Monitoring the training of the sprinter

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by Carlo Vittori

Careful monitoring of the progress of an athlete's training is essential, both to evaluate the efficacy of the current training plan and to indicate what modifications may be needed in future programmes. The article discusses monitoring methodology, using the example of the training of sprinters. The training phase suitable for the taking of tests is suggested and a list of appropriate tests is provided. The tests, which can also be used as training means, are divided into four groups, according to the respective abilities concerned. A detailed explanation of the tests follows and, finally, an example is given of the data recommended for inclusion in the athlete's progress record form.

Carlo Vittori is a Technical and Scientific Committee member of the Italian athletics federation FIDAL, a former national coach for Italy and personal coach to 200m world record holder Pietro Mennea.

(Translated from the original Italian by Mary Dougan)

1 Introduction

A vital but sensitive element of the monitoring of training consists in carrying out tests, with the aim of evaluating the improvements achieved and the degree to which the effects of training correspond with the objectives set at the planning stage the working hypothesis.

It is a way, therefore, of verifying the efficacy of the means chosen, the methods adopted and the suitability of the tasks performed. The information that can be obtained from monitoring is not limited, however, to a check on whether or not progress has been made; it also includes the extent of that progress, since it is only from this data that we can get some idea as to whether the training programme is sufficient to achieve the timed performance presumed in the model.

Monitoring strategy should, therefore, answer two questions: Have the improvements in ability envisaged in the programme been achieved? Is this improvement extensive enough to enable the athlete to achieve the expected results? These interventions raise the overall calibre of training, as they represent an important stage shared by many scientific phenomena; which means that training can, by extension, be assimilated to them.

The significance of the monitoring objectives can be better understood in an activity like the training of sprinters which, involving as it does a large number of qualities over a long period of time, inevitably produces a heterochronic progression in the results of the training itself.

We need only consider how many times, during preparation, we are obliged to encourage the development of a more specific condition, to vary our plans and substitute less direct means and methods with others, which are more specific and better suited to the new tasks.

Therefore, any change in the development of training programmes must be based,

according to the pointers provided by the tests, on the level that the abilities stimulated by the training itself have attained.

It should be stressed, then, that the principal significance of the monitoring process is to project the values of the present into the future, and in this way to reassure us of the final outcome. To meet this objective, a series of data ("parameters") is required, each referring to the whole range of tests and corresponding to a precise timed performance over 100 metres, so that a comparison can be made between the result of the test and the corresponding parameter envisaged for the timed performance we are interested in.

2 Monitoring methodology

The monitoring operations are carried out towards the end of the periods in which the workload is lightened and reduced or, in other words, when we are certain that psychonervous regeneration and physical "supercompensation" have taken place.

Only those tests which draw on the skills stimulated in that training cycle will be used.

The tests can be divided into four groups:

- Tests for the a-cyclical expression of strength
- Tests for the cyclical expression of strength
- Speed tests
- Specific running tests.

2.1 Tests for the a-cyclical expression of strength

Squat

To measure maximum dynamic strength of the extensors of the legs.

The reference datum or parameter that should be taken as the objective, is the lifting of a load equal to at least double the athlete's weight.

S0 = vertical jump from standstill, from half-bent legs, hands at the sides (Bosco)

Vertical jump starting from half-squat with the hands at the sides and still. This measures the explosive strength, through the height reached. Performance depends on the capacity for instantaneous recruitment and on maximum dynamic strength.

The parameters are the following:

for 10.60/10.40sec 40/45cm
for 10.20/10.00sec 52/58cm.

Scm = vertical jump with counter-movement, hands at the sides (Bosco)

Vertical jump with counter-movement, with hands at the sides. This enables the explosive-elastic expression of strength to be evaluated. If the result obtained in the previous test is subtracted from this one, we obtain a differential which can be ascribed to the elastic component (index of elasticity), of around 10cm.

The parameters are the following:

for 10.60/10.40sec 48/53cm
for 10.20/10.00sec 60/68cm.

Scma = like the previous one but with swinging movement of the arms (Bosco)

Vertical jump with counter-movement and co-ordinated swinging of the arms, backwards-down-forwards. This test measures the explosive-elastic-reflex expression of strength, principally of the thigh muscles. The powerful swing of the arms, to the full extent of their downwards movement, tends to reinforce the downwards moment of the eccentric contraction at the point where the movement changes direction. The "surplus" of elevation which is found in this test, with respect to the previous one, arises from this and from the co-ordination with which the combination of movements takes place.

The parameters are the following:

for 10.60/10.40sec 60/65cm
for 10.20/10.00sec 72/80cm.

St = vertical jumps with feet together, between obstacles (Vittori/Bosco)

Vertical jumps, with or without obstacles, with legs straight and together, to perform the highest, fastest bounds possible. The contact and flight times of the two best bounds are used to obtain the average. This test enables the efficiency of "reflex strength", mainly of the musculature of the sural and synergic triceps, to be evaluated, and provides, together with the previous one, an indication as to the functionality of the entire propulsive system.

If muscular development, in terms of this expression of strength, is balanced, the heights reached in the two tests (no. 4/5) should be more or less equal (Vittori: L'Allenamento della forza dello sprinter <Strength in the Sprinter>: Atletica Studi April 1990).

The contact times should, however, fall between 170 and 145 milliseconds. It is clear that the shortest times are linked to the best performances.

2.2 Tests for the cyclical expression of strength

The term "cyclical" means that, as strength develops alternating movements are produced which are repeated, in the same order, at intervals. These tests enable us to discover the athlete's ability to express repeated peaks of strength in exercises with faster and faster movements (from alternating jumps to long striding, as physical condition improves. It is very important to be able to investigate the ability to alternate, in rapid succession, states of strong contraction with states of complete relaxation or inhibition and also to obtain some indications as to the development, balanced or otherwise, of strength and of the speed with which it is expressed.

While the alternating bounds show us the abilities most closely linked to the starting and acceleration stages, the other two exercises, the bounding run and the run with longer than normal strides, allow us to evaluate certain components of the complex range of abilities governing the 'flat-out' stage of the 100 metres run.

Alternating jumps: triple and quintuple

These two exercises are from a normal standing start.

The result for the five jumps, in an individual with good capacity for expressing strength rapidly, should be at least 70% greater than for the triple (5 jumps theoretical).

The parameters are the following:

	triple	quintuple
for 10.60/10.40sec	9.00/9.50m	15.50/16.20m
for 10.20/10.00sec	10.00/10.50m	17.00/17.90m.

Run with strides longer than normal over 100m

This exercise consists of covering the 100 metres while attempting to reconcile two different requirements: to go quickly, and to use a limited number of strides. The time and the number of strides to be taken are set out in the model prepared at the planning stage (see Fidal Centro Studi Publication, no. 6/1986, pp. 451/456).

This, together with sprinting, is the classic exercise for the dynamic synthesis of all the physical capacities the sprinter puts into practice in races. The number of strides (from which the average length is calculated) and the time taken are measured. These two data should be compared with those of the reference model. For the purpose of clarification we show here the example which appeared in the before mentioned Centro Studi publication. The data refer to an athlete for whom a result of 10.50 is assumed.

	Presumed model 100m race	Run with longer strides than normal model 100m
Time	10.50sec	* 10.68sec
Number of strides	46	* 40.7
Average frequency of strides	4.38	3.81
Average length of strides	217.4cm	245.7cm

* from standing start

A comparison of the test data with those of the model will help us to judge how appropriate the training procedures are. But to be sure of how the data develops over time, all we have to do is plot them on Cartesian coordinates, on which the point of intersection of the data for the model has been plotted.

By joining up with a line the points of intersection of the data collected, it will be possible to see whether or not the line leads to the point shown for the model; we thus have all the information required to evaluate any deviation and apply the corrections required to bring the behaviour more into line with the model.

Bounding run over 100 metres

This test also takes place over a distance of 100 metres and again involves calculating the number of strides and the time taken. It can be considered as the methodological link between a-cyclical strength exercises and the more specific cyclical strength exercises, such as runs with longer than normal strides. It is, in other words, an exercise which encourages the transfer of a-cyclical into specific cyclical strength abilities, of which the run with longer than normal strides is the most significant manifestation.

By dividing the distance of 100 metres by the number of bounds performed, we obtain their average length,which, when divided by the time taken in the test, enables us to obtain the index of "cyclical rapid strength". However, as the same index can be obtained from the relationship between many sets of data it was considered essential to set the size of one of the two criteria, so that the index would be the clear expression of a precise behaviour. The preferred choice was the length of the bounds, since the experience and knowledge accumulated over the years through the use of this exercise would undoubtedly benefit the search for the parameter most closely matching the requirements for the measurement of rapid strength.

For the bounding run, therefore, a length of bound was set that was about 25% greater

than the average length of stride in the run with longer than normal strides model. Consequently, for the athlete from the previous example, who should have achieved an average length of stride of 245.7cm in the run with longer than normal strides, the reference parameter for the length of the bounds should be about 307cm (245.7cm + 25% = 307cm).

The parametric indices are the following:

for 10.60/10.40sec	22.5/23.5%
for 10.20/10.00sec	24.5/25.5%.

2.3 Speed tests

Run with shorter than normal strides over 100 metres

This is the classic exercise to find out the number of revs the subject's engine is capable of reaching, or in other words, the number of strides per second that he or she can reach at high speed. The run with longer than normal strides, on the other hand, enables us to discover the power of the engine in relation to the transmission; that is, to the length of the legs and the strides at high speed.

As was the case with the run with longer than normal strides, the times and the number of strides are also measured for the run with shorter than normal strides. The average frequency is then obtained by calculating the relationship between the number of strides and the time. The time and frequency should then be compared with those for the run with longer than normal strides. The sprint model for the same example quoted for the run with longer than normal strides, is shown; this was the subject of the Fidal Centro Studi Publication no. 6/1986, p. 451.

For this test too it is advisable to transcribe the data into Cartesian co-ordinates, so that, if the speed development line does not lead to the point of intersection of the parameters of the model, the corresponding observations and corrections can be formulated more accurately.

	Presumed model 100m race	Run with shorter strides than normal model 100m
Time	10.50sec	* 10.68sec
Number of strides	46	* 52.9
Average frequency of strides	4.38	4.95
Average length of strides	217.4cm	189.2cm

* from standing start

For a further check of the results obtained in the two tests of frequency and length, the following simple mathematical calculation, which starts from a very straightforward line of reasoning, can be carried out: if the athlete in the first example has to achieve, in the run with shorter than normal strides, a time of 10.68sec and a frequency of 4.95 to obtain a timed performance of 10.50sec, what timed performance can the athlete register, if in the test he achieved a frequency of 4.80 and a time of 11.08sec. Given the above values, all we have to do is perform the calculation:

$$10.50 \times \frac{4.95}{4.80} \times \frac{11.08}{10.68} = 11.234.$$

Thus the athlete rates, with regard to frequency skills, a performance of about 11.20sec, starting from the blocks and with electric time-keeping.

The same operation can be carried out for the run with longer than normal strides test. If the athlete in the example has achieved a time of 10.76 in the test, taking 42 strides, we obtain:

$$10.50 \times \frac{10.76}{10.68} \times \frac{42.0}{40.8} = 10.89.$$

10.89sec is the value of the performance linked solely to length development skills. From which it can be deduced that, in this athlete, length development skills are better than frequency skills.

Fast skipping: 50 skips

Rapid skipping with 50 touch-downs, running almost on the spot with knees raised. While the exercise is being performed, attention should be focused on the height reached by the knees, since this is the only detail to influence time. The knees must reach the horizontal, to allow adequate engagement of the ilio psoas. At the end of the test the average frequency is calculated by dividing 50 (the set number of times the feet touch the ground) by the time taken. The reference parameters for this exercise have the same value as the frequency envisaged in the sprint model for the same athlete, since both exercises are on the whole influenced by the same biotypological qualities.

The effectiveness of this test is greatly influenced by the efficiency of two important muscle groups: of the leg itself (synergic sural

Abbreviations to and explanations of Figure 2➤

S_0 = squat jump without additional load
Scm = countermovement squat jump
Scma = countermovement squat jump with support of swinging arms
St = vertical jumps with muscle stiffness
cog = centre of gravity
Amortisation time = time of negative muscle work.
For further explanation refer to text explaining tests

SUMMARY FRAMEWORK OF THE TESTS AND PARAMETERS

Performance 100m	Squat	Scm cm	Scm cm	Scm cm	Sh	Triple m	5 jumps m	Run with longer strides	Bounding run	Run with shorter strides	Skipping 50 skips	30m standing start	30m running start
10.60/ 19.40	Relative force (ratio of weight lifted to body weight, should be at least 2)	40/45	48/53	60/65	Same height of the Scmb test with contact times between 170-145 milliseconds	9.00/ 9.50	15.50/ 16.20	As per model envisaged in the hypothesis	22.50/ 23.50	As per model envisaged in the hypothesis	Performance with frequencies practically equal to running with short strides	3.70/ 3.60	2.88/ 2.78
10.20/ 10.00		52/58	60/68	72/80		10.00/ 10.50	17.00/ 17.90		24.50/ 25.50			3.50/ 3.40	2.70/ 2.62

Figure 1: Scheme of the summary framework of the tests and parameters

Form for transcription of data taken throughout the year

Athlete
date of test | place | date of birth | discipline | weight | height | sex | personal bests

squat max

1/2 squat jump (S_0)
flight time | height | cog

c. mov. jump (Scm)
flight time | height | cog

index of elasticity
Scm – S_0

countermovement jump with arms (Scma)
flight time | **height** | centre of gravity
F max | **force** | average
pushing time | **pushing time** | amortisation time

Wmax | **force** | **(N/kg)** | **V (m/s)**
expected performance

reactive force (St)
max. height | t contact min.
result of Scma
difference between St and Scma
contact time
flight time
height of cog

short stride run
speed
no. of strides
frequency

long stride run
speed
no. of strides
length of strides

alternative jumps
triple
5 jumps
5 jumps theoretical
performance for 100m

performance model
time • leg length • no.of strides • length of strides • frequency
... ...

bounding runs
time
no. of strides
index

running with short strides | *running with long strides*
time
frequency
no. of strides
length of stride

skipping, 50 contacts

30m with standing start

30m with flying start

Figure 2: Form for transcription of data taken throughout the year
(scheme by Roberto Bonomi 1995, translated and re-drawn version)

triceps) and of the flexors of the thigh (tensor of the fascia lata, sartorius, and rectus of the quadriceps and ilium-psoas).

2.4 Specific running tests

30m from standing start

30m from a flying start

There is not much to say, from the methodological point of view about these two tests, although some explanation is required with regard to the equipment to be used and the way in which to use it.

The times must be taken electronically, using, in the tests with 30 m sprint from standing start, a little block on which to place the back foot and a photoelectric cell, both linked to a chronometer.

The back block serves as a switch which, at the moment the foot leaves it, starts up the chronometer, which will stop when the athlete passes through the cells.

For the 30 metres running start test a run-up of about 30 metres, or of whichever distance will enable the athlete to reach maximum speed, is required.

To increase the amount of information available and have, therefore, more tools at our disposal to increase our knowledge of the phenomenon, it is important, before the tests, to set out a supply of paper on the track, so that the length, number and average frequency of the strides can be measured from the marks make by the spikes. Leftovers of paper used in rotary printing presses can be used.

The data resulting from this operation are of great interest and extremely useful to gain an understanding of how the athlete constructs his or her sprinting rhythmics and of whether this corresponds to the hypothetical model. From this data one can evaluate the compromise between length and frequency of stride which results in the development of the highest speed.

The parameters for the two tests are:

Times	30m sprint	30m from running start
10.60/10.40sec	3.70/3.60sec	2.88/2.78sec
10.20/10.00sec	3.50/3.40sec	2.70/2.62sec.

In conclusion, it should be pointed out that all the exercises presented in this test are normally also used in training, as a means of developing the same abilities that are being monitored.