and also within a range of training phases. Similarly, advanced performance requires high levels of cognitive effort and may benefit from the use of constraints led approach, but even at this advanced level, the addition of a behaviourist approach can facilitate the honing of fundamental technique.

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