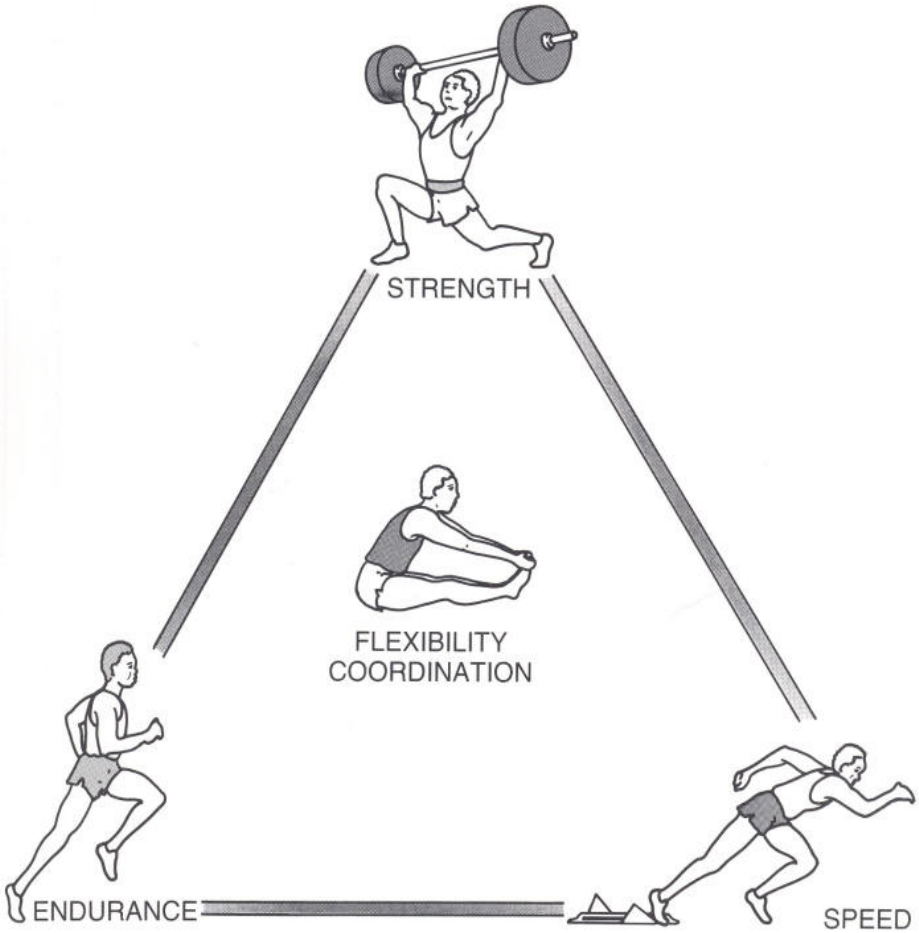
FROM: IAAF "Introduction to Coaching Theory"

Biomotor Abilities

Fitness has been defined as how well a person is adapted to and capable of living a certain lifestyle. The athlete obviously has greater fitness than the non-athlete because of his training for a chosen event or events. But what is fitness made up from? The law of specificity states that there is a specific response to the specific nature of a training load. This specific response will tend to emphasise one or more of the abilities that make up fitness. These abilities are basic and respond well to training. Since these abilities affect how the body moves they are given the name "biomotor abilities".

The Components of Fitness

There are five basic biomotor abilities and these are strength, endurance, speed, flexibility and coordination.

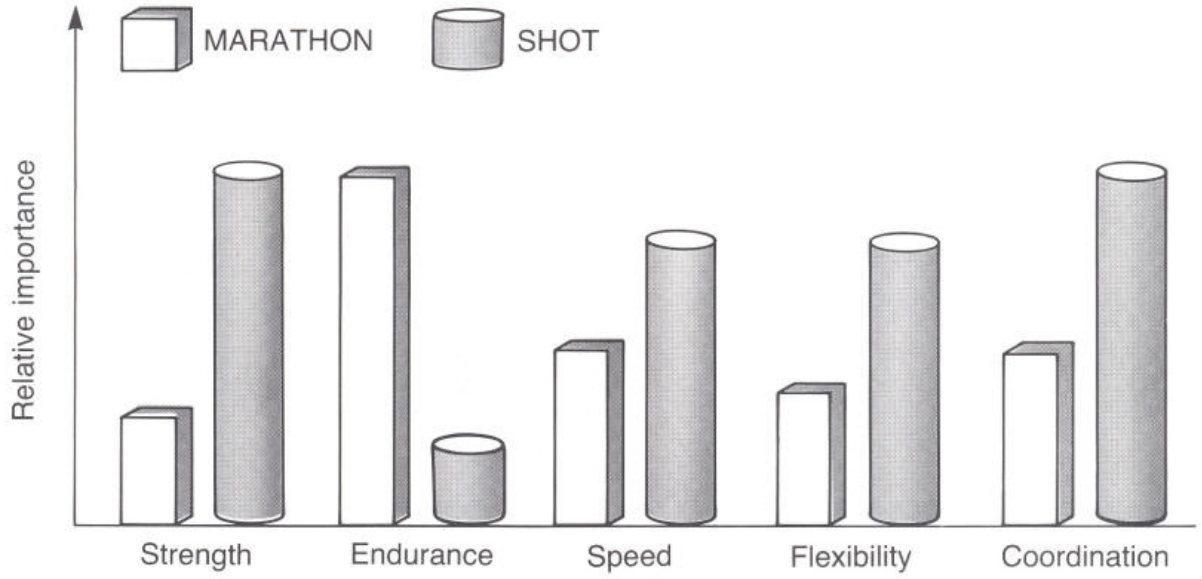


Relationship of the biomotor abilities

Each exercise in training will tend to develop a particular biomotor ability. For example, when the load of an exercise is maximal it is a strength exercise. Quickness and frequency of movement would give a speed exercise. If distance or duration is maximal the exercise becomes endurance based.

Exercises that have relatively complex movements are called coordination exercises. This is a simplified view and in practice exercises usually develop two or more biomotor abilities.:

Different events have different demands on fitness. The fitness of the marathon runner is obviously very different to the fitness of the shot putter. The table illustrates the relative needs for strength, endurance, speed, flexibility and coordination in these events.



Profile of biomotor abilities for marathon and shot

To develop the specific fitness required for an event it is necessary for the coach to understand the characteristics of the five biomotor abilities and how to develop them.

Strength

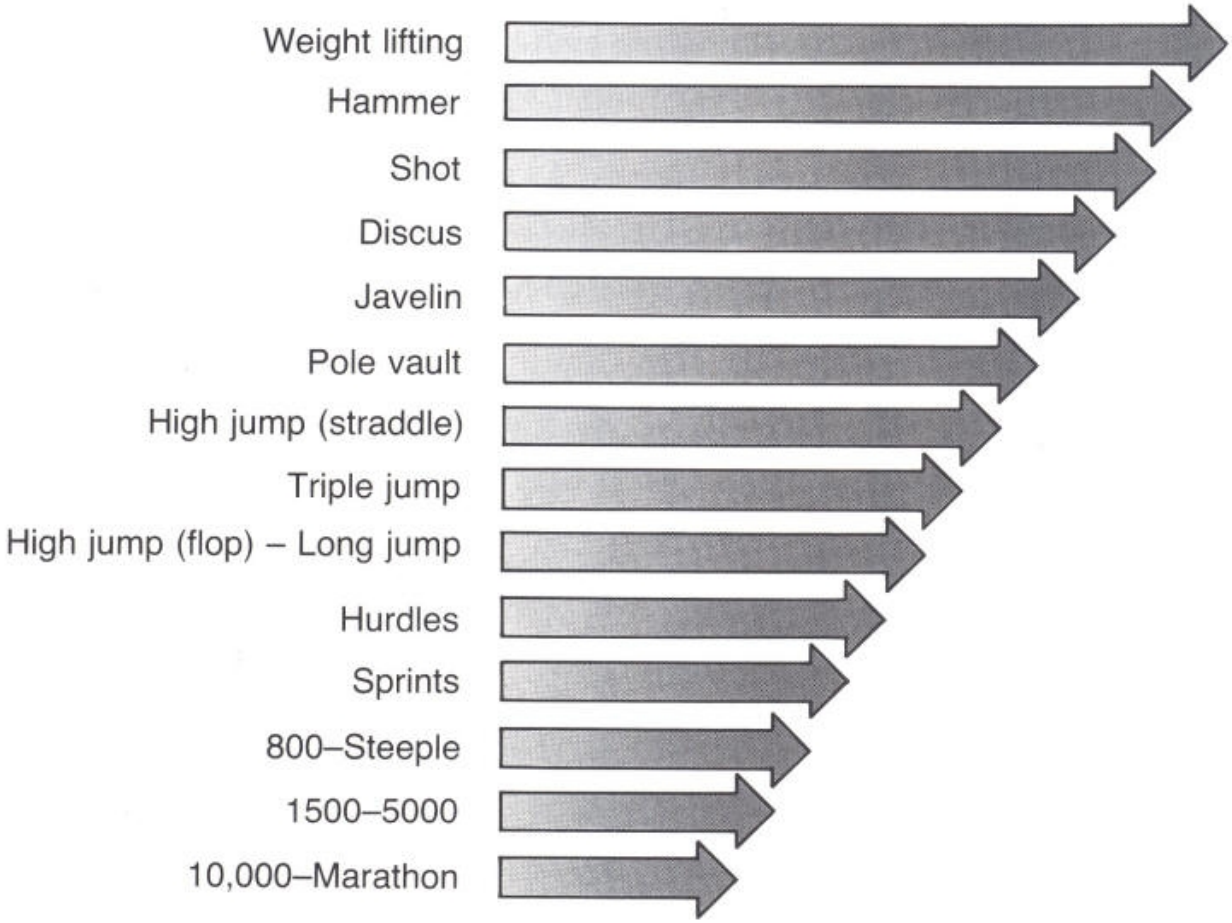
Muscular strength is the ability of the body to exert force. Strength is important to every event for both men and women. Muscle fibres within the muscles respond when subjected to weight or resistance training. This response makes the muscle more efficient and able to respond better to the central nervous system.

Strength may be broken down into three types:

- **Maximum strength**
- **Elastic strength**
- **Strength endurance**

Maximum Strength

This is the greatest force that a contracting muscle can produce. Maximum strength does not determine how fast a movement is made or how long the movement can be continued. It is important in events where a large resistance needs to be overcome or controlled.



Representation of maximum strength contribution to various athletic events

Elastic Strength

Elastic strength is the type of strength required so that a muscle can move quickly against a resistance. This combination of speed of contraction and speed of movement is sometimes referred to as "power". This special type of strength is of great importance to the "explosive" events in running, jumping and throwing.

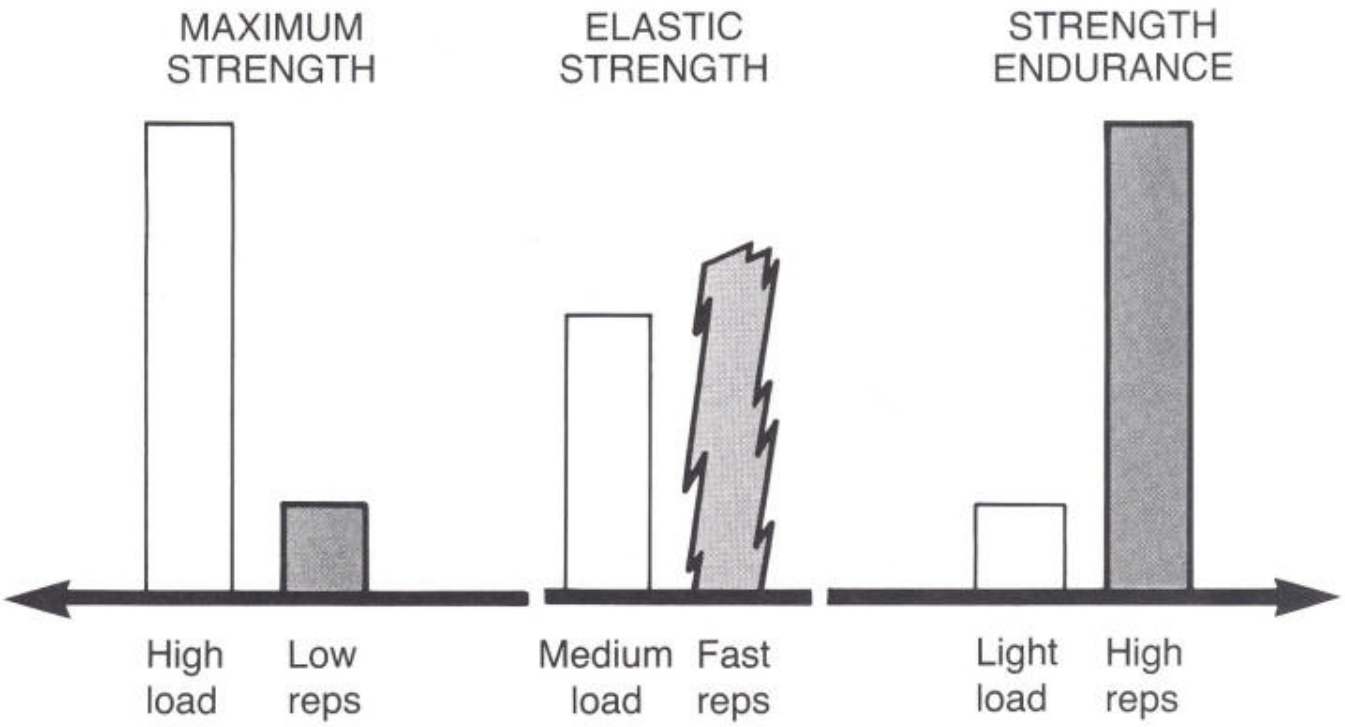
Strength Endurance

This is the ability of the muscles to continue to exert force in the face of increasing fatigue. Strength endurance is simply the combination of strength and duration of movement. Performing an exercise, such as sit-ups, to exhaustion would be a test of strength endurance. This strength characteristic determines an athlete's performance where a movement is repeated over a fairly long period of time. Runs between 60 seconds and 8 minutes, for example, require a lot of strength endurance.

Development of Strength

Weight training and resistance training will both develop strength. If there is an increase in muscle mass as a result of training this is called hypertrophy. Muscle hypertrophy is associated more as a result of training for maximal and elastic strength rather than strength endurance. When strength training stops the law of reversibility indicates that some strength will be lost and the muscle mass may reduce. Reduction in the muscle mass is known as atrophy. Muscle atrophy is a direct result of low, or no, activity and may be a factor in injury rehabilitation.

Maximum strength is best developed by exercises which involve a low number of repetitions and a large resistance or loading. Elastic strength is developed through fast repetitions using a medium loading and strength endurance is developed using a high number of repetitions with a low resistance. We will see in this course how these methods can be combined into an overall strength programme and how the combinations vary for different events.



Development of strength

In strength training the following terms are used:

- **Resistance** The load a muscle or group of muscles is required to move.
- **Repetitions** The number of times an exercise is performed without stopping (Reps).
- **Sets** A specified number of repetitions comprises one set. Three sets of ten reps would be written: 3 x 10 x resistance.

Young athletes should avoid weight training. Instead they should use resistance exercises with bodyweight, circuit training and medicine ball exercises.

Endurance

Endurance refers to the ability to perform work of a given intensity over a time period, and is sometimes called stamina. The main factor which limits and at the same time affects performance is fatigue. An athlete is considered to have good endurance when he does not easily fatigue, or can continue to perform in a state of fatigue. Endurance, of all the biomotor abilities, should be developed first. Without endurance it is difficult to repeat other types of training enough to develop the other components of fitness.

There are two basic types of endurance:

- **Aerobic endurance**
- **Anaerobic endurance**

Aerobic Endurance

Aerobic means "with oxygen" and aerobic endurance means muscular work and movement done using oxygen to release energy from the muscle fuels. We have seen how the absorption and transport of the oxygen to the muscles is carried out by the cardio-respiratory system. Aerobic training leads to both a strong cardio-respiratory system and an increased ability to use oxygen in the muscles. Aerobic endurance can be developed by continuous or interval running. The longer the duration of an event the more important is aerobic endurance. Aerobic endurance should be developed before anaerobic endurance.

Anaerobic Endurance

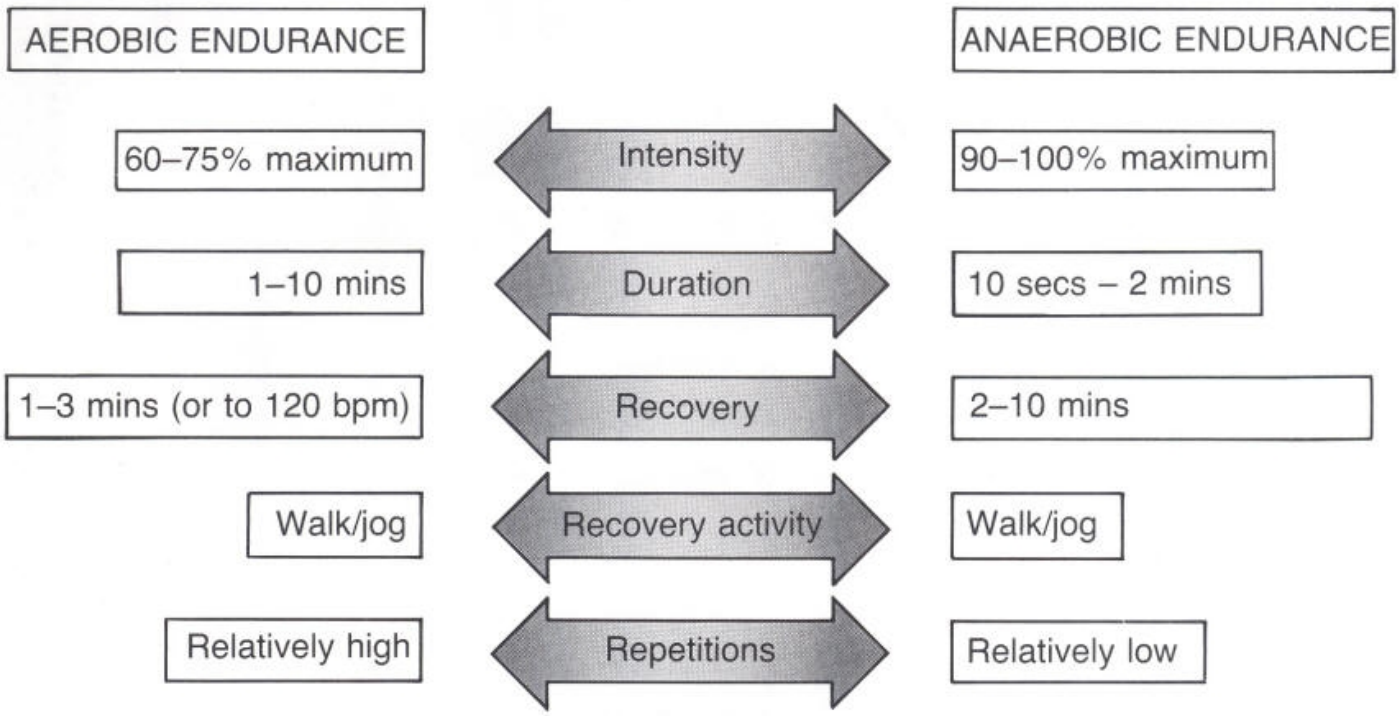
Anaerobic means "without oxygen" and anaerobic endurance refers to the energy systems which allows muscles to operate using energy they already have in store. Anaerobic training allows the athlete to tolerate the build up of lactic acid. There are two important types of anaerobic endurance, speed endurance and strength endurance. Developing speed endurance helps an athlete to run at speed despite the build up of lactic acid. Strength endurance, which has already been discussed, allows the athlete to continue to express force despite the lactic acid build up.

Development of Endurance

Both aerobic and anaerobic endurance can be developed using interval type training.

The variables in interval training are:

Intensity Speed or velocity of the repetitions. This may be expressed as a percentage of maximal speed or effort.
Duration Length of time or distance of one repetition.
Recovery Time of intervals between repetitions and sets.
Recovery activity Normally a low intensity movement such as a walk or jog.
Repetitions The total number of repetitions in a session. These may be divided into sets.



Comparison of interval training for aerobic and anaerobic endurance

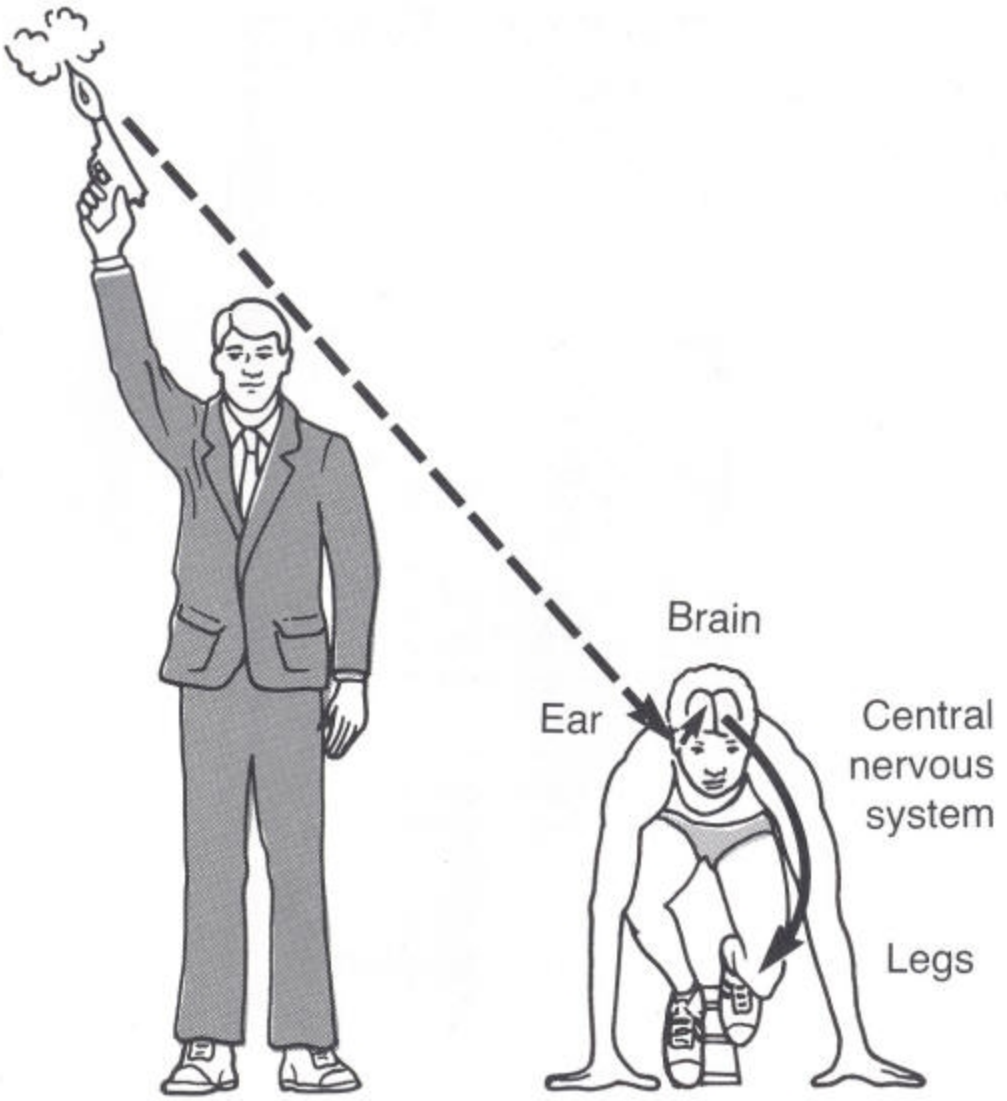
Speed

Speed is the capacity to travel or move very quickly. Like all biomotor abilities speed can be broken down into different types. It may mean the whole body moving at maximal running speed, as in the sprinter. It may involve optimal speed, such as the controlled speed in the approach run of the jumping events. Or, it may include the speed of a limb, such as the throwing arm in the shot or discus, or the take-off leg in the jumps.

Development of Speed

Speed training involves development of a skill so that the technique is performed at a faster rate. To develop speed the skill must be practiced on a regular basis at a maximum or close to maximum rate of movement. Maximal running speed, for example, is developed by runs over short distances at maximum effort. The skill of moving at speed should, like all skills, be practiced before the athlete becomes fatigued. For this reason recovery times between repetitions and sets should be long enough to recover from any fatigue.

When considering speed it is important to include reaction time. Reaction time is the time between a stimulus and the first movement by the athlete, such as the firing of the starter's pistol and the athlete's movement from the blocks. There are many factors both physiological and psychological which influence reaction time and the initiation of movement. Reaction time can be improved with practice, provided the practice situation is realistic.



Reaction time of the athlete in the sprint start

Flexibility

Flexibility is the ability to perform joint actions through a wide range of motion. The natural range of motion of each joint in the body depends on the arrangement of tendons,
ligaments, connective tissue and muscles. The limit to a joint's range of motion is called the "end position". Injuries can occur when a limb or muscle is forced beyond its normal limits. Flexibility training can help reduce the risk of injury by gradually increasing a joint's range of motion.

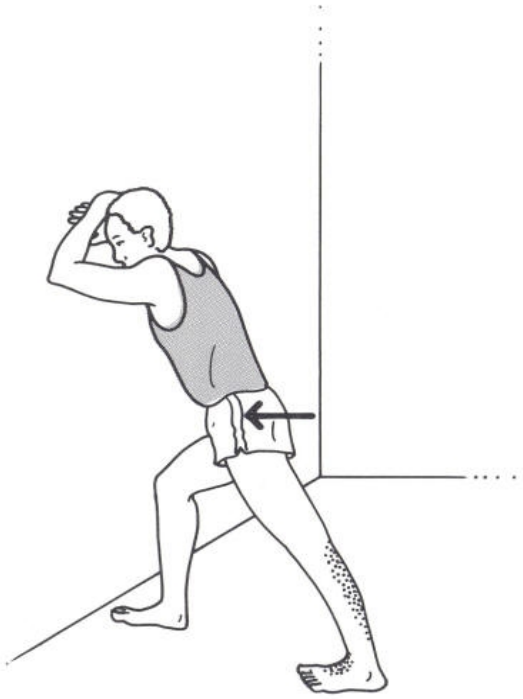
Restricted flexibility is one of the most common causes of poor technique and performance. Poor flexibility also hinders speed and endurance since the muscles have to work harder to overcome the resistance to an efficient stride length. Flexibility tends to decrease as we get older, while females are usually more flexible at all ages. The ideal is to start young athletes on regular stretching programmes to prevent the loss of flexibility that comes with age.

Development of Flexibility

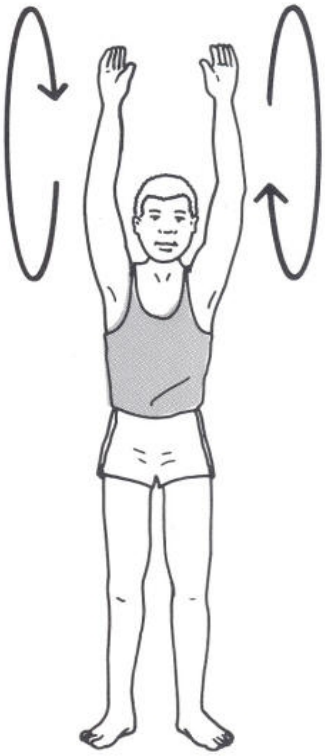
Improving flexibility, like the development of other fitness abilities, is a slow process. To increase the range of motion of a joint the muscles have to be stretched beyond their normal point of resistance. This should be done daily with appropriate flexibility exercises. There are two main types of stretching exercise:

- **Active stretching**
- **Passive stretching**

In active stretching the athlete controls the movement. These exercises are either done in the end position, a static exercise; or by moving through the full range of motion, a dynamic exercise.



An active static exercise



An active dynamic exercise

In passive stretching the exercises are only performed in the end position, the static type of exercise. A partner controls the movement and great care is required. The athlete actively goes to the end position and the partner progressively applies pressure. At this point the athlete should concentrate on relaxing the muscles being stretched. Passive static stretching exercises can produce good improvements in range of motion.

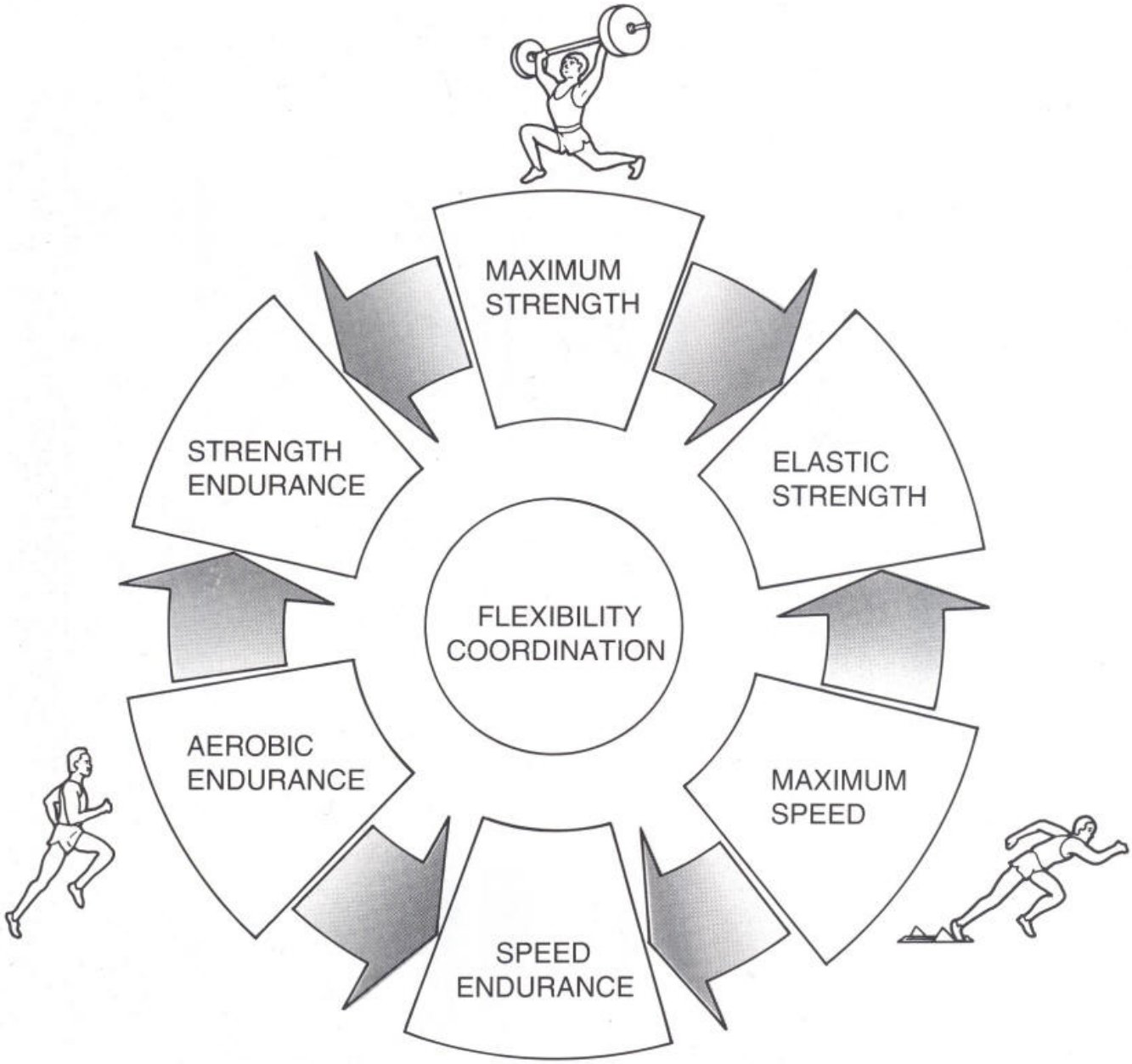
A passive static exercise

Coordination

Coordination is the ability to perform movements of various degrees of difficulty very quickly and with efficiency and accuracy. It is considered that an athlete with good coordination is capable not only of performing a skill well, but also of rapidly solving a training task.

Development of Coordination

The coordination required for running, jumping and throwing can be developed from a young age. Girls between the ages of 8 and 11 and boys between the ages of 8 and 13 have exceptional rates of learning. Basic coordination exercises that are learned at this age become the foundation for later event specific skill development. In the mature athlete coordination exercises and drills remain important as they maintain a balance against the imbalances caused by very specific training.



Inter-relationship of the biomotor abilities

The biomotor abilities have been presented separately to identify the characteristics of each. In practice there is no such thing as a "pure" strength exercise or a "pure" speed exercise. The biomotor abilities are components of overall physical fitness and an understanding of their inter- relationship allows the coach to plan training more effectively.