2 Basics of treatment with the sprinter/skater coordination concept

Britta Dietz

2.1 PNF training with sprinter and skater coordination patterns

Kim Tae-yoon (translation: Britta Dietz)

For the past 20 years, Prof. Dr. Kim Tae-yoon has been teaching at the Universities of Seoul and Gwangju on the question of which training method to use in order to achieve the best possible results in motor learning in the shortest possible time. In 2003, he met Britta Dietz, PNF (Proprioceptive Neuromuscular Facilitation) instructor, who uses three-dimensional scapula and pelvis patterns to create a combination she calls sprinter and skater. These combinations are clearly seen as optimal coordination in sprinting and skating. Key points for the sprinter/skater are the inferior angulus of the scapula and the tuber of the ossis ischii. Prof. Dr. Kim Tae-yoon examines this new PNF approach to treating patients holistically in the sprinter and skater patterns, and presents his research findings here.

2.1.1 Background and objectives

In physiotherapy, exercises are simultaneously regarded as motor learning, and the clinical emphasis is on the instructions for the exercise. Motor skills are practiced, and their implementation becomes the homework program. Patients are advised to change their lifestyle to avoid health problems. Few therapists ask how to make the training method more effective. There are hardly any articles in the specialist literature that deal with improving the learning method. Also, effective exercise instructions or techniques are not available. The articles by Sumway-Cook and Wollacott (1995), Thelen and Smith (1994) and Ketelaar et al. (2001) deal with this problem. PNF is a well-tried concept. Nevertheless, the results and advantages of sprinter/skater coordination in selecting active exercises should be discussed.

2.1.2 Applications and results

The sprinter/skater coordination exercises were practiced with 14 high-school baseball players. The exercise program was performed in three units three times a week over three months, depending on the severity of the exercises. The players were evaluated before and after this time according to “Inbody 3.0” (USA), and tested for muscle growth. In addition, changes in posture and balance were recorded according to Chattagona, USA. As a result, all players showed increased muscle gain, improved balance in the anterior-posterior and left-right levels, and improved posture. The number of injuries was extremely reduced.

In addition, a female patient, 26 years old, suffering from hemiplegia after brain damage from a car accident was treated. The patient was regularly tested in the sprinter and skater, and the results were recorded on video. The quality of the rehabilitation could be shown as well. Today, all patients are recorded by Dr. Kim in his office by video, and treated in the sprinter and skater. The results will be summarized soon.

2.1.3 Overview of the new concept

2.1.3.1 With simple coordinative structures, the sprinter and skater exercise program is an excellent method of learning movement and remembering movement.

Sprinter and skater have their origin in sport. Every sport requires motor skills as a response to changes in the environment and necessary goal orientation. In order to achieve this, humans look for the most effective movements. Within the shortest time, stability is combined with the highest energy supply.

Sprinter and skater patterns use highly efficient and functional movements. These patterns also explain very complicated interactions between extremities, trunk, and head in a simplified coordinative way.

The sprinter/skater exercises are in line with the explanations of Turvey et al. (1982) on muscle chains and coordination in the theory of motor control. They are also extremely simple forms of free movement. They provide answers on how muscles are functionally chained to each other, and they are a simple explanation for complicated processes in motor control. From the point of view of motor learning, sprinter/skater exercises are easy for the learner to recall, since human movements are stored in memory as an abstract form, and not as a single movement (Schmidt 1987).

2.1.3.2 The sprinter/skater patterns provide an answer to how irradiation can be used functionally.

Irradiation is used in PNF for indirect treatments to achieve a muscle response in the patient. However, the responses vary greatly in direction and extent, depending on the therapist. There are different PNF patterns whose muscle activity at a certain level always shows the same picture. Other patterns show different responses, depending on the situation (starting position). The sprinter/skater patterns involve the whole body, and the irradiation response follows predetermined paths.

An example: sprinter/skater, one leg is in the closed chain as a supporting leg. The therapist can use the other extremities to specifically generate irradiation in this supporting leg, i.e. which abductors or adductors or which rotation he aims at.

2.1.3.3 The sprinter/skater patterns provide clear information on the success of the motor learning process. They serve the evaluation by the patient/therapist.

Motor learning is an intrinsic process. The performance is measured by the improvement of the activity, and the change of the movement behavior.

Another result of motor learning is the independent organization of the brain, i.e. it designs a new movement structure and adapts to the environment.

Learning motor skills is the process of designing a movement that is the result of harmonious coordination of all parts of the body in this movement. This movement should be highly efficient.

The sprinter/skater coordination patterns represent a specific movement sequence in different starting positions. If applied adequately to patients, they show the exact quantity and quality of the execution of a movement. This allows us to see the extent of the patient's/athlete's disorder when performing a movement.

In the course of therapy, sprinter and skater help us to control motor learning by changing the sequence of movements.

2.1.3.4 Sprinter/skater coordination patterns allow us to define precise goals, create appropriate tasks according to the level of difficulty, and thereby improve the effectiveness of motor learning.

Locke and Latham (1985) state that the learner is more concentrated and works harder at precisely defined and challenging tasks than at simple and easy tasks. Through precisely defined and challenging tasks, the learner is given a standard against which to measure his or her performance. Different starting positions vary the degree of difficulty of the motor learning process.

The sprinter/skater exercise and gymnastics program developed for this purpose offers the corresponding exercise parts in different starting positions.

It thus makes it possible to address the individual performance level of the patient/sportsperson, offering him or her the corresponding tasks.

Prof. Dr. Kim measures changes in time as well as the extent of movement on the basis of parameters, making them thus visible for patients/athletes. This increases the motivation of the learners, and has a positive influence on the process of motor learning.

2.1.3.5 The sprinter/skater patterns activate weakened muscles using the strong ones, provided that the trunk is always stable. Thus, they meet the required PNF criteria.

Ammons (1956) found that motor activity jumps from one extremity on one side of the body to the other. This also applies to hand and foot activities.

Hellebrandt and Waterland (1962) came to the conclusion that training with large weights increases motor skills on the opposite side, and that many repetitions improve activities.

For therapists, the question is how to activate the weak muscles through the stronger ones. With the sprinter/skater coordination concept, we apply resistance to the healthy/strong parts of the body just as in PNF, while a damaged/weaker part of the body is in the closed chain. This way, we achieve reinforcement for the weak muscles.

The entire trunk is activated by means of sprinter and skater. Thus, the requirement of PNF to include the trunk completely is fulfilled.

Sprinter/skater patterns always consider the head as a possibility to control movement in addition to the extremities.

This ensures that the trunk remains stable, and that the oblique abdominal muscles are activated to secure it.

2.1.3.6 Sprinter and skater can be performed in upright gait. Arms, legs, head, and trunk are exactly in the defined positions. Thus, these two patterns offer the possibility to train the upright gait in its individual phases, or as an overall sequence of movements.

In the gait, different body parts (arms, legs, and head) are coordinated and moved rhythmically in the supporting and working leg phases. Shepherd and Carr (2005) explain that gait exercises that are performed in an isolated way on individual parts of the body are not effective. Sprinter and skater patterns take this aspect into account by integrating arms, legs, and the head into the swing and stance phases of the gait.

These two forms of exercise are used dynamically and rhythmically with resistance in all starting positions. This trains the coordinative movements of the extremities in the sense of the gait pattern.

2.1.3.7 Sprinter and skater are bilateral reciprocal exercises that can be used to correct asymmetric posture errors.

In the sense of motor learning, one-sided movements can lead to asymmetry, with postural errors resulting from them. The reason for this is the great effort of the learner to compensate for his deficits by developing compensation mechanisms that leave the physiological movement patterns. A therapist error is also conceivable in the form of excessive resistance, an unfavorable choice of the starting position, or even execution in the wrong direction of movement.

As bilateral reciprocal forms of exercise, sprinter and skater equally strain the extremities of the right and left sides of the body. This reciprocal training balances asymmetries, thus improving posture.

2.1.3.8 Our own experience

Our own experience shows that sprinter and skater patterns can be equally well taught to therapists and patients/athletes. Both groups are able to implement the instructions within a short time in a target-oriented and adequate manner.

2.1.4 Summary

The results of Dr. Kim's research show that working with resistance in the sprinter/skater has beneficial effects on coordination, symmetry, and motor learning ability.

The new concept considers all basic PNF principles, and incorporates the latest findings from research in the field of motor learning.

The advantage of working with this concept is the therapy/practice in the complete physiological movement pattern, i.e. involving the whole body.

Prof. Dr. Kim Tae-yoon teaches at the University of Iksun, his special field is motor learning, and he is a great fan of my concept. We have given many joint lectures in Korea and Tokyo (2006).

2.2 Background knowledge on Coordinative Locomotion Training (CLT)

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Introduction

Movement is not concerned with a single joint, muscle, or muscle group, but is always the result of the interaction of many body segments. Each segment plays a special role, and is interlocked with each other, as, for example, in a clockwork. This entire system of our body reacts to a single local change in function or structure. If the function of a single segment is changed, the entire system is re-coordinated. In this way, we can influence posture by changing a foot or hand function. A foot is functionally connected to one hand, or a foot is connected to the tongue and diaphragm.

A tongue movement and breathing patterns that can be observed in sports are good examples of how individual parts of the body coordinate with each other. The activation of an orofacial movement – whether it is the movement of the eyes, the tongue, or the jaw muscles – is precisely integrated into the overall movement of the body. Even the diaphragm is not only a respiratory muscle, but plays a special role in the stabilization of a movement (Kolar 2012). Suppose you are lifting a heavy weight: you cannot lift it without holding your breath. At this time, the diaphragm assumes the role of an erecting function. We can say that the diaphragm is part of the lifting function, and is important for this task.

When we analyze movement as therapists, we look at certain movement patterns, and see that all bodily functions are coordinated like a clockwork. If a small cog is defective, the entire system is affected. Therefore, if someone has a single functional problem, this should be seen holistically. Therapists often jump at certain muscles, forgetting to look at the entire musculoskeletal system.

Aristotle already said: "To see the whole is better than the sum of all parts"; our body is not simply composed of many muscles. Human movement is very coordinative and can reorganize itself. The motion system always tries to find the best possible task in coordination, from many variations. If you want to change or improve movement, you have to consider this mechanism.

We think that we need to recognize more pieces of the coordinated movement to explain the concept of CLT (Coordinative locomotion training). In this article, we would like to give the reader more general information about the coordinative structures in the field of motor control and motor learning. We will discover the concept of degrees of freedom, coordinative structures, and phases of learning.

Single movements vs. complex movements

In most cases, studies of human movement in the clinical field are broken down into individual movements. For example, in individual extremities, their strength, mobility, endurance, and coordination are tested. This idea is based on the fact that each quality mentioned above can be examined individually and corrected in an isolated manner. Although patients can certainly benefit from this, it is not certain whether the individual movement can be integrated into the entire movement sequence of the body, and transferred into a function.

Control over Degrees of Freedom (DoF)

It is estimated that we must control 7 DoFs to move our arm. DoF was often used by Nicoli Bernstein (1967) to analyze movement. Bernstein sees learning motor skills as a solution to a problem, namely how to make use of the many DoFs in the human motion system (⦿ Fig. 2.1).

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Fig. 2.1 Degrees of freedom of movements (DoFs)

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Movement can be described specifically in relation to the number of moving joints, muscles, or activated motoneurons. Back to the example above: 7 DoFs are needed to move the arm, 3 DoFs at the shoulder, one at the elbow and radioulnar joint, and 2 at the wrist. If we go further and consider the muscles, we control 26 DoFs, 10 muscles at the shoulder joint, 6 at the elbow, 4 at the radioulnar joint, and 6 at the wrist. If the motor units were added, the number would increase considerably (Rose and Christina 2006).

For other movements, such as hip extension, even more muscles are responsible, which enormously increases the number of DoFs, and entails a very large number of possibilities. It is impossible to analyze and compare each of the possibilities, it would take too long, and overload and fatigue the brain.

Therefore, there must be a mechanism in motor control that selects an effective movement. According to Bernstein, the essential feature of motor control is the automatic elimination of insignificant movements or DoFs. The moving body tries to limit the DoFs to keep the movement under control (Bosch 2015).

We need the smallest unit of DoFs to perform a task efficiently. Theorists see the activation of individual muscles as useless, as these are all closely linked to each other, and stress that the activation of individual nerves does not always trigger a movement (Turvey 1977).

Coordinative structures/muscle response as synergies

Based on these theories, we can solve the problem with DoFs by forcing muscles and joints to function in an intended motion (Rose and Christian 2006). These movement patterns are often called coordinative structures or synergies. Some coordinative structures are already present at birth, such as grasping and general locomotion. Most synergies are also developed over the course of life, also culturally (Turvey 1977), such as inline skating or skiing, and many other sports.

These synergies, especially the locomotion, are inherited in the human movement system. However, these synergies are sometimes severely limited to the purpose of facilitating a particular motor movement. The size of the movement’s amplitude determines the number of muscle responses within the synergy. Movements that are activated in a joint affect other limbs, because all limb segments are interconnected. A forward movement in the hip affects analogous movements in the knee and ankle.

In child development, babies go through a series of fundamental patterns that form the basis for more complex movement (Frank et al. 2013). For example, if a child lies on the floor or sits in different starting positions, it learns to stabilize its head to observe its surroundings (⦿ Fig. 2.2). Its head stability is important for postural control in standing and walking. While reaching for interesting objects, it learns arm/trunk coordination patterns, which it also needs to crawl and walk, and possibly throw things and climb later. When turning from supine to lateral position, the baby stabilizes over one leg, while the other is moved freely; a skill that is the basis for locomotion.

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Fig. 2.2 Baby turns around

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Coordinative structures are muscle chains that have evolved historically (or neurologically) and anatomically to work together as a functional unit (Frank et al. 2013).

It is easier for our nervous system to resort to a small number of general movement patterns that can be put together to form more complex movements. The muscle synergies involved in activating these patterns limit the DoFs and movement possibilities in such a way that movement is easier to organize.

Phases that control the DoFs in motor learning

A new view of the learning process refers to Bernstein (1967), where he describes that the learning process takes place by learning to control superfluous DoFs.

Vereijken (1992) proposes a three-part model of learning. This describes how the learner tries to approach the dynamics of movement as problem solving, in the sense of Bernstein (⊙ Fig. 2.3). In the initial stage, the patient simplifies the movement problem by freezing all possible DoFs. First, he lets the patient fix the joint position for a desired movement, and many other joints as well, almost like a synergy.

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Fig. 2.3 The relationships between the DoFs and the maturation of motor skills

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