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Speed

Lecture - 179
Speed: Concept, Classification, Factors and Methods.

Introduction

Speed like strength and endurance, is a conditional ability. It has a complex nature and to a large extent depends on the efficiency of the nervous system and hence it is less trainable as compared to the other conditional abilities.

G. Theiss and G. Schnabel (1987) gave the definition that "It is the performance prerequisite to do motor actions under given conditions (movement task, external factors, individual pre-requisites) in minimum of time". Speed performances usually cannot be improved through training by more than 20% eg. 100 M. Sprint performance (letzelter, 1979). Speed depends much upon factors which are genetically determined. Hence, the statement, "Sprinters are born and not made". Almost all the sports require fast and explosive movement, therefore, the importance of speed cannot be under-estimated. But in different sports, different speed abilities under different conditions are at premium. A wrestler needs primarily reaction and movement speed abilities, a 400 meters runner needs speed endurance, a thrower needs movement speed and 100m. sprinter needs nearly all types of speed abilities. As a result, in different sports, different speed abilities should be improved.

Concept

Speed is used in sports for such muscle reactions (motor movements) that are characterized by maximally quick alteration of contraction and relaxation of muscles. It is also the ability to execute motor actions, under given conditions, in minimum possible time.

In other words the capacity of moving a limb or a part of body`s lever system or whole body with the greatest possible velocity. Speed ability is highly movement specific. Like strength and endurance, speed is also a conditional ability (strength and endurance) speed depends to a considerable extent on the nervous system. As a result of this speed is more complex in nature and is comparatively less trainable as compared to strength and endurance.

Classification of speed

Speed can be classified into following five types:

1 .Reaction speed

It is the ability, to respond to a stimulus in the shortest possible time. In sports, signals can be of different types e.g., visual, tactile, acoustic. Depending on the degree of complexity of the reaction required the reaction ability can be further differentiated into simple and complex reaction ability. The reaction speed is of two types-simple reaction speed and complex reaction speed.

Simple reaction speed: It is the ability to react quickly in a predetermined manner to a known signal. Here the signal and response both are known to the sportsman. Such reaction are common in track & field, swimming, cycling, etc. The sportsman knows, in case of sprint, that he must run all out on hearing the pistol shot. It is interesting to note that females are poorer in reaction speed as compared to men and that the reaction time increase with the increase of distance. The world class sprinters normally have a reaction time of about 0.12 sec. It has been provided by experiments that a reaction time less than 0.10 secs is not possible. A sprinter giving a reaction time of less than 0.10 seconds obviously has anticipated the gun, i.e. has taken foul start. Reaction time is remarkably stable in case of good sprinters, i.e. a sprinter, most of the time, is able to achieve the same reaction time or very near to that. It is also interesting to note that the reaction time of different body parts is different. The reaction time achieved by right leg can be different from that of left leg. This fact brings into sharp focus the fact that reaction ability is highly specific. As a rule, more distal the body part is, more faster it can react. Reaction of arms is faster than legs.

Complex reaction speed: It is the ability to react quickly and correctly to unexpected signals. The signals are unexpected as the sportsman does not know when and to which signal he has to react. This is further complicated by the fact that most of the time, the sportsman has to select a response, out of many, to react quickly and correctly. The complex reaction speed is of high importance in combative sports and ball games. The complex reaction speed depends to some extent on simple reaction speed.

2. Speed of movement

It is the ability to execute a movement with high speed and can be measured by the time taken to complete the movement. The movement speed depends upon technique, explosive, strength, flexibility and coordinative abilities. The

movement speed is important in a cyclic sports such as wrestling, boxing, jumps, throws, gymnastics and ball games. The performance in these sports depends on the movement speed, i.e., how fast the sportsman can throw, lift, jump, dodge, shoot etc. In cyclic sports it is important in the initial phase or in some phases during the total period of cyclic activity e.g., turns in swimming and hurdle clearance in hurdle event. In cyclic sports movement speed is very closely bound with technique and tactical action. Depending on the nature of the movement the ability of the movement speed depends on a different complex of factors in different sports. But it generally depends heavily on explosive strength and technique.

In combative sports, gymnastics and ball games, movement speed and agility are very intimately inter-related and cannot be separated from each other. The speed with which a closely guarded football forward can shoot into the goal, depends much upon his anticipation, orientation ability, coupling ability, experience, skill and tactical efficiency, as well as on his speed of movement.

3. Sprinting speed (locomotor abilitiy)

It can be defined as the ability to maintain maximum speed of locomotion over as long distance as possible for maximum possible duration. Locomotor ability is important in only a few sports or events e.g., 100m and 200m in track and field, short sprints in track cycling and speed skating. In swimming, rowing etc. Locomotor ability depends to a great extent on mobility of the nervous system which allows for high movement frequency. It further depends on technique ability to relax and explosive strength. The trainability of locomotor ability is very low.

4. Acceleration speed

It is the ability to increase speed from jogging to running and finally sprinting. Acceleration ability depends to a great extent on explosive strength, technique and movement frequency. Performances in sprint events are determined to a great extent by acceleration ability. Acceleration ability is also of crucial importance in all team games and racket sports where high running speeds are to be achieved over short distances.

5. Speed endurance

It is the ability to execute cyclic or acyclic movements at high speed under conditions of fatigue. In cyclic sports the speed endurance is required to continue movements with high speed in spite of the rapid accumulation of fatigue during the activitiy. In noncyclic sports the speed endurance is required to do movements again and again with maximum possible speed under considerably anaerobic capacity, technique and psychic factors.

Factors determining speed

Speed as an important conditional ability has wider application in all games and sports (both cyclic and acyclic). The following factors determine speed:

1. Explosive Strength

For every fast and explosive movement, explosive strength is indispensable. In boxing, a fast punch cannot be delivered if the boxer lacks explosive strength. Explosive strength is a more strong contributor to movement speed and acceleration ability. The importance of explosive strength for speed can be estimated from the fact that the sprinters have since long seen trying to improve their speed, and with success, by improving the explosive strength of the legs.

2. Mobility of the nervous system

During all speed performances the muscle have to contract and relaxed at maximal possible speed e.g., in sprints.The rapid contraction and relaxation muscle is possible when the motor centers in the central nervous system undergo rapid excitation and inhibition. This action is called "mobility of the nervous system ". When this rapid excitation and inhibition of motor centres takes place at maximal speed and for some seconds then the excitation process tends to spread to the neighbouring motor centres (irradiation) causing unnecessary tension in the body and thereby resulting in deterioration in speed performance. The mobility of the nervous system is trainable to a limited extent. It seems to be determined to a great extent by genetic factors.

When muscles contract and relax repeatedly in a definite sequence then the nervous system tends to adapt to this thereby resulting in 'speed barrier'. A strong limiting factor for the improvement of speed performances is the nervous system. In cyclic movements, the rapid contraction and relaxation of the muscles is made possible by rapid excitation and inhibition of the concerned motor centres. The nervous system can maintain this rapid excitation and inhibition only for a few seconds after which the excitation spreads to the neighbouring centres causing tension in the entire body or in the neighbouring regions. This results in decrease or movement amplitude and frequency resulting in decrease in speed. This is a defensive mechanism of the body and comes into operation at a certain movement frequency after a certain period. The threshold level and duration of tolerance can be improved through training but only to a very limited extent. Till now, no method has been discovered to increase the mobility of the nervous system is a very strong limiting factor for locomotor ability and sprint endurance.

3. Muscular Strength

Speed movements to a great extent depend upon explosive strength of the involved muscles. In fact development of strength indirectly enhances speed. Because of the importance of explosive strength and its high trainability most of the times speed performances are improved by improving explosive strength.

Explosive strength further depends on muscle composition, muscle size and muscles co-ordination (inter and intra-muscular co-ordination). It also depends on metabolic processes. Except muscle composition all other factors can be improved through training.

The relative proportion of fast twitch and slow twitch fibres determines to a great extent the maximum possible speed with which a muscle can contract. But this is not trainable as it is genetically determined. Good sprinters have a very high proportion of fast twitch fibres whereas endurance athletes have a very high proportion of slow twitch fibres. According to Hartmann and Tunnemann (1986) printers have fast twitch fibres up to 90% in soleus muscle whereas long distance men have slow twitch fibres up to 90% in the same muscle. The muscle composition, however, is characterized by high inter muscular and individual differences. Some persons by heredity, are more talented for speed performances. It must not be overlooked that muscle composition is the only one factor determining speed performance. This factor can be compensated, as has been demonstrated by many world level sprinters, by adequate improvement of other factors.

4. Technique

Technique is an important factors determining speed performance good technique enables the sportsman to fully utilize his strength, flexibility etc. to achieved high speed. The movements which are unlearnt, can only be executed with slower speed. Technique aims at minimizing the external negative forces and at full utilization of the internal positive forces. The movement speed in gymnastics , combat sports etc. is highly dependent on technique or skill. Like explosive strength technique is also very common aim of training for improving speed performance.

5. Bio-chemical reserves and metabolic power

Phosphogen stores in the muscle should be enough to give high amount of energy need for maximal speed performance. Moreover the metabolic process of energy production must take place at a very high pace. Speed performances depend upon the quick release of energy derived from ATP (adenosine tri-phosphate) and CP (creatine phosphate). If ATP and CP store is less in contracting muscles, the muscle contractions due to insufficient energy supply, become slow after a short time. In addition to the ATP and CP stores in the muscle, the velocity with which these substances can be split to supply energy is equally important. A high rate of energy supply depends on certain enzymes which accelerate the metabolic process. Fortunately, the total amount of ATP, CP and the rate of energy supply (power) can be positively affected by training (Fox 1979, Mathews & Fox 1981). The bio-chemical reserves and metabolic power is clearly an important determining factor for acceleration ability, locomotor ability and speed endurance.

6. Flexibility

Good flexibility allows maximum range of movement of joints without internal resistance, thereby positively affecting speed. Flexibility also enables full utilization of explosive strength. Low flexibility leads to excessive internal resistance, muscle tension and less than optimum strength application.

7. Psychic factors

The following important psychic factors are essential for speed performance. They are motivation, attention and concentration, ability to relax and ability to mobilize one self for a short duration. Apart from these factors the anticipation ability is of high importance for quick reaction. The ability to relax the non contracting body parts and muscles has been found to be of high importance for speed performances especially acceleration, locomotor and speed endurance abilities. But unfortunately this ability seems to depend much on the central nervous system and as a consequence it cannot be significantly improved.

In addition to the above mentioned factors, the muscle temperature, stretchability, elasticity and relaxation ability of the muscles are also important. These factors and some of the above mentioned factors can be positively affected by proper warm up. This is one reason that a thorough but optimum warm up before speed performance is very important.

Methods of developing speed abilities

1. Development of reaction speed:

It is the ability, to respond to a stimulus in the shortest possible time and effectively to different types of stimuli i.e., visual, auditory and tactile. The response to a tactile stimulus is the fastest and to visual stimulus is the slowest. Games and sports can be categorized as requiring simple reaction ability and complex reaction ability.

Nature of exercise:
1. Learn more number of tactics
2. Stereotype must be achieved
3. Shooting, hitting or throwing on uneven surface and to try to collect the ball.
4. Play small area games after all training sessions.
5. Learn to react correctly.

The improvement of simple reaction ability is mostly aimed at reducing the reaction time. A lot of work and time is needed to reduce the reaction time by a few hundredths of a second. For the beginners, games like basketball, volleyball, handball, etc. are very good for improving their reaction ability. But with the passage of time, these means become inadequate for this purpose.

In ball games and combative sports, most of the time the movement of opponent or ball is so fast, that it is humanly impossible to effectively react to these, if the response is started after the end of the movement of the opponent. Therefore, it is of utmost importance to anticipate the intended movement of the opponent in the initial phase of the movement and to react accordingly. For improving the anticipation of a sportsman, the following three points are indispensable are knowledge of movement structure, competition pattern of the opponent and experience.

2. Development of Speed of movement

It is the ability to execute a movement with high speed. The speed of movement is important both for cyclic and acyclic sports. Good technique, explosive strength, flexibility and coordinative abilities are important pre-requisites for movement speed and hence can be indirectly developed by improving these four factors.

Nature of exercise:

1. By repeating the "movements" many times with highest possible speed.
2. Intensity must be sub maximum.
3. Volume must be optimum.
4. Density must be sufficient.

The speed of movement can be improved directly in the following manner:

1. By repeating the movement many times, with highest possible speed. It is better if the movement is timed with a stop-watch and the sportsman is informed about it. Feedback is very important for the improvement of movement speed as it motivates the sportsman to do his best. Such a procedure is possible in boxing, wrestling, gymnastics, but is usually not possible in throws and ball games.
2. By practicing the movement under easier conditions: this can be done by reducing the resistance, e.g., in throws; by giving external assistance, e.g., volleyball, basketball; by changing the ground conditions or surface, e.g., astro-turf in hockey, smooth surface in throws and by using gravitational force. The condition should not be made too easy, otherwise the coordination is affected negatively. It is advisable to practice a few times under normal conditions after practicing under easier conditions.
3. By giving a slightly faster rhythm: Each movement has its own rhythm. Each human being tends to stick to the rhythm. Therefore, if during practice, by clapping, by music, drum, etc. a slightly faster rhythm is given, the sportsman is automatically forced to do the movement faster. But the rhythm should not be too fast and should be carefully given during the movement execution. The movement speed training requires a high amount of concentration, therefore, frequent pauses, consisting of light and interesting exercises, are necessary.

3. Development of Acceleration speed

Acceleration speed can be increased by both direct or indirect methods. For improving acceleration ability indirectly, explosive strength, technique and flexibility are important pre-requisites.

For improving acceleration speed directly, short sprints over a distance of 30 to 80 meters are the best. Henry (1952) found that a sprinter , when starts from a stationary position, achieves best speed in about 6 seconds. Therefore, the distance chosen should be run in about 4 to 6 seconds. However, actual distance

may differ from activity to activity and also on the nature of sport. Number of repetition are between 5 to 8. Between repetition full recovery is to be ensured to facilitate performance of each bout of load at maximum intensity.

The speed training should be stopped when fatigue sets in because then speed cannot be improved. The improvement of acceleration ability can be made specific (in case of basketball, hockey, football, etc.) if the sportsman does the repetitions with the specific equipment, e.g., with football, hockey and ball etc. the acceleration ability should be improved under specific sports conditions after it has been improved by general means.

4. Development of Sprinting speed

It is the ability to achieve high speed from a state of low or stationary position in the short time. The intensity of 99% to 100% can be maintained only over a distance of 20-25 meters. However, this distance varies depending upon the training state and age of the sportsperson. In the case of a beginner or a less conditioned sportsperson this distance is less. Indirect development of locomotor speed can be achieved by improving the efficiency of the central nervous system even though it is less trainable. Explosive strength, technique and flexibility, which are trainable factors, also improve sprinting speed indirectly.

1. Henry proved that the sprinters usually achieve their maximum speed approximately after 6 sec.
2. Intensity is sub maximum or maximum.
3. Duration must be optimum.
4. Repetition 10 to 12 generally.
5. Density is complete between repetitions. (4-10 min)
6. Rest is given between sets. (Active)

In case of track & field, it is a common practice to improve acceleration ability and locomotor ability at the same time. Acceleration runs, hollow sprints, wind sprints, etc., are the common forms in which acceleration and locomotor ability are improved simultaneously. One must note that while training for locomotor ability, the acceleration ability is automatically trained. But when special stress is to be held on these abilities, then it is advisable to improve these abilities separately.

5. Development of speed endurance

It is the ability to execute cyclic or acyclic movements at high speed under conditions of fatique. Speed endurance is a special speed quality and can be developed using both indirect and direct training means. Indirect development can be ensured by improving anaerobic capacity, technique and explosive strength. Optimal development of basic endurance is an important pre-requisite for improving speed endurance.

Nature of exercises:

1. Running or cycling or swimming over slightly (10-20%) than competition distance.
2. Running at high speed.
3. Intensive interval methods can be used in all sports. (hockey, football, basketball, combative sports)
4. Load components are to be adjusted accordingly to the special demands.
For e.g., In ball games, high intensity with complete rest.

The speed endurance training is highly strenuous. Therefore, the volume in a training session and weekly cycle should be just optimum. In a micro-cycle, there should not be more than 1-2 training sessions aiming at the improvement of speed endurance.

Conclusion

Speed, like strength and endurance is a conditional ability. It has a complex nature as it depends to a considerable extent on the central nervous system. Speed is used in sports for such muscle reactions (motor movements) that are characterized by maximally quick alternation of contraction and relaxation of muscles. Speed movements to a great extent depend upon explosive strength of the involved muscles. In fact development of strength indirectly enhances speed.

Good technique, explosive strength, flexibility and coordinative abilities are important pre-requisites for movement speed and hence can be indirectly developed by improving these four factors. Psychic factors are also responsible for affecting performances in speed activities.