A new concept for sprint start and acceleration training

by Remi Korchemny

Introduction

The traditional approach to coaching the sprint start concentrates on the initial starting effort. The author proposes a new concept based on a starting model which stresses the importance of making the first few steps of acceleration dynamic and of making the transition between initial starting effort and these steps smoother and faster. He completes the concept by giving a description of training drills and a sample training programme which will help to develop the skills demanded.

1 Introduction

An analysis of the accepted coaching approach to sprint start training reveals that coaches have taught their athletes to initiate an explosive starting drive while they are in their blocks, to project the body’s centre of gravity forward and then to sprint. In the past, few people have questioned this approach.

However, a close examination of coaches’ training instructions shows that often these instructions are limited to the manner and effort used in leaving the starting blocks as fast as possible. For example, though coaches will normally stress:

- either a one or a two leg starting effort,
- a vector of effort in the 45-50° range,
- vigorous arm movements,

very few coaches combine these instructions with advice on the actions needed during the first steps of acceleration.

Study of the starting action, using video, and evaluation of the force exerted during ground contact, using impulse signal mats, show that athletes who concentrate solely on the execution of a powerful starting effort are unable to control their momentum during the first contact with the ground. Even physically well developed athletes may stumble during this first step and be forced to apply additional effort to regain horizontal acceleration and balance.

The compressive forces over the hip and knee joints during this phase are so high that athletes lacking eccentric (elastic) strength...
there will take longer to recover from the compression of the first steps. This increases ground contact time and retards acceleration. (Elastic strength can be defined as the ability of muscles to develop tension while external forces such as gravity lengthen the muscle).

The main purpose of this article is to propose a revision of the traditional approach to sprint start training to a new concept based on a model which makes the transition between the drive from the blocks and the following steps during acceleration much smoother and faster.

2 Starting and acceleration models

For many years, I have experimented with my students (elite, advanced and novice athletes) using different models of starting and acceleration. These include:

1) short choppy strides (greater frequency)
2) long strides, or power drive with a transition to frequency at the moment when the stride length stabilizes (optimal target length)
3) active first stride, similar to the depth jump with rebound, followed by actions similar to uphill running (stride length and frequency are increased concurrently)

It transpired that model 3) proved to be the most effective action, especially in terms of improvement of acceleration and better control of effort.

3 Introducing a new concept

The preferred model requires athletes to learn a new way of performing the starting action and acceleration phases. Athletes are taught to aim for an extremely active and powerful ground contact during the first step, then immediately rebound upward and forward, making better use of muscle elasticity (the ability to accumulate potential energy during stretching and to return this energy during the following activity) and the ability to reverse efforts from eccentric to concentric.

A four month experiment using a new concept of training based on the preferred model conducted during preparation for the 1992 indoor season resulted in the achievement of more efficient acceleration. This is shown by the following data:

1) The number of steps over the first 10m was decreased on average by one stride (for males from 7.5-8 to 6.5-7 steps and for females from 7.5-8.5 to 7.7.5 steps),
2) While stride length was increased, the average frequency remained almost unchanged during the first 30m (4.2-4.4 steps per second),
3) The 20m time from blocks was improved by almost 0.15 seconds,
4) Nearly as much improvement was also seen in competition results over 55-60m (see Table I). Results achieved in tests of other direct and indirect characteristics after the experiment can be seen in Tables 2 and 3.
Table 2: Test results of indirect characteristics following new training concept experiment

<table>
<thead>
<tr>
<th>Test</th>
<th>Results</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Squat to 90° (one repetition)</td>
<td>181-227 kg</td>
<td>140-181 kg</td>
<td></td>
</tr>
<tr>
<td>5 fast squats to 90° with 80% body weight</td>
<td>under 4.30 secs</td>
<td>under 5 secs</td>
<td></td>
</tr>
<tr>
<td>Clean &amp; Jerk</td>
<td>90.5-113.5 kg</td>
<td>54.5-68 kg</td>
<td></td>
</tr>
<tr>
<td>Standing long jump</td>
<td>3.0-3.30m</td>
<td>2.55-2.70m</td>
<td></td>
</tr>
<tr>
<td>Standing triple jump</td>
<td>8.23-9.14m</td>
<td>7.62-8.23m</td>
<td></td>
</tr>
<tr>
<td>Standing vertical jump</td>
<td>80-85cm</td>
<td>70-75cm</td>
<td></td>
</tr>
<tr>
<td>1-step approach vertical</td>
<td>87.5-90cm</td>
<td>75-80cm</td>
<td></td>
</tr>
<tr>
<td>Depth/rebound jump from box</td>
<td>(45cm) 6.75m-6.90m</td>
<td>(30cm) 6.30-6.60m</td>
<td></td>
</tr>
<tr>
<td>(landing on one leg and then jumping horizontally)</td>
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<td></td>
<td></td>
</tr>
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</table>

Table 3: Test results of direct characteristics following new training concept experiment

<table>
<thead>
<tr>
<th>Test</th>
<th>Results</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vmax (10m flying from 30m approach)</td>
<td>0.91 sec or better</td>
<td>1.0 sec or better</td>
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</tr>
<tr>
<td>Vmax = Distance / Time</td>
<td>11.0m/sec</td>
<td>10.0m/sec</td>
<td></td>
</tr>
<tr>
<td>Stride length</td>
<td>2.35m or longer</td>
<td>2.15m or longer</td>
<td></td>
</tr>
<tr>
<td>Stride frequency</td>
<td>4.65 per sec or better</td>
<td>4.70 per sec or better</td>
<td></td>
</tr>
<tr>
<td>30m from start (timed first movement)</td>
<td>3.85 sec or better</td>
<td>4.20 sec or better</td>
<td></td>
</tr>
<tr>
<td>Vavg</td>
<td>7.80m/sec</td>
<td>7.15m/sec</td>
<td></td>
</tr>
<tr>
<td>Stride length</td>
<td>1.82m</td>
<td>1.72m</td>
<td></td>
</tr>
<tr>
<td>Stride frequency</td>
<td>4.30 per sec</td>
<td>4.15 per sec</td>
<td></td>
</tr>
<tr>
<td>Number of strides</td>
<td>16.5</td>
<td>17.5</td>
<td></td>
</tr>
<tr>
<td>% of V 30m avg to Vmax</td>
<td>71%</td>
<td>71%</td>
<td></td>
</tr>
<tr>
<td>Reaction time</td>
<td>0.130 - 0.160 sec</td>
<td>0.150 - 0.180 sec</td>
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</tr>
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</table>
4 Practical Application of preferred model

4.1 Strength and skill requisites

In order to master the skills required for the preferred starting and acceleration model, the athlete should work on the development of:

1) Eccentric strength in the muscles that surround the hip, knee and ankle joints (hip and knee extensor and especially the soleus),

2) Awareness of the execution of specific actions during the 'set' position, block clearance, the first ground contact and the following transitional steps.

4.2 Instructions for the specific actions

1) Teaching the set position:
The hips should be raised slightly above shoulder level, bringing the angle between the front leg and the ground to 65-70°, and the knee angle of the back leg to 140-150° (Figure 1).

Instead of shifting the body forward, as they tend to do when they adopt the set position, athletes should distribute their weight evenly between the starting blocks and hands, and then slightly press the body downward, increasing tension in the arms and leg extensors, thus activating elastic resistance. However, the athlete should keep the elbows straight and avoid over-flexion in the legs (Figure 2).

This eccentric loading will assist the leg muscles to respond with stronger concentric efforts during block clearance.

2) During block clearance:
The initial drive should project the body's center of gravity forward through better utilization of:

- extension of the front leg and hip,
- complete flexion of the rear leg as it is pulled through,
- forward-upward thrust of one arm and upward-backward thrust of the opposite arm, similar to the arm action used during the attack on a hurdle (Figure 3).

Concurrent with hip extension from the front block, the well-loaded front leg should drive the body's center of gravity forward. The resulting vector of driving efforts (taken by drawing a line from the athlete's front block to his head as he makes his first starting effort) should be at about an angle of 40-50° (Figure 3). The distance between the front block and the projection of the body's center of gravity should be 100-120cm (Figure 4 overleaf).

The rear leg should move forward, in the most economical way possible, towards the chest. At this moment the foot should be dorsiflexed (cocked), about 3-5 cm above the
ground, with the lower leg almost perpendicular to the ground.

Our experiments prove that the effectiveness of the first stride depends upon:

- the height to which the foot is lifted,
- the distance the centre of gravity is projected forward,
- the amount of leg separation executed,

See Figure 5. In addition to these factors a vigorous arm thrust plays a significant role in assisting the great drive exerted upon the first impact with the ground by providing additional momentum.

4.3 Transitional steps model

The actions of the transitional steps should correspond with the preferred model of acceleration over the first, second and third 10m segments.

The transitional steps model consists of:

1) The number of strides over 10, 20 and 30m. Elite male sprinters can run 30m in 17 steps or less, and achieve optimal stride length (230-250cm by step 17.)

2) The frequency of these strides.

3) The percentage of maximal velocity (V%) achieved in each 10m segment of a 30m interval (measured both from a starting position and from a flying start with 30m approach).

The 'stick drill' (see section 5.1) with progressively increasing spaces between the sticks, is highly recommended as an exercise to master the requirements of the transitional steps model.

The more powerful the foot torque and the greater the acceleration of the centre of gravity, the more ground reaction forces are delivered from behind the forward moving body's mass. This leads to better horizontal acceleration.

The athlete who executes efficient landing and drive will have tremendous eccentric strength in the knee joint muscles, and will be capable of reversing efforts in a very short time (the elapsed time between eccentric and concentric efforts is within 0.02 sec.) These strength and reversibility abilities will permit very fast and powerful first and following transitional steps.
4.4 The pursuit of start perfection

Although I would advise sprinters to learn the specific actions detailed above, it does not mean that they should ignore other factors which contribute to what I would describe as start perfection. Relevant actions include:

- double foot force application
- reaction
- an explosive burst

Besides these skills, the sprinter should learn to make the transition from the reaction effort into the first and subsequent steps and to perform acceleration to the maximal speed level, gaining speed constantly and progressively. This can be accomplished by increasing both stride length and frequency.

Explosive starting actions require the application of concentric forces through the hip, knee and ankle joints, while the execution of the fast running strides requires tremendous elastic strength in the hip and knee regions. Excellent hip joint mobility is also required. Hip joint mobility will enable athletes to have good leg separation during the knee-lift phase. Elastic (eccentric) strength should prevent the leg from collapsing at the knee and hip during impact with the ground and reduce elapsed time for the amortization phase.

Concentric strength in the legs is also a very important component of striding efforts. Concentric strength benefits the fast forward rotation of the body over the supporting area and the powerful drive off the track (ankle torque).

5 A training programme

I have devised a training programme to meet the requirements of the practical application of the preferred starting model. This programme was followed, with considerable success, by the athletes mentioned in section 3.

The programme can be accomplished in 20 weeks by integrating two sessions per week into the athlete’s overall training schedule. In the following sections I will describe the various drills which are used. In Table 4 I give an overview of the programme and the drills which make up each session for the 20 weeks.

In addition, flexibility and joint mobility exercises should be included in the warm-up, specific muscle strength exercises with resistance can be applied during weight training sessions, and jumping drills can be inserted at the end of speed related sessions.

5.1 The stick drill

As mentioned in section 4.3, the ‘stick drill’ is an important exercise for achieving the transitional steps model. In training, place a stick as a mark 90-100cm from the front starting block and add 15cm for each subsequent mark (first 5 steps). Then add 10cm for the next 5 marks and another 5cm for the next 5-7 marks (15-20 sticks). Run this drill from the ‘three point’ position (one hand on ground, similar to sprint relay take over position) before the athlete tries it from blocks. Advanced athletes can be controlled for 7 steps over the first 10m segment, for 5 steps for the next 10m, and for 4.5 following the 10m interval (about 16.5 strides over 30m).

Advance the drill by adding weighted shorts (2kg-7.5kg), by running downhill (for 2-3°) or by adding an elastic dragging device.

If photo timing is not available, the coach may test this skill by counting the steps and hand timing 20 and 30m segments from the first movement. If a photo timing device is available, time can be detected every 5 or 10m. If the runner’s foot leaving the rear block lands on the 10m line, the number of steps will be odd (7 or 9). If the runner lands with the foot that has left the front block, the number of steps will be even (6 to 8).

It is uncommon in practice to sprint 10m in 6 or 9 strides. For example, one can assume a sprinter runs the first 10m in more than 6, but less than 9 strides. In this case, do not count the number of steps, but look for the leg which lands closer to the 10m line, and note whether it was the rear or front leg in the blocks. Once this is known, add or sub-
tract a fraction of a stride if necessary. To further clarify:

- If the rear leg lands before the 10m line, the frequency is more than 7 steps,
- If the rear leg is on the line, the frequency is 7 steps,
- If the rear leg is over the line, the frequency is more than 6 steps,
- If the front leg lands before the 10m line, the frequency is more than 8 steps,
- If the front leg lands on the line, the frequency is 8 steps,
- If the front leg lands over the line, the frequency is more than 7 steps.

Similarly, we can determine the number of strides for 20 and 30m using lines.

5.2 Additional drills

'Crawl + run':
The athlete crawls from the set position in the blocks, he takes two or three ‘steps’ with the arms, steps on to the ground and then runs.

'Rocking run':
In the set position, the athlete leans forward as far as possible. He then rocks backward and forward twice and then runs out of the blocks.

'Tap-tap + run':
In the set position, the athlete moves the shoulders well forward so that a great deal of weight is placed on the hands. He then lifts the rear foot 3-5cm off the ground, pulls the rear leg through to a maximal hip flexion with the lower leg perpendicular to the ground, taps the ground with the foot 2-3 times and then runs.

'Crack drill':
From the blocks the athlete drives forward from the front leg, with the trunk taking up an angle of 50-60 degrees. As the rear leg is brought through, the athlete tries to hold it close to his chest for a moment before actively striking the ground (like cracking an egg) The crack is executed downwards and slightly backwards while the front leg drives the body forward forcibly.

Pull ‘escape’ drill:
The coach or another athlete holds the runner’s hips with hands, towel or harness in order to restrain him while he begins the first drive from the blocks. He is then released and runs.

Push ‘escape’ drill:
Similar to above, but the runner is now held back by his ‘partner’ standing in front of him and pushing against his shoulders.

5.3 Drills from ‘three point’ starting position
(crouch position with one hand on track)

a) 6-8 x 30-40m ‘stick drill’ (see section 4.4). Progressively increase distances between sticks, up to the target stride length. The first step is executed slowly and all successive steps at moderate pace. Athletes execute full hip extension (front leg) and near maximum hip flexion (rear leg). Practise active and powerful foot placement on the track with a powerful forward pull of the body over the foot.

b) 4 x 30-40m stick drill with weighted shorts + 4 x 30-40m without.

c) 4 x 30-40m stick drill with weighted shorts downhill (2-3° gradient) + 4 x 30-40m without.

d) 4 x 30-40m stick drill with elastic resistance + 4 x 30-40m without.

e) 4 x 30-40m stick drill with elastic resistance downhill (2-3° grade) + 4 x 30-40m without.

f) 4-6 x 30-40m long stride/frequency drill from three point start position (10-20m of long strides of almost jumping style + 10-20m at near maximal frequency) + 2-4 x 30-40m at near maximal efforts emphasising stride increase and frequency increase.
Table 4: Overview of training programme for introductory and advanced athletes

<table>
<thead>
<tr>
<th>Week</th>
<th>Introductory</th>
<th>Advanced</th>
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<tbody>
<tr>
<td></td>
<td>a)</td>
<td>a)</td>
</tr>
<tr>
<td>1</td>
<td>a) + a.1)</td>
<td>b)</td>
</tr>
<tr>
<td>2</td>
<td>a) + b.1)</td>
<td>c) + c.1)</td>
</tr>
<tr>
<td>3</td>
<td>b) + b.2)</td>
<td>f) + c.1)</td>
</tr>
<tr>
<td>4</td>
<td>c) + c.1)</td>
<td>g)</td>
</tr>
<tr>
<td>5</td>
<td>d) + b.2)</td>
<td>c.3) + c.5)</td>
</tr>
<tr>
<td>6</td>
<td>e) + b.3)</td>
<td>d.1) + f.1)</td>
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<td>7</td>
<td>f) + c.1)</td>
<td>d.2) + f.3)</td>
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<td>8</td>
<td>c.2)</td>
<td>d.3) + f.3)</td>
</tr>
<tr>
<td>9</td>
<td>c.3) + c.5)</td>
<td>d.4) + f.4)</td>
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<td>10</td>
<td>d.1) + f.1)</td>
<td>d.5) + g.1)</td>
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<td>11</td>
<td>d.2) + f.3)</td>
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</tr>
<tr>
<td>12</td>
<td>d.3) + f.3)</td>
<td>e.2) + f.2)</td>
</tr>
<tr>
<td>13</td>
<td>d.4) + d.5)</td>
<td>e.3) + e.5)</td>
</tr>
<tr>
<td>14</td>
<td>f.1) + g.1)</td>
<td>e.4) + e.5)</td>
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<tr>
<td>15</td>
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<tr>
<td>16</td>
<td>f.3) + f.4)</td>
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<tr>
<td>17</td>
<td>f.4) + f.4)</td>
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</tr>
<tr>
<td>19</td>
<td>e.4) + f.4)</td>
<td>f.3)</td>
</tr>
<tr>
<td>20</td>
<td>f.3)</td>
<td>f.3)</td>
</tr>
</tbody>
</table>

Note: codes refer to drills in sections 5.3 and 5.4

g) 4 x 30-40m long stride/frequency drill with ankle weights + 4 x 30-40m sprint without weights.

5.4 Drills from starting blocks

a.1) 6-8 x 20m ‘crawling’ + run
a.2) 6-8 x 20m ‘rocking’ (front and back) + run
a.3) 6-8 x 20m ‘tap-tap’ + run
b.1) 6-8 x 20m ‘crack’ drill + run
b.2) 6-8 x 20m pull ‘escape’ efforts/active ‘crack’ + run
b.3) 6-8 x 20m push ‘escape’ efforts/active ‘crack’ + run
c.1) 6-8 x 30m where 10m is run in 7 or less steps (moderate pace)
c.2) 6-8 x 30m downhill (2-3°) where 10m is run in 7 or less steps

c.3) 4 x 30m with ankle weights where 10m is run in 7 or less steps + 4 x 30m without

c.4) 4 x 30m downhill with ankle weights where 10m is run in 7 or less steps + 4 x 30m downhill without

c.5) 4 x 10m time trial (7 steps frequency)
d.1) 6-8 x 40m where 20m is covered in 12.5 steps or less (moderate pace)
d.2), d.3), d.4), d.5) – same ‘modifications’ as c.2), c.3), c.4) and c.5) above
e.1) 6-8 x 50m where 30m is run in 16.5 steps or less (moderate pace)
e.2), e.3), e.4), e.5) – same modifications as c.2), c.3), c.4) and c.5) above
f.1) 4-6 x 30-40m ‘chasing’ starts (partner/s 1-3m in front)
f.2) 4-6 x 50m ‘chasing’ starts (on sound, an assistant ‘holds’ a sprinter in blocks for a moment and then lets him/her go to run and ‘chase’ the front sprinters)
f.3) 4-6 x 50m ‘chasing’ starts. Two sprinters start in the outside lane on the bend about 115m -120m from the finish. The sprinter on the outside stands a little ahead of the sprinter on the inside. They both start together and run in a straight line (about 15-20m) towards the finish. The sprinter on the outside should outrun the inside sprinter and arrive in the straight alongside him.
f.4) 6-8 x 50m relay run (outgoing part)
g.1) 3 x 30m + 2 x 60m time trials with partners (from blocks/full procedures)

6 Conclusion

This article has outlined a new concept of sprint start and acceleration training which stresses the importance of an extremely active first step and of making the transition between an athlete’s drive from the blocks and the first steps of acceleration smoother and faster. I have also tried to show how a coach can put this new concept into practice to improve athlete’s race times.