Movement Training for Field Sports: Soccer

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SUMMARY
QUALITY MOVEMENT IS A FUNDAMENTAL ASPECT OF PERFORMANCE IN THE MAJORITY OF FIELD SPORTS. AS A BASIC MOTOR SKILL, SPORT MOVEMENT SHOULD BE SUBJECT TO A SYSTEMATIC DEVELOPMENT PROGRAM IN WHICH QUALITY PRACTICE AND QUALITY COACHING PLAY A LEAD ROLE.

A look at the vast majority of team games at any level clearly demonstrates the importance of movement. Movement binds together all of the skills of the game into a coherent flow and is important in many sports. Often, what marks outstanding performers is not solely the level of their skills but the standard of movement that accompanies these skills. This article outlines a movement training program for team sports. A key message in this article is the need for movement training to ultimately be related to the sport, with the major aim of any movement training program being the enhancement of sports performance. To emphasize this point and to provide a context for the application of the model, I use soccer in this article to outline how to develop a sport-specific movement program. Soccer provides an excellent model in that players will cover a large distance during a game (often more than 10 km), with this distance featuring an array of movement distances and movement patterns, the majority of which are perceptually stimulated. However, although soccer is used as an example, the concepts outlined can be applied to all field-based team sports.

THE MULTIDIMENSIONAL NATURE OF MOVEMENT TRAINING
Movement training has, at its aim, the establishment of motor programs that allow a player to optimize soccer performance. Therefore, an important starting point is to evaluate the specific movement requirements of the sport. Establishing these movements requires the identification of the key movement patterns used in the sport, along with the perceptual stimuli that trigger these movements.

In the first part of this article, I examine the needs analysis of field sports. Given the great variation in the movement requirements both during and between games, the importance of generalized motor patterns is outlined, together with the perceptual requirements of field sports like soccer. In part two of the article, I discuss the development of a movement training program and establish the optimal methods of eliciting the movement requirements established in part one. Part two will outline how movement training needs to incorporate 3 key domains—quality development, quality practice, and quality coaching—otherwise known as the “movement training triad,” which are founded on 3 key sport science domains: motor learning, biomechanics, and pedagogy. Because movement is a skill, in the process of developing a movement training program, one needs to examine movement skills via a motor learning approach that optimizes motor learning. Additionally, movement is mechanically based, and the need for all practice to be mechanically sound is addressed.

An essential, but often overlooked, part of any motor learning process is the standard of coaching. Quality coaching plays a key role in the movement training triad. Optimizing coaching requires that practice be based on sound pedagogical, motor learning, and biomechanical principles, and an outline of these is presented in this article.

WHY MOVEMENT TRAINING?
When evaluating the standard of movement used by players, it needs to be evaluated, not only in terms of speed, but also in terms of efficiency and effectiveness. The ultimate test is the ability of players to perform the skills of the game (11). Movement training incorporates traditional speed and agility training but tries to relate these more directly to sports performance, rather than on simply measuring these elements on their own. Although speed and agility are crucial elements in a movement training program, they cannot be considered successful unless they directly enhance sports performance. Movement training works not only on speed and agility but also on the ability to express these in a sports context and the ability to integrate these movements with sport specific skills.

The standard of an athlete’s movement facilitates the standard of his or her sports skills, so much so that, often,

KEYWORDS: movement; coaching; practice; development; field sport; soccer
when skills break down, it can frequently be traced to poor movement, insomuch that the athlete’s movement and the resultant body position did not allow for the successful accomplishment of the skill. In soccer, often the root cause of a poor shot, a poor tackle, of a defender losing his or her opponent etc. is not solely a lack of soccer skill but often a breakdown in the movement patterns and the resultant poor position from which the skill was attempted.

Given the need for movement to provide a position by which sport skills can be performed, optimal movement training must be seen as more than simply speed and agility and related drills (7). What will ultimately decide the success of any movement training program is ensuring that movement allows for the effective execution of the required sports skill (7). In this way, simply getting to the ball quickly will never be optimal unless the player arrives at the ball in a position to carry out the required skill (7,12). To optimally achieve this, movement drills need ultimately to be related to the exact requirements of sports, and success needs to be measured not necessarily by improved times in an agility drill, but by improved performance on the field.

PART ONE: MOVEMENT REQUIREMENTS OF TEAM SPORTS

PROGRAM OVERVIEW: START WITH THE END IN MIND

Any sports movement program needs to focus on the end product it is trying to achieve. With sport, as with the majority of field sports, movement training needs to produce players who are able to produce movements that place them in optimal position to perform the key sport-related skills. In short, the aim is to make them better players, and this concept must be the aim of any movement training program. This requires that athletes are able to move effectively in game situations and in response to the key perceptual and decision making factors that stimulate movement (20), which ultimately requires that sound movement patterns are stable and automated, enabling players to be focused totally on reading and reacting to game situations, in the knowledge that their movement patterns will help them get to a position from where the skills required can be best produced.

Automation of movement that is directly transferable to the game situation is therefore a key goal in any sports movement development program. This automation requires the player get to a level of development where they no longer have to pay conscious attention to producing movement, with quality movement happening automatically. As with most skills, it requires a great deal of practice of the movement patterns involved.

By starting with the end in mind, a movement training route-map can be created. With the ultimate aim established, it is possible to work back through a development program that will bring the player to this level, and this will be developed in part two of this article.

THE SCHEMA: THE AIM OF MOVEMENT TRAINING

One of the challenges of team sports such as soccer is their random nature, and although automation is achievable, it must be set against the exact movement requirements of the game, where movement patterns vary in terms of a multitude of factors, including direction, speed, position of the opposition, position on the field, and position of the ball, to name a few. In this way, an almost-infinite number of movement combinations are possible in a game and, clearly, repetition of all the possible combinations of the aforementioned factors would be an impossible challenge, even for the best coaches with no time limits.

A key to developing sports movement skills lies in the way in which skills are learned. Schmidt’s schema theory of generalized motor programs (15) provides a model that explains the development of skills in situations such as soccer with its multitude of movement situations, and provides vital information to guide the development of skill development programs. The schema theory states that rather than producing a single motor program for each movement required, what is produced is a general program, which can be varied according to the precise requirements of each given situation (15). Skills are learned by learning rules about how a body functions during the performance of the skill (17). In this way, the basic skill of side shuffling would be developed as a general program, which could then be altered in terms of speed, distance, and direction, with the player applying the general program to the task at hand. This is analogous to learning to drive; once the basic skills have been mastered, we can drive on any road, not only ones on which we have practiced. Although a great deal of research has been conducted on the mechanisms of schema learning (17), the basic schema theory of generalized motor programs remains a valid base around which to build a skill development model.

NEEDS ANALYSIS

It is clear that in setting up a field sport based movement program, the movement requirements of the game must be identified and developed. Additionally, when the movement patterns used in sport are identified, their aim within a game must also be clearly delineated, so that the transfer to the game is maximized. By addressing the movement patterns and their target function (7,8), a series of development drills can be set up that hone the precise movement patterns required and address these according to their specific role in sport. To aid in this goal, it is useful to be able to classify movements in terms of their target function. Jeffreys (7,8) proposed that three classifications of target movement functions can be identified. These are:

1. Initiation movements: Movements that are used to start or change motion
2. Transition movements: Movements that are used as preparation for
subsequent actions, the aim being to maintain a position from where subsequent action can be successfully and efficiently used.

3. Actualization movements: These represent the key movements that ultimately decide the success of the actions. These normally involve a soccer-related skill or moving to a given position as quickly as possible.

**KEY SPORTS TARGET MOVEMENT PATTERNS**

By using this classification, one can break down sports movement into key tasks that need to be achieved, such as starting to the side, starting to the rear, etc. (11). Once these tasks are identified, then the optimal movement patterns to achieve these tasks can be set out. Table 1 outlines the key movement tasks to be achieved within each target function classification and the key techniques that need to be developed to achieve these tasks in soccer. These form the basis of the movement pattern development process, representing the key skills that will form the foundation stones upon which the movement development program will be built, and representing a virtual movement syllabus for each sport. It is important to note that Table 1 is a simple classification, and within these movements are broad ranges. For example, initiation movements need to be performed from both standing and moving positions; these moving positions are likely to be in a range of directions and using a range of movement patterns such as back-pedaling, side-shuffling, etc. Additionally, running patterns need to include curved patterns and not just straight line running. However, the classification provides a structure around which to work.

**PERCEPTUAL SKILLS ARE A KEY PART OF SPORT MOVEMENT**

Although the movement patterns provide an effective syllabus for a movement training program, the program’s success will be determined by its effect on performance. The athlete’s ability to use these movements in the right place at the right time will require the contextualizing of the skills within the sport. In particular, the athlete will need to develop the ability to read and react to the key cues of the sport. High-level field sports performance requires that players are able to move and produce sports skills in relation to a multitude of sport specific perceptual cues. This requires that players are able to identify and react effectively to the key perceptual cues (1,20), enabling them to pick up anticipatory information and move accordingly (20). This ability to anticipate and respond to key perceptual cues is typical of higher-level athletes (2), and evidence suggests that this skill is very sport specific (2,20). Movement training ultimately needs to be directly related to the key movement patterns and perceptual cues present in the sport. The key stimuli to soccer movement, for example, are the movement of factors such as teammates, the opposition, and the ball. Because movement in many field sports is relatively continuous, the regulation of movement is far more dependent upon environmental stimuli than in discrete tasks (tasks that have a definite beginning and end) (17).

<table>
<thead>
<tr>
<th>Type</th>
<th>Aim</th>
<th>Movement pattern</th>
</tr>
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<tbody>
<tr>
<td>Initiation</td>
<td>Start to front</td>
<td>Acceleration pattern</td>
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<tr>
<td></td>
<td>Start to the side</td>
<td>Hip turn and drive</td>
</tr>
<tr>
<td></td>
<td>Start to the rear</td>
<td>Drop-step</td>
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<td></td>
<td>Change direction</td>
<td>Cut step / plant step</td>
</tr>
<tr>
<td>Transition</td>
<td>Static wait</td>
<td>Athletic position</td>
</tr>
<tr>
<td></td>
<td>Jockeying</td>
<td>Moving athletic position</td>
</tr>
<tr>
<td></td>
<td>Moving to the side</td>
<td>Side-shuffle</td>
</tr>
<tr>
<td></td>
<td>Moving to the rear</td>
<td>Back-pedal</td>
</tr>
<tr>
<td></td>
<td>Moving to the front/curved</td>
<td>Efficient running action</td>
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<td></td>
<td>Tracking the attacker diagonally</td>
<td>Cross-step run, body facing target</td>
</tr>
<tr>
<td>Deceleration</td>
<td></td>
<td>Chop-steps to athletic position</td>
</tr>
<tr>
<td>Controlled movement to front</td>
<td>Athletic position chop-steps/ adjustment steps</td>
<td></td>
</tr>
<tr>
<td>Actualization</td>
<td>Acceleration</td>
<td>Acceleration movement patterns</td>
</tr>
<tr>
<td></td>
<td>Move to top speed</td>
<td>Kick from a rolling start</td>
</tr>
</tbody>
</table>

Table 1: Movement patterns in soccer
In this way, it is vital that the player is subjected to drills and exercises that develop these perceptual skills as well as simply focusing on movement patterns. Fitts et al. (4) suggest that there are 3 main areas of perceptual information that an athlete needs to be able to identify and that these form a continuum from simple to complex. In their model, a player would need to identify three factors about environmental stimuli namely:

• its position;
• its velocity; and
• its acceleration.

Fitts et al. (4) suggest that at the earliest stages of training, players may only be able to pick up the simplest information, which is position. With increased practice, the player will be able to use velocity information and later acceleration information (14). What is clear is that perceptual skills need practice, and given that they are sport specific (2), this requires that movement training is ultimately as sport specific as possible once basic movement patterns have been stabilized. In this way, drill triggers need to incorporate sport-specific stimuli and not rely simply on verbal commands. Additionally, perceptual information needs to conform to a hierarchical system, with increasing levels of complexity used through a development process (17). This further emphasizes that advanced athletes will require different types of drills to intermediately who in turn require different drills to beginners and that an appropriate development system needs to be in place to facilitate this.

PART TWO: DEVELOPING MOVEMENT TRAINING PROGRAMS

THE MOVEMENT TRAINING TRIAD

The concept of movement training, rather than the more commonly used term speed and agility training, reflects a key concept, that in which the ultimate aim of the program is to enhance sports performance (12). Although speed and agility tests such as the 40-yard dash or pro agility have a place in any movement program and can indicate strengths and weaknesses in key underlying attributes, the key performance indicator has to be performance in the sport. The concept of movement training focuses on the relationship between fundamental movements and the associated sports performance.

In developing a comprehensive movement training program, 3 key elements need to be present, namely:

- quality development;
- quality practice; and
- quality coaching.

These elements comprise the movement training "triad," and the integration of all 3 allows for the application of the motor learning, biomechanical, and pedagogical bases of movement training. Figure 1 summarizes the essential elements of the movement training triad.

QUALITY DEVELOPMENT

Classifying sport movement as a skill has important implications in the way skills are developed. A look at most skill-based activities, such as writing, music, and sport skills, shows that the vast majority go through very distinct phases of development (1). Skills should be developed progressively over time, starting with the fundamentals and moving through developmental stages until they can be produced automatically and consistently even under high pressure situations (17). The whole process takes time and requires a series of progressive drills and exercises that takes the individual through the three stages of motor learning (16).

Skills are built upon previously acquired capabilities (17) and, therefore, a sound base of stable movement patterns is critical to optimal movement development. The complex movements we see in a game need to be built on firm movement foundations if they are to be optimally developed. These foundation movements need to become automatic and stable, because in learning new skills there is a high dependency upon stable patterns (13). It is crucial that movement training is sequentially developed and that a framework of development is established that conforms to skill-development principles (11). Previously Jeffreys (9,10) identified 3 key phases of movement skill development, based upon the 3 phases of motor skill development (17). These stages are the foundation stage, the development stage, and the peak stage, and they provide for an appropriate system from which a development program for sport can be established.

THE FOUNDATION PHASE

The major aim in the foundation stage is to establish the key movement
patterns (10) and the fundamental movements identified in Table 1 should be the focus of the work in this stage (12). Although the drills required for the development of these patterns may appear basic, they really are the key building blocks of any movement program. As with all skills, quality practice, supported by augmented feedback (additional feedback to what the athlete can gain from the task) and guided discovery (the application of drills and questioning that guides the athlete into self discovery), is required to master these movements. Jeffreys (10) presents guidelines for the optimal application of coaching in these phases, which are summarized in Table 2. At this stage, the need for sport-specific drills is relatively limited, but what is important is that the drills used are selected to ensure that the fundamental movement patterns required for soccer performance are developed (11).

THE DEVELOPMENT PHASE

The development stage is a progression from the basic movement patterns of the foundation stage to the highly specific soccer movement of the peak stage (10). Players at this stage will have sound technique in all of the foundation movements required in soccer. What is now vital is that these movements can be pieced together progressively to slowly build up what we know as sport movement. This is analogous to basic dance steps being put together into a whole routine. During the development stage, it is not just the main movements that are important, but the way in which they are smoothly pieced together, again just as a dance routine. Movement patterns break down, not in the performance of a single pattern, but in the change between one and another, for example, changing between a side shuffle and a back-pedal. This is a problem for a program that completely differentiates between linear speed and lateral speed because these are never differentiated in this way in many field sports and, within this type of system, crucial movement combinations may never be developed.

It is important that players develop the ability to move effectively between movement patterns, and the identification of typical movement sequences is fundamental to this process. This requires an analysis of how movements are put together in sports, and videos of sports matches are a great tool in achieving this goal. For example when a player back-pedals, what are the subsequent movements, and what actions trigger the subsequent movements?

Table 3 outlines typical movements that comprise a back-pedal in soccer. Armed with the information, the coach can then build drills that reinforce these patterns. Initially, these drills can be closed (with preset movement parameters) but increasingly they should be open drills (where the movement patterns are random and depend upon the reading of, and reaction to, external stimuli), with the player required to react to the same stimuli that he or she will need to react to in a game. For example, a 2-player open drill may involve player 1 back-pedaling while player 2 runs at player 1 with the ball. Player 1 will then need to react to the movements and actions of player 2 and then initiate the appropriate response to whatever actions player 2 takes. The whole sequence will resemble a game situation, with the key stimuli recreated. Appropriate coaching interventions on the result of the movement can result in an ideal learning experience.

The development phase should therefore be characterized by a move from closed drills to open drills. Although closed drills are extremely useful in developing basic movement patterns and combinations, a weakness with many closed drills is their predictability. Once movement is started, there is a preset sequence of movement, from which the athlete does not need to deviate, which is never the case in field sports, where movement requirements can change instantly. For example, in soccer, a fullback sprinting back to cover a winger, although running at high speed, may be required to stop and change direction instantly if the winger decides to check. This type of movement change can never be totally developed by the use of closed drills (20). What is important here is that the typical movement changes observed in sports are identified, such as moving from a side shuffle into a sprint, and are initially developed and stabilized via closed drills. However, as an athlete progresses these need to be progressed via open game like drills, and increasingly in relation to the key perceptual skills required in a game (12).
Guidelines for coaching at the development level have been given by Jeffreys (10) and are summarized in Table 4.

**THE PEAK PHASE**

The key aim of the peak phase is to ensure maximal transfer from the previous 2 phases to sports performance. To facilitate this, random, sport-specific drills should predominate. Although the game situation is the target context in which the player will need to perform, simply playing the game may not produce the ideal movement development environment, because the information required for optimal schema development may not always be easily accessible or identifiable. Instead, situations that mimic aspects of the game are better suited, where specific movement patterns and combinations can be targeted, and with appropriate coaching interventions made. These also need to replicate the visual and perceptual requirements of the game.

What is vital is the quality of augmented feedback (see the section “Coaching Feedback,” later in this article) provided and the standard of the players own guided discovery. The aim ultimately is to develop the player’s ability to assess his or her own movement and to be able to answer performance-related questions, an ability that will allow the player to analyze his or her own performance during a game and make any needed adjustments. To facilitate the process, augmented feedback needs to be precise and at a level that enhances the performance of an already experienced player. Much of the success of the peak phase will be based upon the successful completion of the previous stages (11), because this produces players with sound movement patterns and movement combinations who are able to perform these automatically and in a range of sport-specific conditions. As with all phases, the standard of coaching and or practice design is crucial, and guidelines for coaching in the peak stage have been given by Jeffreys (10) and are summarized in Table 5.

**QUALITY PRACTICE**

Once an appropriate development process is in place, then the next key stage of the movement “triad” is quality practice. High-quality practice is vital for the development of expert performance (18), and the more opportunity players have for movement practice, the greater will be the development of movement skill. In constructing practice, the following questions can provide a framework around which to construct sessions:

- Is the session goal driven?
- Is the drill selection goal driven?
- What is the drill distribution?
- Is there variability?

**GOAL DRIVEN**

Every session and every element of a session should have a specific goal. For example, a session in soccer at the development stage could have the aim of developing a player’s defensive jockeying technique, providing the framework around which the whole session can be designed.

**DRILL CHOICE**

Any drill selected should have a specific aim both in terms of the movement patterns to be developed, the target mechanics used and, as progress advances, its transferability to sports performance. The drills need to be selected in terms of the overall goal of the sessions and should be related to the player’s ability.

**DRILL DISTRIBUTION**

Once the session goals and the drill to be used are selected, coaches can then distribute the drills within the session to optimize learning. In general, drills with beginners should be distributed, with plenty of breaks, whereas
Table 5
Guidelines for the peak phase

- Use a variety of complex open drills
- Drills should be highly sport specific
- Drills should be randomly distributed and include variance
- Feedback should be infrequent but precise
- Feedback should enable the athlete to answer movement-related questions

Variability of Practice

Once the goal of the session has been established, and drills selected and distributed to achieve the goal, the key element to be addressed is variability within the drills. Given that the aim of movement training is to produce a series of general movement rules that can be applied to different situations then variability in training is crucial (6) and provides a positive factor in motor learning (17). Some degree of variability needs to be built into practice at all levels but is crucial in the development of the automaticity required at the highest levels of performance (8, 16). Variability in practice requires an athlete to constantly evaluate key movement features and strengthens the development of the schema rules (15). It does this by providing a widely based set of experiences upon which a schema can be developed (17) and is especially successful when supported by the intelligent application of augmented feedback.

Quality Coaching

One of the most overlooked aspects of any movement training program, indeed of many speed and agility programs is coaching. Although the selection and application of drills is undoubtedly important, their effectiveness will only ever be optimized in conjunction with quality coaching. Quality coaching is both science and art, built around the application of scientific principles but also grounded in personal relationships and quality interactions. Therefore, coaching is a key element in the movement training “triad” and needs to be based upon sound pedagogical principles.

Movement coaching will revolve around 3 key issues:
- providing a learning environment;
- providing for guided discovery; and
- coaching feedback.

The Learning Environment

The results of any movement program will be significantly enhanced by the environment a strength and conditioning coach creates within their coaching program. Providing a motivational climate in which an athlete actively engages with the learning experience and feels stimulated and supported is important for optimal learning (3). Indeed, a report (18) into talent identification and development asserts that performance will only be developed in an environment that facilitates the individual’s capacity to develop. Additionally, the provision of guided discovery, together with well-delivered coaching interventions optimizes the learning environment.

The Art of Guided Discovery

A critical feature of optimizing schema learning is the need for movement outcome information. An interesting feature of schema learning is that there are positive learning benefits from both correct and incorrect movements. What is critical for the incorrect movements is that they are identified when they occur, and the reason for them sought. This can take the form of guided discovery, combined with intelligent coaching. Encouraging athletes to evaluate their movement patterns is one of the best ways of developing schema based movement patterns. This process also empowers athletes to evaluate and correct their movements, which provides for a powerful learning environment (16).

Guided discovery can be instigated from the start of any movement program whereby, rather than provide a list of coaching cues before movement, players can be encouraged to try a drill, and then come up with the answers to any movement issues identified. Questions such as “how did that work?”, “what do you think happened there?”, and “How did it feel?” are great tools in enhancing guided discovery because they draw the athletes attention to the key features of the movement pattern. In this way, players can increasingly evaluate their own movement and gain the ability to draw out key movement-based information. Once players can evaluate why things are happening as they are, they can greatly enhance the learning gained from all movement experiences. This skill also transfers well into game situations where players are able to evaluate performance and make any necessary adjustments.

In the optimal provision of guided discovery, it is important that the complexity of the guided discovery is appropriate to the athlete’s development level and that it grows with the athlete, allowing the athlete to access important movement-based information (4). Achieving this goal requires an accuracy of coaching, where movement-based questions that promote guided discovery are used, whenever movement patterns need to be addressed, or a learning experience presents itself. These need to be targeted at the most relevant sources of task information (19). In many cases, sports skill
breakdowns can be traced to mistakes in movement, and these can provide for learning situations when combined with a high level of coaching.

The application of drills also needs to be appropriate to the player's performance level—players just starting a program will need relatively simple drills, where the focus is on identifying their optimal mechanics in a number of basic movement patterns such as backward pedaling, side-shuffling, etc. However, once these patterns are established, the ultimate aim is their transfer to the game, which requires the use of drills that as closely replicate game situations as possible (2). There should therefore be a move from general patterns through to highly specific drills through the whole development program (9).

COACHING FEEDBACK

A key feature of the schema theory is that athletes need to learn rules about movement, rules that can then be applied to various situations (17). In developing movement rules, 4 key features of information can be identified: (17)

1. Information about the initial conditions (e.g., example, body position, foot position, etc.)
2. The movement pattern parameters (e.g., speed, direction etc.).
3. Augmented feedback about the outcome of the movement.
4. Sensory consequences of the outcome (how it felt, looked, etc.)

If all 4 of these elements are in place, then skill learning and schema development will be optimized. If any of the 4 elements are missing, then schema development will be retarded (17). In many instances, although the information may be present the player may not have the skill to be able to use it and here the coach will need to draw the player’s attention to this information (16). This is the key to augmented feedback where the coach provides key information to the athlete that fills in any gaps in the information required for scheme development. The coaching of drills and movements is so much more than the drills themselves, and coaches need to ensure the presence of the aforementioned information if the session is to produce optimal learning and, hence, optimal movement development (9). Simply performing a drill, however well-designed, without using the optimal movement patterns and without the presence of augmented feedback, can never be an optimal skill development experience (9). As with guided discovery, augmented feedback will change as an athlete develops, moving from frequent and general to infrequent and precise as the athlete moves through the development process.

THE APPLICATION OF TARGET MECHANICS

All movement should be based on sound mechanical principles, because they provide a foundation for effective movement coaching and feedback. For coaching, feedback to be successful, it is vital that coaches have a clear model of technique for different movement patterns. Table 1 identifies a range of key basic techniques, which form the movement syllabus for soccer. What is crucial here is that when these movements are performed they are performed with a technique that optimizes performance. Optimal technique can be termed the target mechanics and needs to be based on sound biomechanical principles, allowing the optimization of movement efficiency, effectiveness, and force production (7).

For each movement pattern, the key movement mechanics can be set out (9). These mechanics provide a coaching template for the application of any drill and provide a template around which to provide coaching feedback. Optimal mechanics will focus on 3 main areas, posture, arm action, and leg action, which is commonly referred to as the PAL paradigm (5):

1. Posture: Including body alignment, weight distribution, center of gravity position, line of gravity in relation to the base of support, and head position.
2. Arm Action: Including amplitude of action, direction of action, force production potential, etc.
3. Leg Action: Including foot placement in relation to the body and leg, weight distribution on the foot, leg alignment, force production potential, direction of forces, base of support, etc.

Each movement pattern will have its own target mechanics (12). These provide the basic mechanical rules around which optimal technique is based. Although there will be a degree of individualization within techniques used, all must comply with basic mechanical principles. Just as there are subtle technique differences among the world's top sprinters, all the techniques used comply with the general rules that govern motion (11). The key when evaluating technique is to evaluate whether the player is achieving the basic mechanical requirements and whether they transfer directly to the game. A good example is the side shuffle motion, a key transition movement in soccer that is used as a player is waiting to react to various stimuli, such as a move by an attacker. The ability to redirect is vital to side shuffling in soccer, and this redirection may occur at any time. Effective redirecting requires that the center of gravity in the player is kept stable and low and that the player's feet are kept low to the ground. However, often when this drill is performed many players' center of gravity will come up and down when performing the motion, with their feet coming high off the ground. Although this action may allow them to get from A to B relatively quickly, in the air they cannot redirect, and so the up and down movement would be totally ineffective in the context of a soccer game and so should not be taught or allowed in drills. This is a good example of the importance of starting with the end in mind, and not simply focusing on the drill. The target mechanics therefore provide a model around which coaching feedback can be given.

CONCLUSIONS

Effective and efficient movement is fundamental to sports performance and can be the difference between average players and top class players.
Movement is a skill and, as such, can be trained and developed. As with most skills, this requires a long-term approach based upon sound motor control principles. By breaking sports movement down into constituent parts, a progressive system of development can be set up that optimizes movement development and its transfer to enhanced sports performance. When quality practice is applied within this development system and is supported by quality coaching, the movement training “triad” is established, which optimizes skill learning and movement development.

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REFERENCES