A few aspects of the theory and practice of speed development

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The author briefly surveys the basic concepts of speed, stressing its importance in a wide range of sporting disciplines. He then defines and examines the various components, including amplitude, frequency, reaction time and acceleration capacity. He concludes by presenting a philosophy of speed development, identifying and formulating the 10 major problems faced by an athlete specializing in the sprint events.

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1 Introduction

The quality called speed is not confined exclusively to the sprint events in athletics. To illustrate this, the following three points should be noted:

- Speed is a requisite for a great number of sporting events, ranging from team games to wrestling and including endurance disciplines, where success may often depend on speed and therefore on its effective development.
- Speed is a principal element of general training programmes for young athletes.
- A modern interpretation of the purest of sprint disciplines, the 100 metres, does not regard the event as an expression of pure speed but as an expression of a form of endurance, i.e. speed endurance.

Although the most common definition of speed as a 'quality that enables one to perform a given movement in a very short length of time' provides a useful basis for its schematic analysis, it does not illustrate its complexity. Speed is indeed a very complex quality, consisting of strictly separate nervous and muscular components. The first involves the transmission of nervous impulses and the activity of the association cortex, while the second is concerned with the speed of contraction of the muscles. Both of these have a specific range that governs the intensity of a performance. When the exercise is brief and the intensity high (for instance during short sprint events in athletics, or speed events in track cycling), it is the nervous component
which determines the performance because it affects the efficiency, consistency and the economy of the movements. The limitations which it imposes become evident through a progressive loss of co-ordination, a deterioration in technique or a decrease in the speed of execution. The limitations determined by the muscular component are mainly related to the resynthesis of the substrates in the phosphate pool, which is a real energy accumulator in the working muscles.

It is certainly possible, within the bounds set by hereditary characteristics, to improve the scope of both the nervous and the muscular components of speed through specific training or with the influence of other environmental factors. As we know, the performance of brief and very intense exercises can be improved by perfecting technique - in other words by applying various training methods which enable even the younger age groups to learn to carry out the necessary movements correctly.

In the same way, modern training methods include a number of extremely specific, targeted exercises which affect muscular function and so increase its scope.

2 The components of speed

A coach faces different problems depending on whether he has to teach simple or cyclic (complex) movements. In this study we shall concentrate on cyclic movements, which can be divided into two main components:

- **amplitude** of the propulsive movements;
- **frequency** of these movements, or the number of propulsive movements achieved in the unit of time.

The real expression of cyclic movements is therefore the 'product of amplitude and frequency'. In order to increase the speed of execution of cyclic movements, it is obviously possible to improve the amplitude or the frequency of the movements, or both these parameters. Such a choice is never random; it is determined by the characteristics of both athlete and discipline, by the athlete's stage of development, and also by the fact that one will gradually identify the most profitable compromise between amplitude and frequency.

Finally, frequency of movement is the parameter most dependent on the genetic factors governing the nervous system and the energy supply of the muscles. This implies that an athlete's natural speed should be considered a qualifying element in aptitude tests for disciplines requiring a high frequency of movement.

Speed of performance in certain sports disciplines is influenced by what is known as reaction time, i.e. the time it takes an athlete to set himself in motion after the start signal. Although this is not directly related to an athlete's maximum speed, it clearly determines the final result of his performance. Reaction time is not, as one might think, only relevant to those disciplines in which the athlete always starts in the same manner in an unchanging response to a stereotyped signal, such as the starting gun in the 100 metres. In such a case reaction time could be defined as simple. There are a number of other disciplines in which an athlete's reaction time involves the selection of a specific action as well as its accomplishment. In such cases, reaction time could be defined as an example of discrimination, and is undoubtedly longer; mainly because the response cannot be prearranged but has to be conceived and carried out in constantly changing situations.

Cyclic movements always have two fundamental phases:

- an acceleration phase (in sprint events, for instance, the first 10-12 strides);
- a phase in which the speed tends to be relatively stabilized.

An athlete's capacity for acceleration has little to do with his maximum speed. However, the final result depends a great deal on the quality of the acceleration. At this point we should distinguish between
three different concepts: **maximum speed**, **average speed** and **relative speed**.

The average speed is 'the average speed achieved over a given distance', while the relative speed is the highest speed achieved over a given distance. By maximum or absolute speed, we mean the highest peak of speed an athlete is capable of reaching at a given time.

The parameters involved in the acceleration phase are not related to those in the full speed phase. The training programme should obviously incorporate them all, since the first set allows an athlete to attain high speed in a short time, while the second allows him to maintain this speed for a long time. The first phase requires explosive strength and speed strength, the second phase requires elastic strength.

**3 Introduction to sprint disciplines and specialization**

After this brief survey of the basic concepts of speed, I should now like to present what can be considered as a philosophy of speed development. It is in part the fruit of experience obtained on the field, and in part the result of scientific research that often corroborates field experience. I have here identified and formulated the problems that generally arise when an athlete is first introduced to sprint events and when he undertakes specialization. They are listed in the form of a decalogue because I believe each of these 10 points to be of equal importance.

1. An athlete should begin to specialize at around 13-14 years of age, provided his biological age corresponds to his chronological age. It is important to stress that, in this age group, specialization should be directed towards a group of disciplines, never towards a single event. Since the young athlete is still in a phase of growth and development, his natural biological evolution will, in itself, cause an improvement in performance. At this age performances may improve even despite an incorrectly planned training programme. When performances improve over a period of 2-3 years at the same rate as the athlete's physical and psychological development,
this cannot be considered as an indication of the effectiveness of the training programme. Coaches should beware of overestimating the influence of training programmes in this age group. The training programme should not include a large quantity of low intensity exercises. Coaches should be aware that such work can lead to:

- an inevitable and irreversible loss of specific skill;
- negative effects on the fast twitch muscles.

What is even more dangerous is that the intermediate muscle fibres are also affected; the dynamics of these fibres approach those of slow twitch muscles. An adequate workload will cause them to take on the dynamics of fast twitch muscles.

2. As the effect of physical development diminishes (usually around the age of 17 for boys and 15-16 for girls), the increase in both volume and intensity of the work-load should be quite significant. It should also be organized progressively, cycle after cycle, so as to ensure a stabilization phase followed by an improvement in performance.

3. With regard to the old aphorism 'speed and endurance are incompatible', we now know that there are various forms of endurance. In fact, in speed performances, the relationship between the lactacid anaerobic mechanism and aerobic glycolysis is such that it emphasizes the importance of exercises aimed at developing lactacid capacity and power. In the 100 and 200 metres events, for instance, the lactacid process is the one that sustains the lactacid process, so that although the 'primary energy' (the one that is directly used for the performance), comes from the phosphate pool, the concentration of hydrogen ions (H+) in the working muscles increases. We now believe that the hydrogen ions stimulate, among others, the creatin phosphokinase enzyme. This implies that a greater quantity of the substrates of the phosphate pool is made available, sometimes referred to as a better depletion of the phosphate reserve. This novel phenomenon, derived from modern findings, is worth underlining: the lactacid energy used by the sprinter is not equivalent to the primary lactacid energy, i.e. energy produced by direct resynthesis of the ATP during low intensity work. The sprinter uses the secondary lactacid energy, produced during high and very high intensity work, in order to resynthesize the CP, which in turn resynthesizes the ATP. Running exercises over distances varying from 100 to 300m create the conditions in which the lactacid process is engaged indirectly, i.e. high intensity work. I believe these exercises are the only ones that can serve the dual purpose of accustoming the athlete to running at a high speed despite the increase of the concentration of lactic acid in the muscles and, simultaneously, stimulating the enzymes responsible for the degradation of the CP.

4. The coach should not hesitate to carry out very intense and prolonged work with athletes in the younger age groups. For one thing, in young boys and girls, the SNC function is very specialized, so that they are naturally protected from performing exercises that would overburden their organism. Also their enzymatic system, connected to lactacid work, is not fully developed - in fact we sometimes even distinguish different 'enzymatic age groups'. These two factors allow young athletes to perform a great number of repetitions and obtain increasingly better times without producing a high lactic concentration in the leg muscles; the concentration built up is nowhere near that of an adult. High intensity work is therefore indicated for young athletes, because it does not harm them, because it stimulates the activity of a number of enzymes which are affected by the intensity of the work, and because this remains the best way to increase an athlete's speed.

5. The first stages of specialization embrace a whole group of disciplines and should be considered as a means to provide general preparation without necessarily
producing important results in any single event. It should also be understood that the aim of a training programme for young athletes is primarily to develop their physical and psychological preparation in order to give them a correct attitude towards adult training loads.

6 Young athletes should be given many opportunities to match their capabilities against other athletes, instead of working alone at bettering their performance. A solar year can include as many as three preparation periods and three competition periods. For mature athletes the standard of performance is higher, but the number of competitions decreases.

7 The three main groups of specialized training means for sprint events (general, specific and competition exercises) should all include a wide range of exercises. This has proved necessary to make up for a lack of basic motor skills that is encountered all too often. The use of varied exercises provides a further advantage in that it prevents the athlete from coming up against the speed barrier and even tends to produce a general increase in speed.

8 The concept of multilateral training programmes is applied to both young and elite athletes. In the first case however, the programmes are multilateral in an effort to be as general as possible, while in the second instance, they are multilateral but always remain specific.

9 The identification of the bioenergetic and technical model of sprint events is becoming increasingly important. In other words it is now considered essential that the athletes attain a high technical level in each one of the different phases of their evolution. We believe, or rather we have observed, that it is impossible for an athlete to exploit fully his energy potential (both chemical and nervous) without the support of correct technique. Even the slightest fault in timing or variation in style should not be tolerated if it interferes in any way with the economy of the movement.

10 Exercises should be progressively more direct and specific as the athlete matures. The fundamental training must consist of running exercises, where the intensity varies from high to very high, and the speed varies from maximum to supra-maximum. In this way it is possible to avoid the mistakes of various European and non-European schools, which tend to be distracted by secondary issues such as muscular development without considering that, during competition, a sprinter is required to run fast, not to do any weight-lifting.