Differential Coordination and Speed Training for Tennis Footwork

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INTRODUCTION

The demands on tennis players are many and very complex. However, this article will focus on coordination and footwork as fast and suitable footwork patterns (technique) are strongly linked to stroke technique and when combined correctly they should result in successful stroke execution. High quality conditioning training should first deal with the analysis of specific coordination performance requirements (Neumaier, 1999). As practical experience and empirical evidence shows, coordination training focusing on specific skills is more successful than general coordination training (Hirtz, 1995). The training concept proposed in this article has been developed, giving due consideration to the abovementioned factors, because in our opinion on-court footwork could be trained more effectively.

Coordination performance requirements in tennis are influenced by certain conditional performance parameters. Match (tennis) specific factors, especially speed and power, influence certain coordination skills. Additionally, a low level of speed endurance might have a negative effect on coordination execution during match play due to fatigue.

COORDINATION AND SPEED DEMANDS IN TENNIS

Psychological, or cognitive, speed (perception, anticipation, decision-making) is especially important as it determines ones ability to react and decide rapidly, and is a characteristic commonly found in top athletes. A good example is when a player hits a poor return. The server immediately finds the appropriate response, positions themselves inside the court attacks the ball, opening the court and finishing the point at the net.

Coordination speed is primarily seen as a fast reaction to the opponent's stroke (e.g. a powerful, explosive burst) and in response to a recognised or anticipated stroke (being in an optimal position to retrieve an attacking shot, moving to a passing shot, preparative actions, etc.). It is also evident when the player has to perform a stroke in a rapid manner due to time and/or situation pressure (e.g. perfectly placed forehand or backhand stroke [precision] on return of serve, etc.).

The aforementioned factors determine the optimal stroke execution speed for a given player in a given situation. The stroke execution speed is essentially characterised by the level of coordinative abilities (skills) in different tennis specific situations: balance during stroke (stable position), orientation on the court (opponent, ball), reaction speed (volley, return), rapid adaptation to the opponent's actions, linking of lower and upper body movements in difficult and complex situations, rhythmical stroke production, kinaesthetic differentiation (controlled force production) of lower and upper body.

The reception and processing of information (perception) by all sensory organs is very important for efficient coordination and for developing a high stroke execution speed or racket head speed. Thus, a high level of alertness with all sensory organs during a match is the basis for executing actions quickly.

Due to the complex and variable situations which occur during tennis play, players have to adapt constantly resulting in an extremely high level of match-specific pressure on stroke production (influenced by opponent, fatigue, court, optical efficiency, perception, etc.). This leads to the following crucial question: Is it possible for players to control and coordinate movement and stroke techniques while under constant pressure, or is it impossible to perform strokes and movement smoothly? It seems that this differentiates the great athletes from good athletes as the great are able to do this more often then the good athletes. Given that the combined recruitment of speed and coordination skills seem to be determining factors for performance, questions regarding ideal footwork and movement training arise.

DYNAMIC SYSTEMS APPROACH AND ITS ROLE IN TENNIS SPECIFIC COORDINATION TRAINING

The dynamic systems approach arose under the influence of non-linear dynamics, synergetics, the catastrophe theory, theory of complexity and neurophysiology. Since the early 1990's the theory has found great approval in sport science and has been integrated in daily practice. According to the dynamic systems approach, mechanical-technical explanations are outdated, especially in complex, unstable systems such as human beings. In relation to stroke production and movement patterns the key concept is lifelong differential learning and peripheral self-organising patterns instead of drill training and technical models!

The method of differential learning can therefore be used for tennis specific coordination and speed training. According to Schoellhorn (1999), an athlete's ability to extend their range of possible solutions, which is analogous to the occurring differences during biological adaptations, is a determining factor. When utilising this form of training the athlete has the possibility to elect which movement techniques/patterns they will use whether it be consciously and/or unconsciously. By performing possible "errors" in various combinations, the athlete will find their individual optimum movement pattern.

Differential learning (learning from differences) combines the knowledge of possible movement technique adaptations and compares the execution of movements within possible solutions to "errors". This method focuses on learning from differences through the use of varied exercises. Enforcing movement technique adaptations during the skill acquisition and automating phase should cause specific self-organising patterns in the athlete (Schöllhorn, 1999).

An essential characteristic of differential learning is the importance of information that is found in the transition between different movement patterns (e.g. the change between jump, sprint, step versions (Fig.1)).

PRINCIPLES OF DIFFERENTIAL TRAINING FOR TENNIS FOOTWORK

The following principles can be discussed in order to develop a specific training method for footwork in tennis:

1. The combination of new and uncommon exercises may lead to faster adaptations. The learner is forced to react more quickly to varying demands. The main idea of this

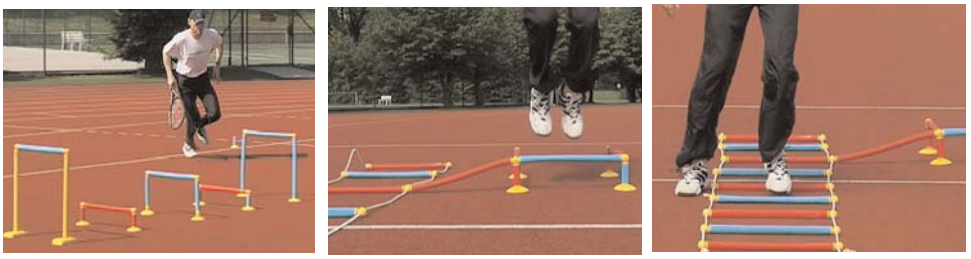

Fig. 1: Jump-sprint-step versions of footwork training

method of coordination training in contrast to drill training is: "repeating without repetition" (Neumaier, 1999; Bernstein, 1988). In "frequency-speed-training", versions of tapping exercises should vary (e.g. standing, seated, supine/prone positions, or tapping combined with extra tasks). Regular repetition of the same exercise may lead to stereotypical motions which can result in the stagnation of performance.

2. Repeat an exercise only until the quality of the movement is solid and stable.
3. In coordination training, various levels of difficulty need to be implemented (according to the performance level of the athlete) to create constant instabilities which are relevant in differential learning. Athletes should neither be overextended nor under challenged in order to guarantee optimal stimulus intensity.
4. Demanding, exercises are necessary not only to challenge athletes, but also to create fun and motivation, to help them to stay alert and consequently, to have a lasting training effect. It is easier for the system "player" to recall positive stimuli and furthermore, learning is more efficient.

CRITICAL LEVELS OF DIFFICULTY IN TENNIS SPECIFIC FOOTWORK TRAINING

How can tennis specific footwork training be modified to reach this critical level of difficulty, where the outcome is movement instability?

Regarding this question Neumaier's work on "Categories/Classes of coordinative demands/tasks" (Neumaier, 1999) is insightful, especially in terms of the dynamic systems approach. Using the categories detailed in figure 2 makes it easier to structure and characterise coordination training and the demands of a task.

The suggested model consists of two parts: information demands and pressure conditions (Roth, 1998).

1. INFORMATION DEMANDS (FEEDBACK DEMANDS)

This part establishes or defines (afferent) information demands that are related to exercise. Demands include the identification of essential and relevant information from different sensory organs. For example dynamic balance in tennis is dependent on the adequate processing of sensory information, kinaesthetic, tactile, vestibular and optical, and is assigned to information demands.

2. PRESSURE CONDITIONS (UNDER WHICH ATHLETES HAVE TO PERFORM)

The second part of this model enables a differential judgement of coordinative difficulty of the task. Furthermore manipulation of these variables results in an increase in the variety of exercises and allows for the critical task difficulty to be maintained.

From a methodological perspective, it is almost impossible to reduce or increase information demands and pressure conditions independently. Therefore when manipulating exercises it is common to vary both information demands and pressure conditions simultaneously.

Precision pressure

This involves increasing the demand on the player's ability to master controlled movements. For example more pressure regarding result precision (target precision) and/or process-precision (precision of execution) (Neumaier, 1999, p. 118). This type of pressure condition might not be linked directly to improving footwork, but is very important in combining footwork abilities with stroke production.

Time pressure

Time pressure, or speed demands, can either be created at the beginning of a movement (reaction speed) and/or during the movement (action speed). For example, different starting signals can be combined with ladder/agility patterns performed under time pressure, through the use of a stop watch.

Complexity pressure

Coordinative demands are increased due to increased task complexity as players have to process a greater number of successive or simultaneous demands. Simultaneous coordination is the increase of task difficulty by using simultaneous performance of an additional movement pattern. For example running through an agility circuit combining tennis specific tasks such as, bouncing a tennis ball with a racquet or simulating tennis strokes.

Combining successive movements and being able to change between different footwork patterns, characterises successive coordination and is another method of complexity pressure. As previously mentioned, much relevant and essential information is discovered by players during the transition between different movements. Possible combinations include various tapping exercises, combined with stepping, sprinting, and jumping tasks on the spot/through an agility ladder and/or jumping cones/hurdles.

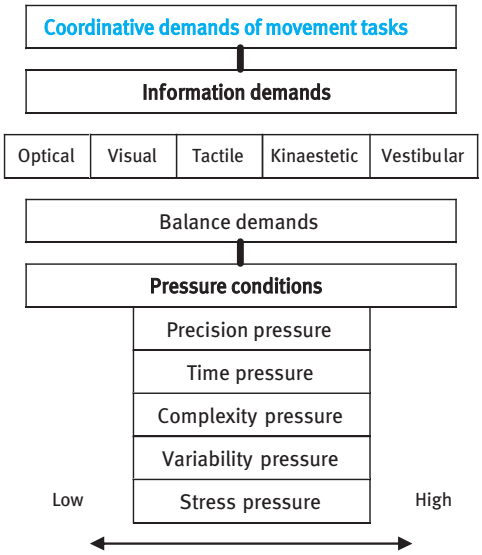

Fig. 2: Classes of coordinative demands: information demands and pressure conditions (Neumaier, 1999, p. 113).

Situation/Variability pressure

When performing movement tasks, the variability of the external conditions (environment) determines the orientation/proprioceptive demands (Roth, 1998). By varying the environmental conditions, anticipation can be either more or less difficult. The demand of a task is influenced by the complexity of a situation, according to the range and number of variable environmental characteristics (opponent, ball, light, wind etc.). These "principles of variation" in terms of general conditions, feedback (perception conditions) and movement, are strongly linked to pressure conditions and therefore have particular importance for footwork training.

Stress

Physical stress

There is a strong correlation between coordination and physical requirements. Therefore, coordination training should be performed, sometimes, when fatigued. It can easily be combined with specific speed endurance training. It should also be remembered that matches are often won by the player who moves better and whose game is more stable when fatigued.

Psychological stress

Coordination exercises should not only be performed under time pressure but also under competition stress (presence of opponent). By performing exercises with an opponent it increases the risk of failure (incorrect movement pattern/technique) or losing and develops competition character. This method is also known as "stress training".

The implementation of differential coordination and speed training in tennis will be covered in a continuation of this article in a future edition in 2007.

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