The Technique of Sprinting

Modern sprint running is analyzed and some exemples of strength exercises are presented that can contribute to design the best possible sprint technique and strength for speed

Jan Melén

The picture at front page shows - the jamaican sprinterAndrew Fisher

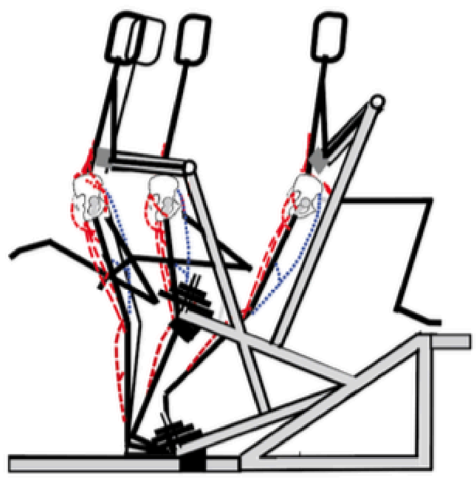
The Technique of Sprinting

A new type of specific strength training for speed called Powersprint is presented. Muscle strength - Scientific basic.

The Technique of Sprinting

A new type of specific strength training for speed called Powersprint is presented. Muscle strength - Scientific basic.

Jan Melén



CONTANTs

CONTANTs continue at next page…….

Foreword

Over the years, many articles has been written about new research findings covering strength and sprinting speed. Among coaches there has been some frustrations regarding sometimes conflicting information though.

Introduction

This compilation of facts in the book's introductory section is intended to contribute to the knowledge and concepts of sprint mechanics.

Henrik Olausson has with great interest and perhaps not so little patience, helped me with description of Tom Tellez ”technical model” (page 12-18). At a visit in Houston in 1999 I had the privilege to in person discuss with coach Tom Tellez and had also the opportunity to film some true world class sprinters eg. Mike Marsh. This resulted in significant contributions to my understanding how sprinting can and should be developed.

Also covered is a summary of various sprinting techniques based on several biomechanical studies. This is an attempt to describe different types of sprinting techniques.

Regardless of individual sprinting techniques I'm convinced that development of specific strength by the usage of the Swedish Power Sprint® Machine is beneficial. The first simple prototype was tested by coach Håkan Andersson in the training of two of Swedens most successful sprinters Peter Karlsson and Torbjorn Eriksson in the 1990s prior to the Europen Indoor Championship in 1996 when they both won bronze medals in 60m resp. 200m. Coach Andersson still uses this machine mainly for the development of the basic strength of the gluteus and hamstrings muscles. In recent years he has coached Stefan Tärnhuvud and Tom Kling Baptist both multiple Swedish champions 2008-2016.

In 2017 a new rising star came up with the name of Austin Hamilton. He surprisingly won a 60m bronze medal at the Indoor European Championship - exciting continuation follows. Hamilton basic years at the Malmö Athletics High School included "Powersprint training" in combination with regular olympic lifting. The coaches, including Morgan Rosberg, Alexander Lyshag and Jörgen Becke all believed in the ideas of Powersprint.

The Powersprint machine is now newly built without support plate against stomach, which is now successfully since half a year used by Håkan Andersson.

2020 April Jan Melén

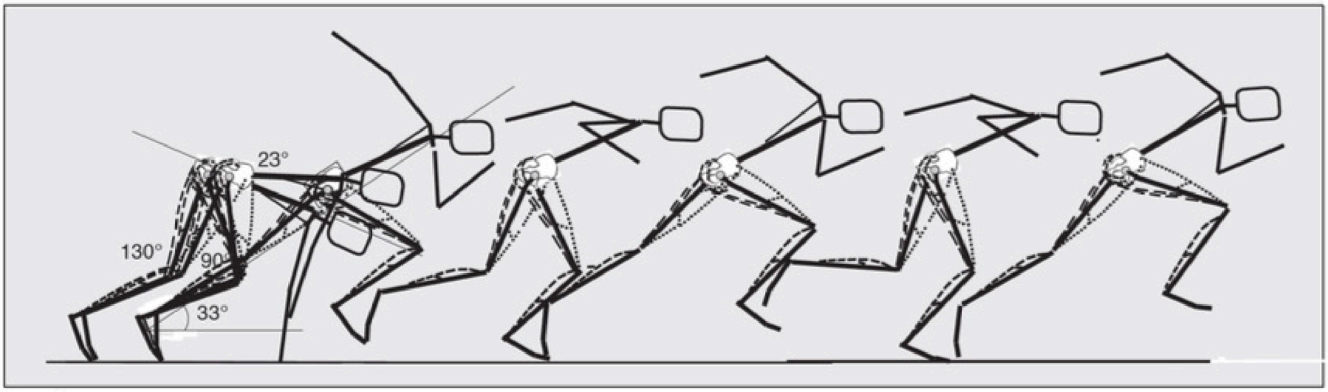


Fig. 1 *Schematic diagram showing an example of a modern start of the "super elite": "Ready" and the first two steps.*

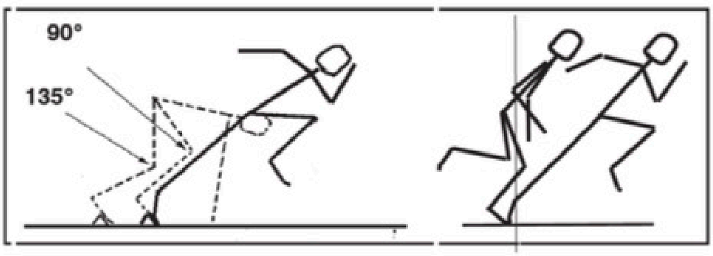


Fig. 2 *Chematic diagram showing an example of start technology for youth and moderate elite*

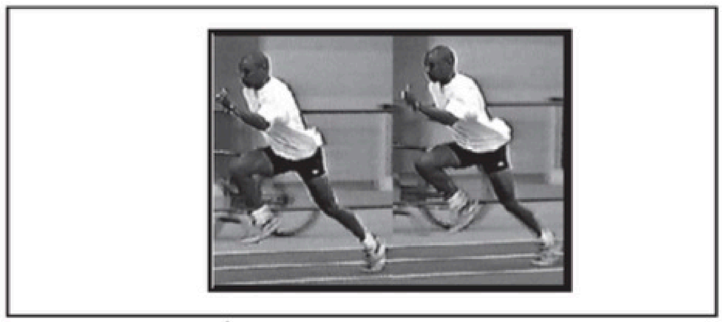
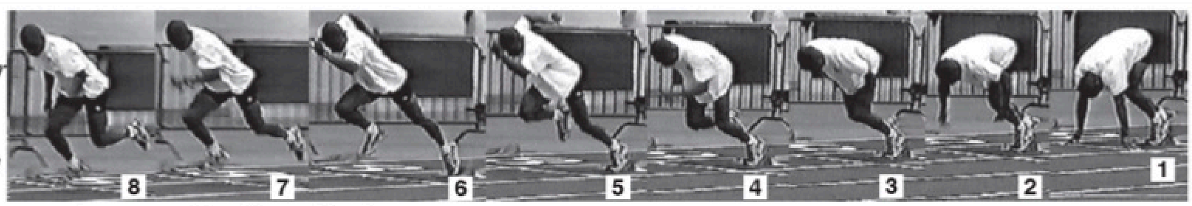
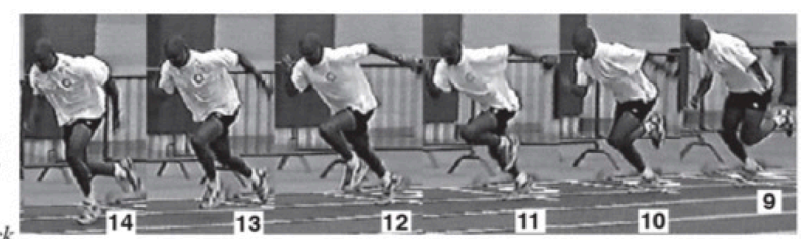


Fig. 3 *Mike Marsh.4 Note the incomplete knee extension during the ground phase (ground contact).*

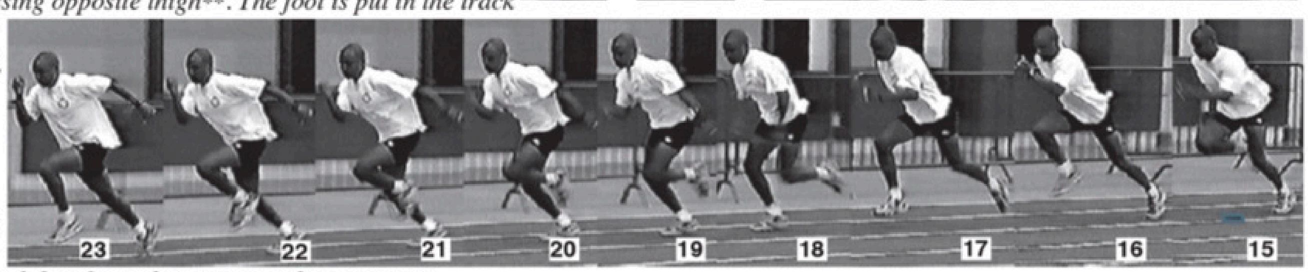
Pictures of Mike Marsh shows his starting technique during the first four steps. At the push from start block right arm swings back up relatively extended in the elbow



*(120 °) (5). Left arm however swings more flexed up to head height. The power from the arm swing is in harmony wit the pushing action from the start block, in an ideal direction through trunk (cf. Fig 99a). When the right knee moves forwards, the foot is describing a motion (3-6) forwards upwards to knee height. The angle of the knee becomes first quite small when the knee swings up to a relatively high position (5) and the foot is crossing opposite thigh**. The foot is put in the track*



*on the ball of the foot (8, 14, 18) **) and with the first running steps without heel-contact. At the "touchdown"*



the knee of pendulum leg is hanging in a low position

Fig. 4 *Mike Marsh[4] USA Houston Feb. -99 at start training. Figure text describing some important technical details.*

4

1. Technique Model, sprint 100m.

We will begin by describing sprint technique based on a model for the track and field's classic 100m dash[1].

Today's top sprinters can all be characterized by a very long acceleration phases, fore some super elite it takes 60-70m before their maximum velocity is reached.

The start and Acceleration I

From the start block the pushing force is projected from the foot through leg, hip and the body's center of gravity in a straight line with aproximately 35-45° inclination against the track. Start-angles must individually be selected depending on the sprinter stage of development. (Fig. 1, 2). In the first step the sprinter hits the ground with a "stiff" ankle, angled about 90° behind their center of gravity. The push off from the starting block and in the first two steps is usually done with full stretching of the knee joint. The stretching of the ankle, knee and hip, then takes place in the beginning of the race, which we here call *Acceleration I*, with a gradual steepening inclination of lower leg until the angle to the track is 90 °. During acceleration I the running occurs, with concentration of both the large range of[1] motion in the hip joint as high step frequence. This seems to characterize today's elite sprinters at the expense of push offs knee[2] extension, usually over the course becomes something incomplete (Fig 3-6). The running becomes more "fluid", which also characterizes good technique.[3] The work is done with higher power output, ie large force during the short contact time. It utilizes a better SSC (stretch shortenings cykle) (stretch reflex, elastic energy) from the hip extensors - mainly hamstring for the production of larger horizontal force. Favorable may also was an earlier forward swing of free leg.5

1) John Smith, interview (Author-89)). Without losing focus on a job well done hip work with the large range of motion (("Ovals",(Author))

2) According to John Smith. important technique detail (Author-89)

3) Magnus Warfvinge 151212 (Described for the author, which enthusiastically confirmed iaktagelsen. Common conclusion: "A neglected technical detail.")

Note again! The circled. The short ground contact and subsequent uplift of the foot (b - c) takes place so fast that a normal video recording rarely can show this. The common percep-tion is that the foot contact is always on toe without the heel contact.

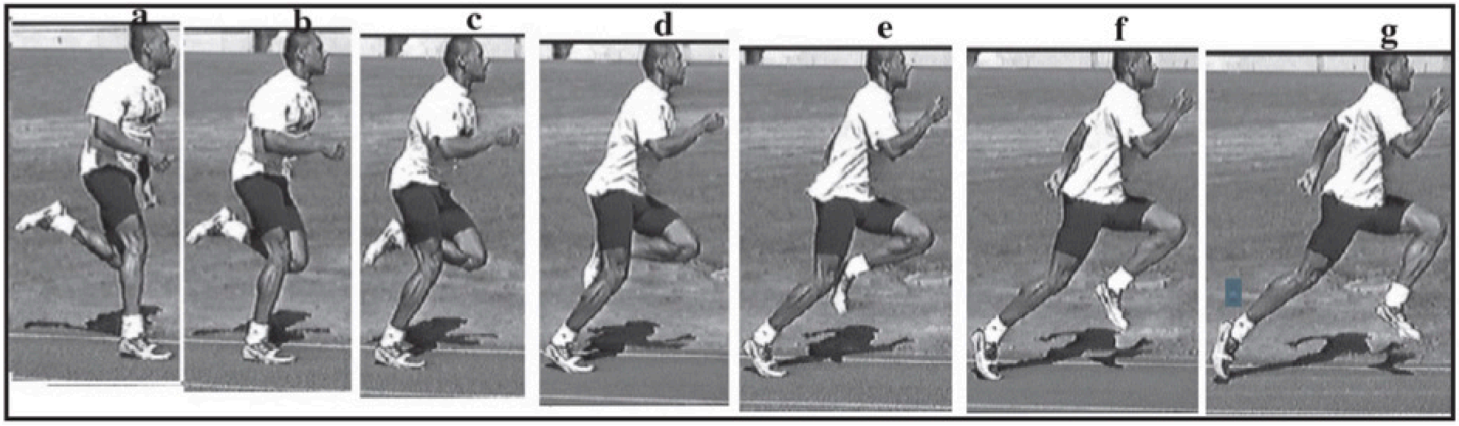
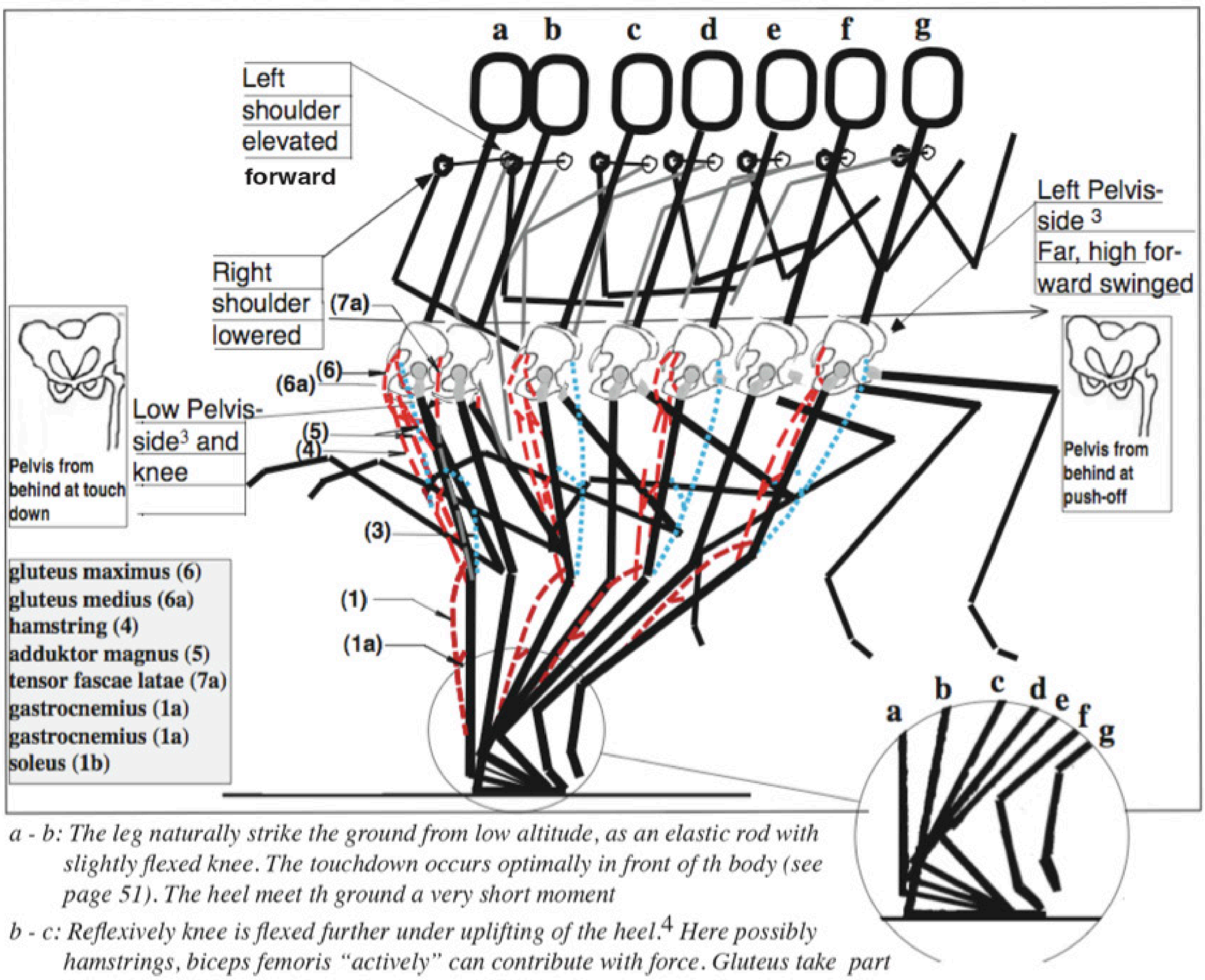


Fig. 5 *Mike M., is accelerating, at training in Houston in February -99*



a - b: The leg naturally strike the ground from low altitude, as an elastic rod with slightly flexed knee. The touchdown occurs optimally in front of th body (see page 51). The heel meet th ground a very short moment

b - c: Reflexively knee is flexed further under uplifting of the heel.[4] Here possibly hamstrings, biceps femoris "actively" can contribute with force. Gluteus take part in hipextension powerful but seems at the front phase together with the quadriceps mainly elastically damping of the high vertical reactive force.

c - f: Extension of the hip and usually incompletely even in the knee joint can be made individually with either ham string (Tidoff, Wiemann) or quadriceps, which get the help of the hamstrings isometric antagonistic function (see Sprint models p. 58-59). Adductor magnus (outer, lower part) is helping in the push off with an inward rotation of the leg in the hip. (See more detailed on page 54, 55, 58-59). Note: The last ground contact in the position (f) with clearly uncomplete extension of the knee and hip (see also biomechanical analysis of the sprinters, p. 51-56. All sprintmodels can be excellent trained specifically with Powersprint Important! Movement = The rotation in the hip joint must be clearly accelererad.

Fig. 6 *Analysis by Mike Marsh with the help of stick figure*

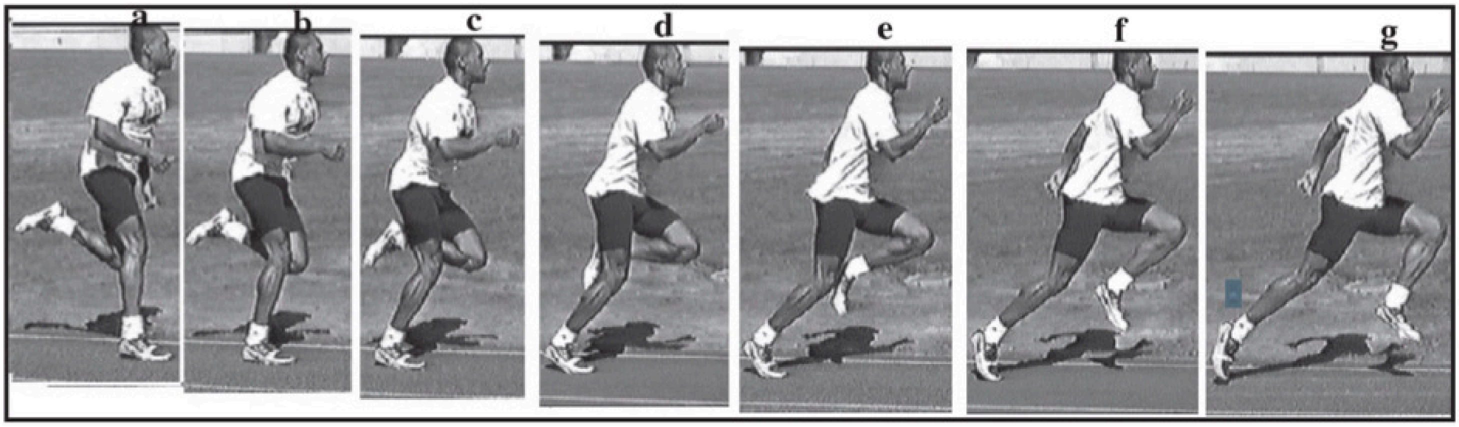
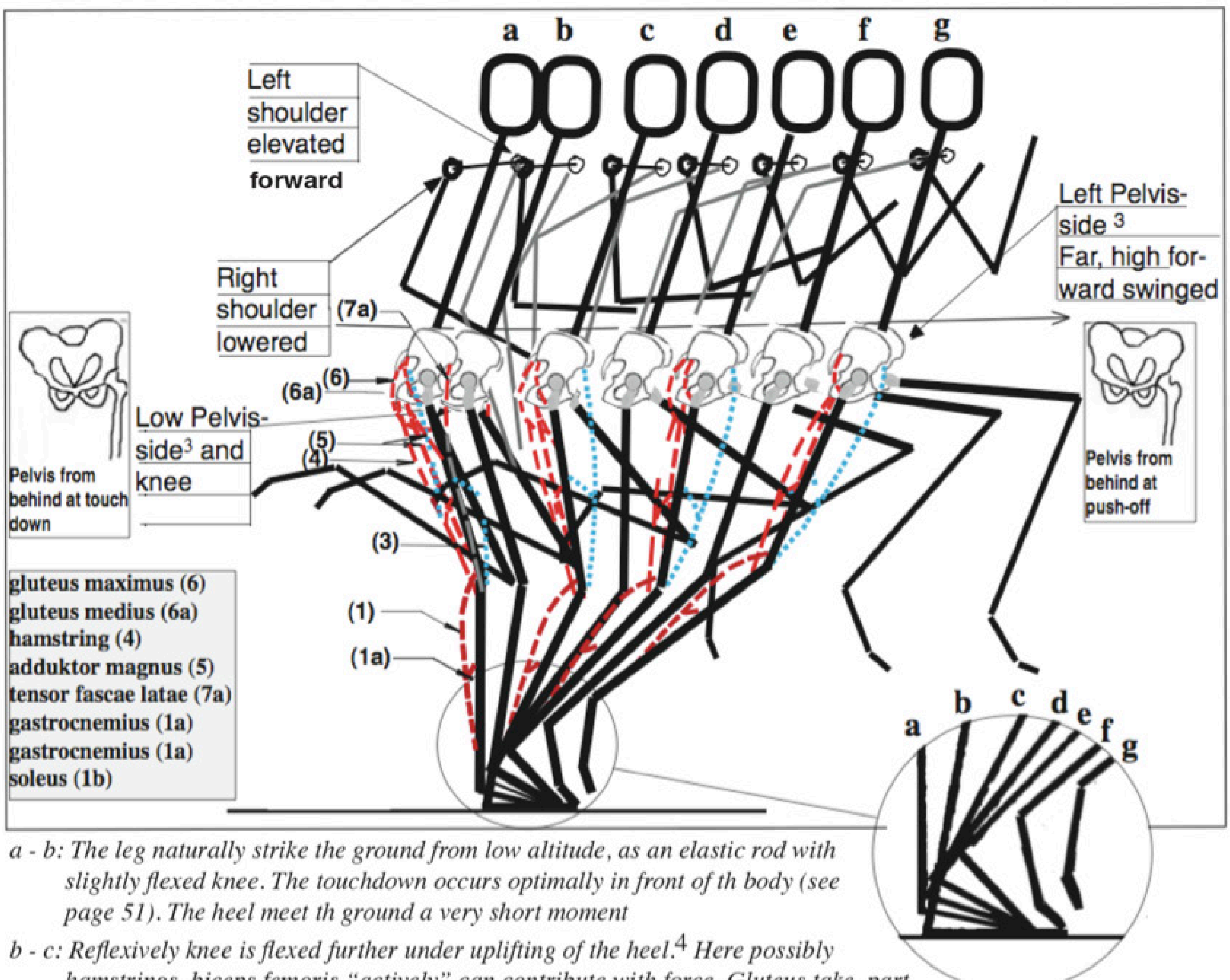


Fig. 5 *Mike M., is accelerating, at training in Houston in February -99*



a - b: The leg naturally strike the ground from low altitude, as an elastic rod with slightly flexed knee. The touchdown occurs optimally in front of th body (see page 51). The heel meet th ground a very short moment

b - c: Reflexively knee is flexed further under uplifting of the heel.[4] *Here possibly hamstrings, biceps femoris "actively" can contribute with force. Gluteus take part in hipextension powerful but seems at the front phase together with the quadriceps mainly elastically damping of the high vertical reactive force.*

c - f: Extension of the hip and usually incompletely even in the knee joint can be made individually with either ham string (Tidoff, Wiemann) or quadriceps, which get the help of the hamstrings isometric antagonistic function (see Sprint models p. 58-59). Adductor magnus (outer, lower part) is helping in the push off with an inward rotation of the leg in the hip. (See more detailed on page 54, 55, 58-59). Note: The last ground contact in the position (f) with clearly uncomplete extension of the knee and hip (see also biomechanical analysis of the sprinters, p. 51-56. All sprintmodels can be excellent trained specifically with Powersprint Important! Movement = The rotation in the hip joint must be clearly accelererad.

Fig. 6 *Analysis by Mike Marsh with the help of stick figure*

Acceleration II to maximum speed[1]

After acceleration I, the distance of 15-25m, depending on the speed level, posture become more up-right . (See fig. 5. From this position, we talk about **acceleration II**. The touchdown now usually occurs slightly in front of the body's center of gravity (fig.5a). The heel is then pressed downwards and for a "milli-second" it's easy touching the track [4] (fig.5b). In[4] fig. 6 Mike Marsh is analyzed with so-called stick figures. Among others here is a enlarged detail of the ankle at touchdown (a) and at the heel contact (b) [4]

Important details:

The figure 6 shows schematically the important pendulum movement of the hip. At right touchdown left hip and knee are in a low position. From here, the left hip swings (Pelvis side) forward in an oval-shaped moving . It is important to reach far forward with the hip at the knee lift.[3] Note that at the touchdown of the right foot, left shoulder[3] is forward elevated in the high position while the right shoulder instead is clearly lowered. Important that the shoulders are lifted and lowered to create balance and long external levers. This is a technique detail that you now clearly can see in particular characterizes the Jamaicans Bolt and Powel, but also for former U.S. Green and Others (author). The arms will also provide a significant force additions to the push off the ground by pendulum force[2] See in particular the left arm (position a and b, dashed) relative outstretched position, with your hand low along the side. Sprinter drops[2] down the arm relaxed and then "swings" arm high up near the face (see p.19) Even backwards swing contributes with force.

1) Tom Tellez model (Houston -99). It should, however, be the personal feeling and experience which is crucial (Author)
2) (Tom Tellez -99)
3) This is a very important technology details."The pelvic side is moving in an oval -shaped moving, and the hip is pressed far forward". (John Smith told the author at visit, UCLA-89. Medical parlance: = Pelvis Pelvis, will continue to be used.
4) Note! The circled. The short ground contact and subsequent uplift of the foot (b - c) takes place so fast that a normal video recording rarely can show this. The common perception is that the foot contact is always on toe without the heel contact.

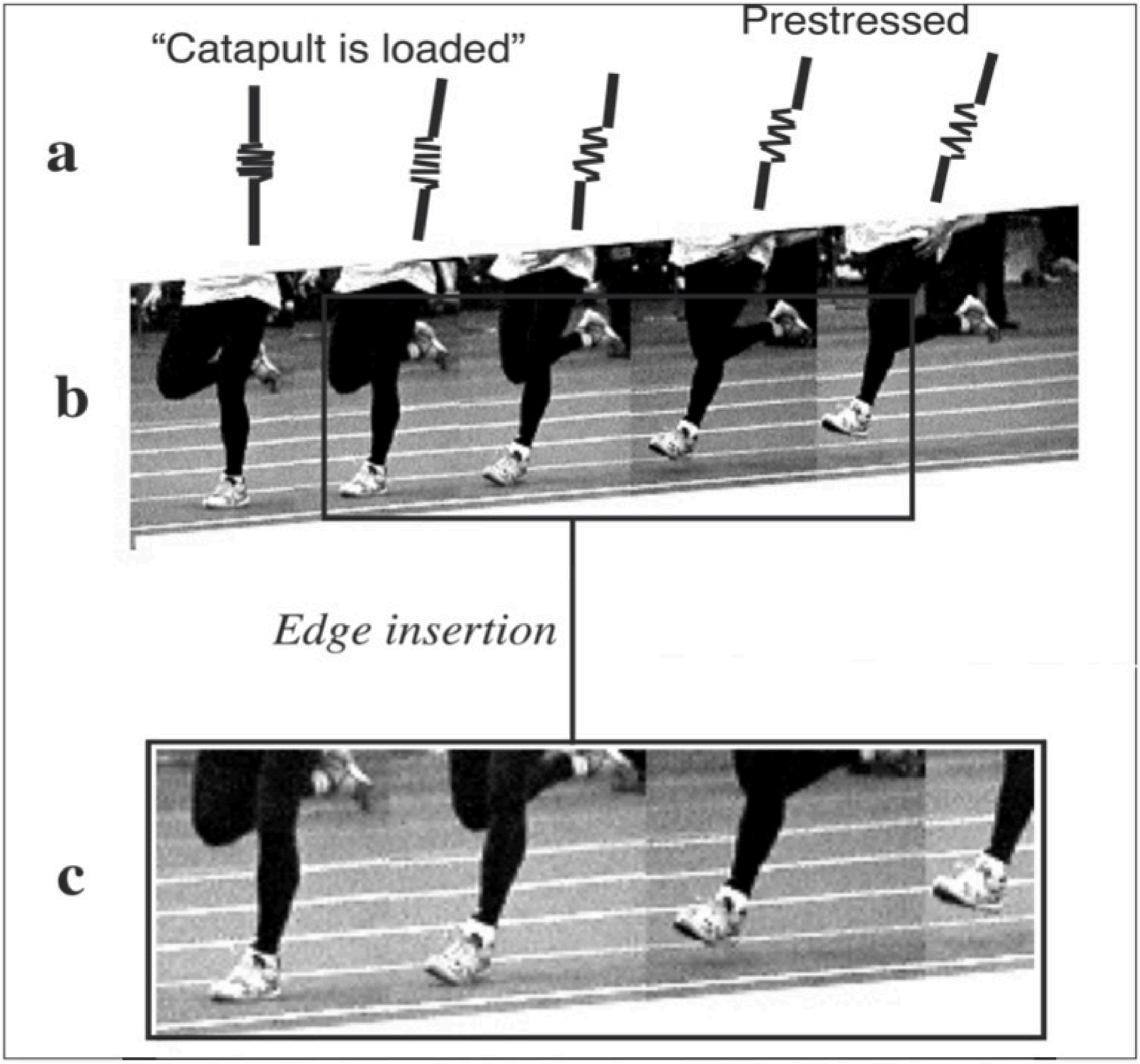


Fig. 7 *The feet edge insertion. Prestressed of ankle ("elastic steel shank"). Extension with "catapult effect"*

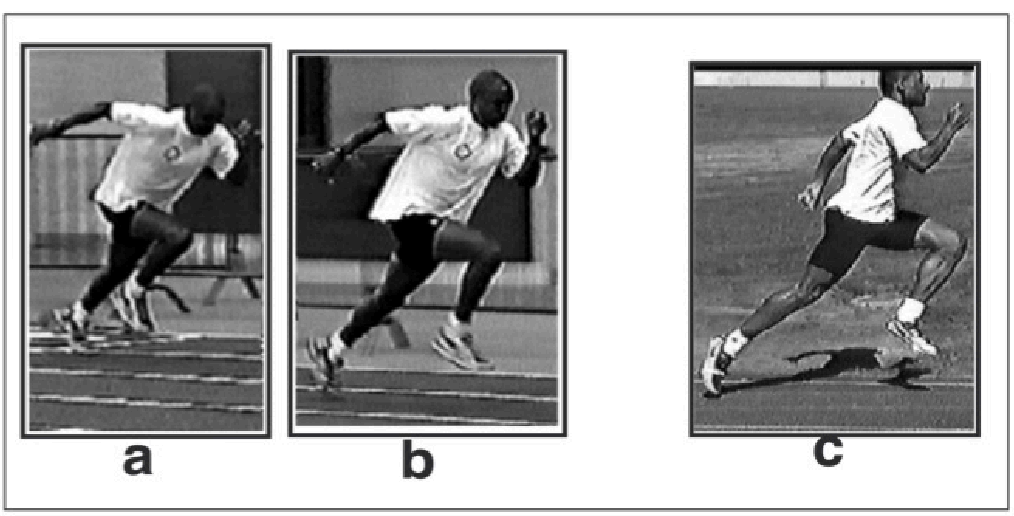


Fig.8 *The direction of the take off's force*

The initial contact with the runway makes the the edge of the ball of the foot (Fig. 7C), then during “a micro second” the heel (Fig.5-7). Elastic energy, stretch reflex and muscle power then extends the ankle, which helps boost the power. This power is also affected by will*), with the exception of the ankle’s extension. Foot ankle - lower leg (Fig.7, a-c) can be likened to a biased elastic spring steel, which at the touchdown is bent and clamped together followed of a “catapult” effect.

The right feeling in sprinting

- The take off from starting block occurs with perfect extensions directed through the trunk (Fig. 8 a and b)*). Already in the early stages of the race most of the sprinters characterized with a more imperfect extension in the knee joint, providing a more propulsive force. The inclination of trunk becomes progressively more upright (Fig. 8c). The final push off occurs with an inward rotation of the leg in the hip. After the foot’s edge-insertion and heel contact, the leg is pushed backwards and inward rotated over the big toe.

- The touchdown is done with a feeling of “wait for” the ground pliable as frequency and speed increas. Important the sprinter does not force a stamping action from a high position into the ground. At low altitude (Fig. 7C) the explosive take off process is starting with muscle prestressed to add the elastic energy (“steel shank catapult” is loaded). The foot then is rotated” downward-outward which creates edge insertion.The challenge is to find the right location at touchdown ie. just right high center of gravity in which the foot hits the track gradually longer in front of CG. During the continued acceleration of the race (**Acceleration II**) and at maximum speed, front foot optimal landing whereby the highest power could be developed during the SSC (stretch shortenings cykle)

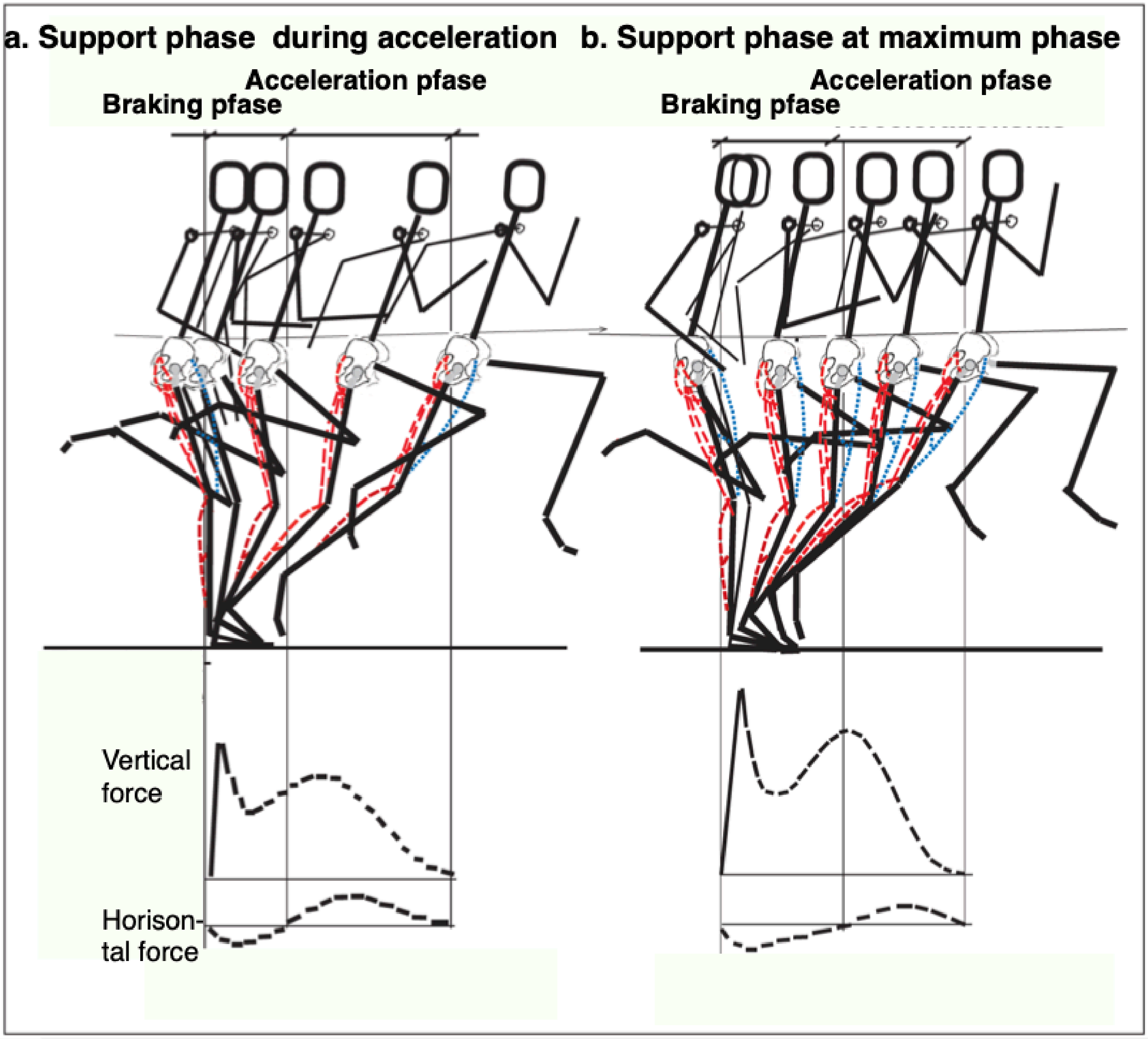


Fig.9 *Biomechanical analysis*[1,2] *of the ground phase in the sprint stride (also page 51) shows motion technique, and vertical and horizontal "reaction force" from the track during ground contact, the so-called ground phase.During the front of ground phase , before the vertical line of center of gravity is crossed, there is a braking. Therefore, we are talking about a braking phase during which, among other things, the elastic energy is loaded ("steel stick - bent and stretched" when the muscle is stretched (stretched). The latter results in the stretch reflex, which together with the elastic energy is starting the push off action. During the rear ground phase the take off is accelerating and as long as the horizontal acceleration energy is greater than the braking force the acceleration takes place.*

1) Stick figures (author)
2) Processed from Ralph Mann Leichtathletic train. 12/99, 24 and Schöllhorn -95, 45.

- Quadriceps is absorbing the shock at touch-down and possibly extends the knee and hip with help of the hamstrings antagonistic function. Individually, the rotation of the hip joint of the leg during the stance phase also take place with muscle force from hamstring. This will be described more in detail later The whole pendulum phase, also called recovery phase, with heel kick, knee lift and forward swing occurs, however unconsciously, as a result of total relaxation in the knee, largely with help of mechanical elastic energy.

Acceleration I, II and Maxfas.

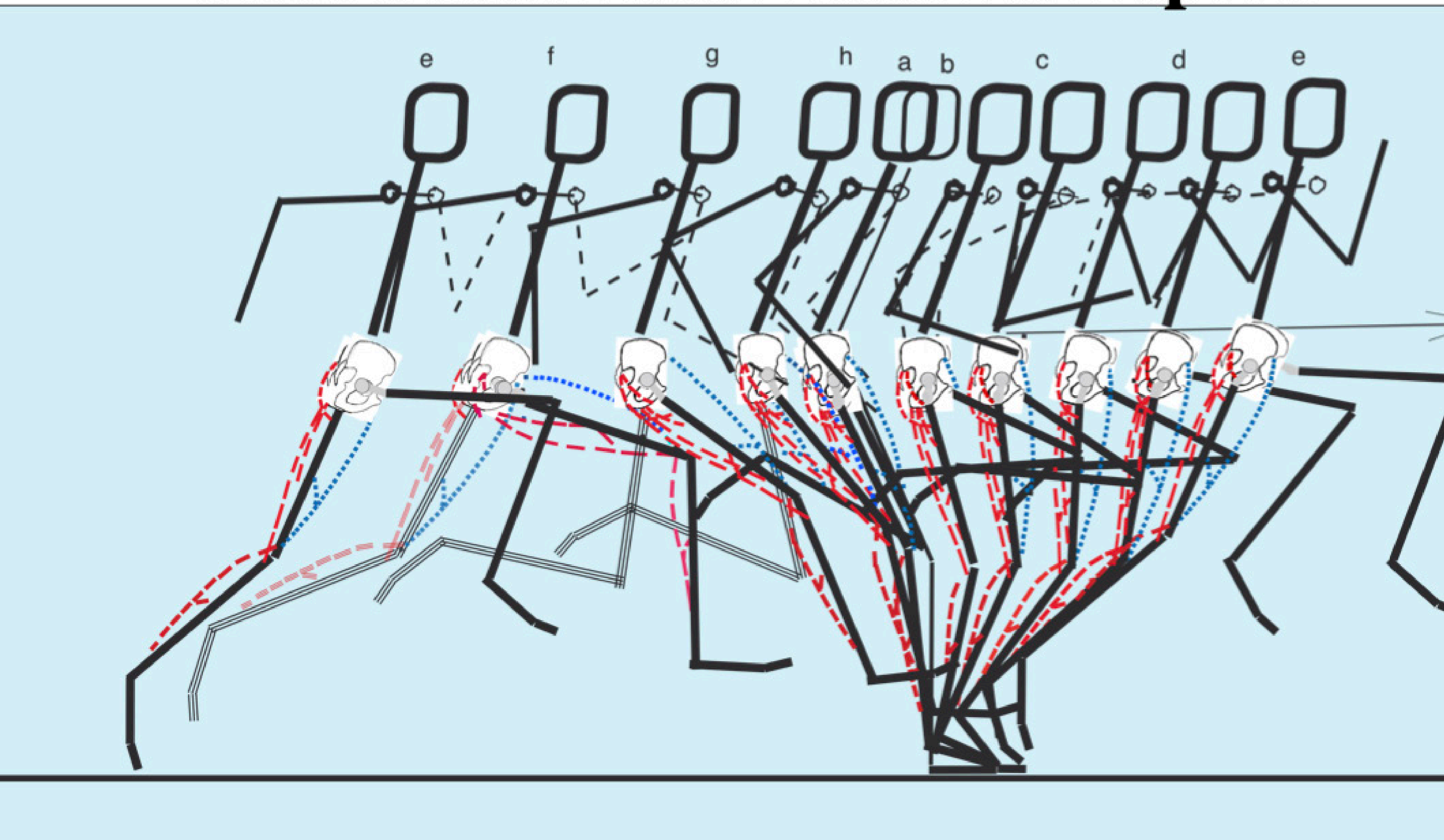
- Technology and muscular demands. See Figure 9. During acceleration the run takes place "driving" in a slightly deeper center of gravity with the torso leaning forward and with the knee joint in the front support phase naturally more lexed. At this stage during the initial stages it is great demands on muscle power from the quadriceps and gluteus. (See also page 54). Gradually, the angle of the knee joint will be greater concurrent with the stature of the torso.

- In the acceleration II and maxfas force from Quadriceps must provide enough elastic "stiffness" in the knee joint, and to withstand the increased vertical reaction force * (see Figure 9, page 14 and the data on page 28,30), and also to use the leg, as a long stable torque arm, rotating in the hip joint with power from hip extensors - mainly hamstring. the "Catapult" of the Ankle must be ended with Pelvis in the forward tilted position (ATP) ** - individually short or far behind the hip.

.

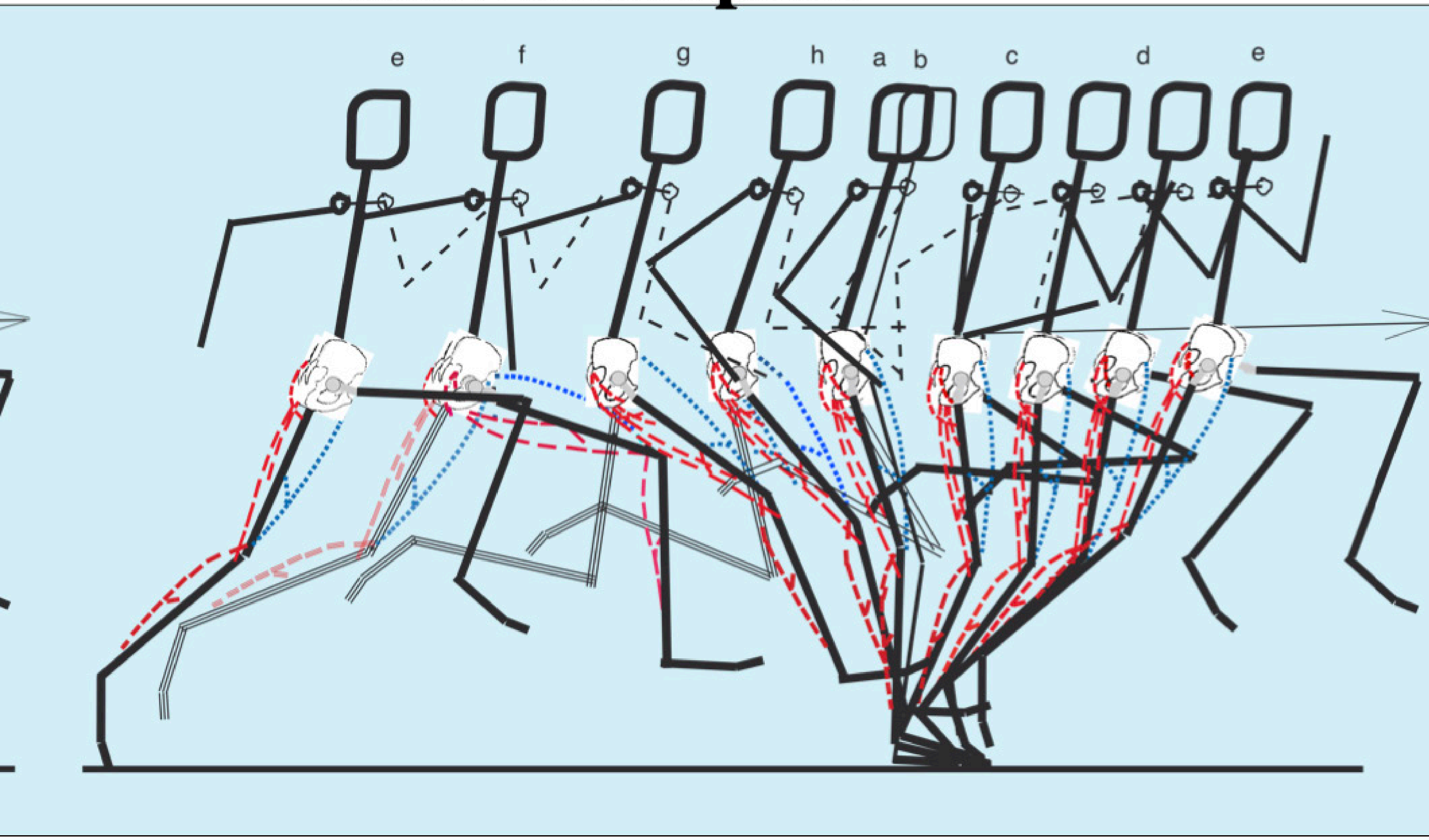
*) From Fig. 103b shows that maxfasens vertical force has increased while the horizontal reaction force is reduced. The former is always more than fifth times greater. Most of the buses has perceived the vertical force as the most crucial for a sprint performance, which greatly influenced the educational method. 2015 JB Morin showed when comparing 4 Elite (9.95 to 10.29), and 5 under the elite (10.4-10.6) as follows: 40m during acceleration load carried a higher (10%) more crucial horizontal force and the vertical force lower (2%) compared with these both. This better acceleration sannorligt expensive leads to better top speed.
**) At the back tilted Pelvis (PPT) any backward movement of the femur isrestricted..

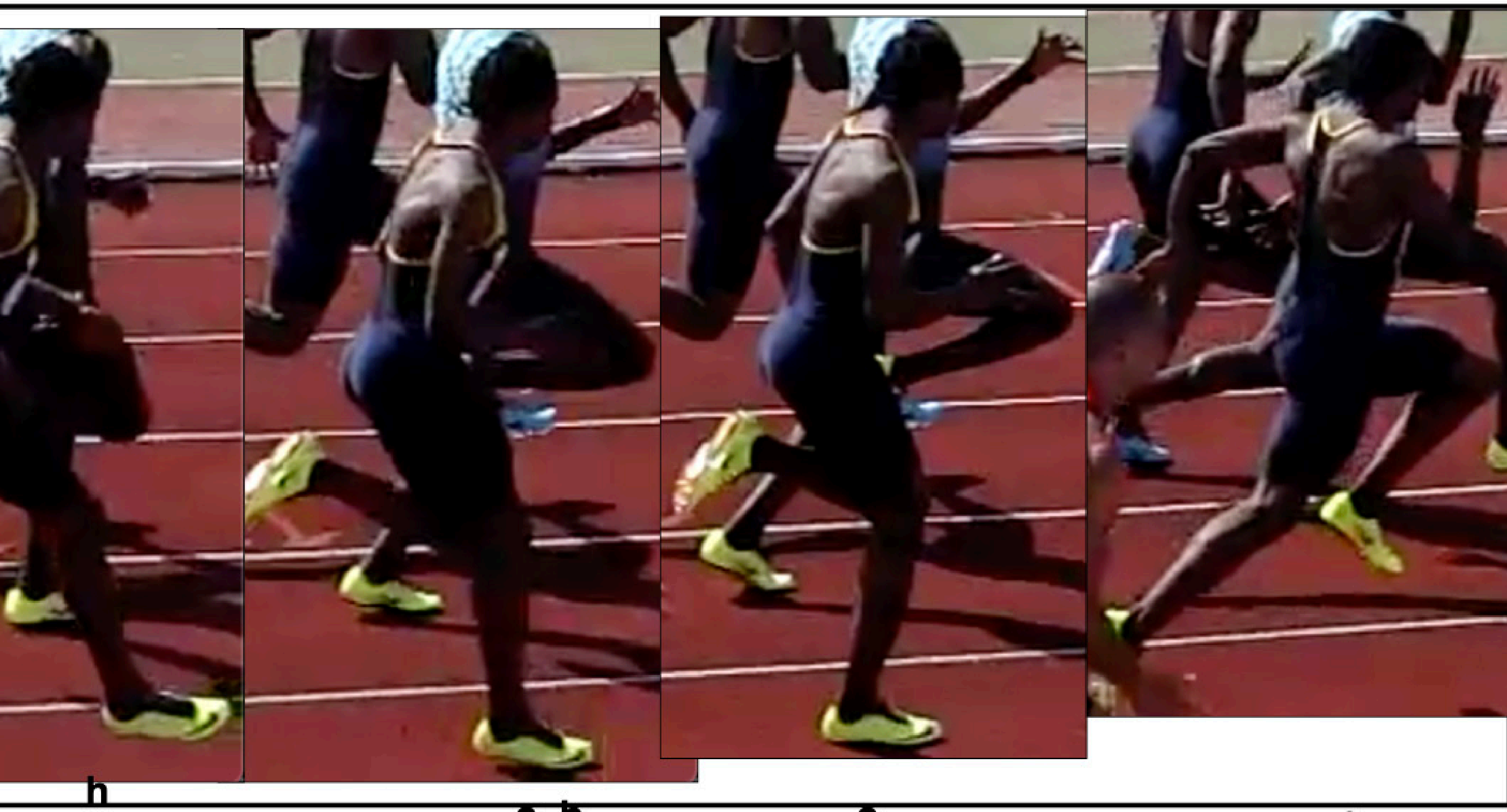
Acceleration near maximum speed



e f

Maximum speed





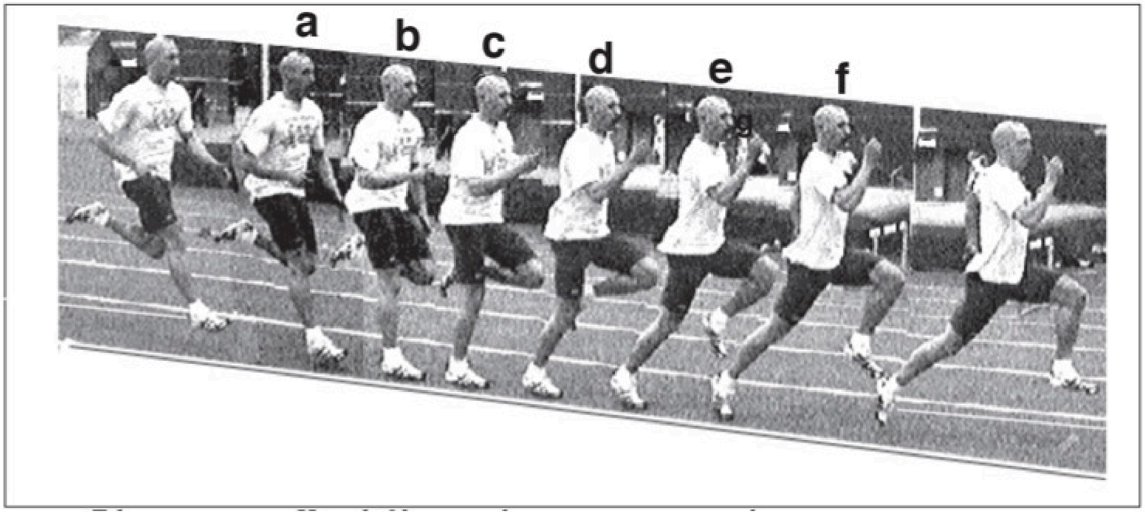
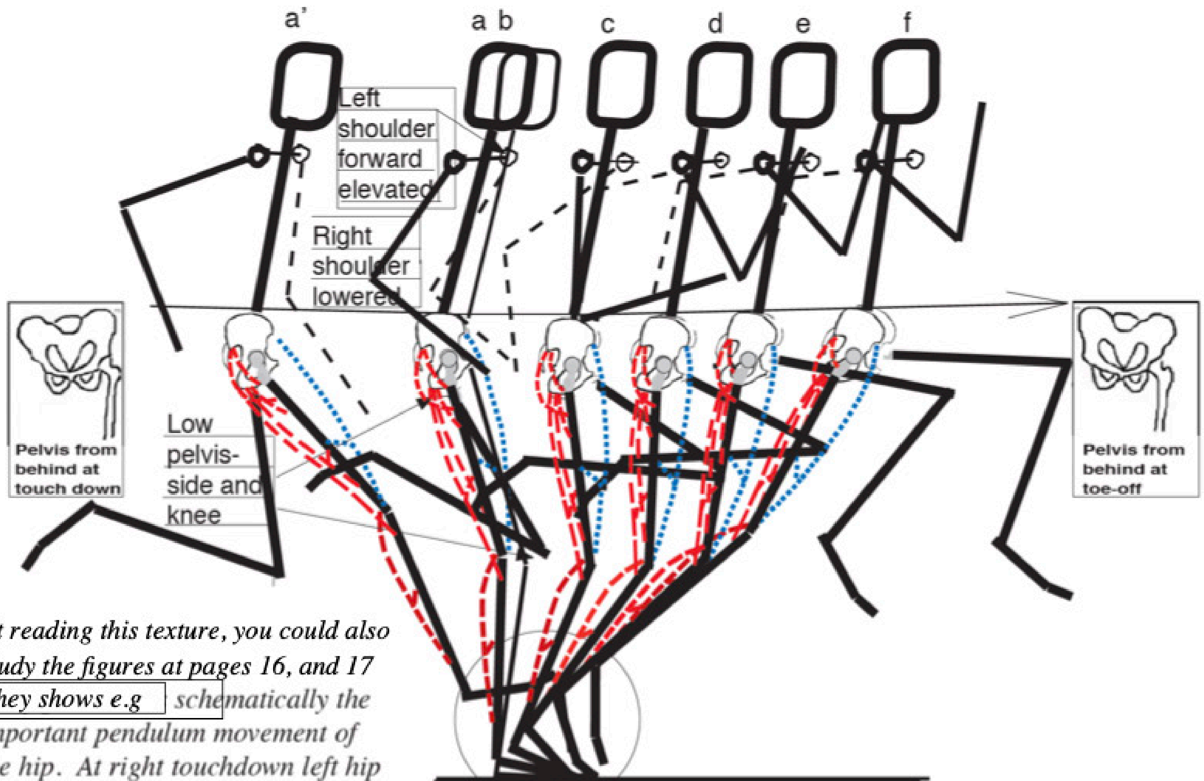
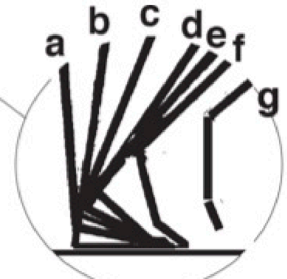


Fig. 10 *Film sequence on Henrik Olausson during maximum speed sprint*
Note: Location (a) is just before touchdown (Fig. 11) below)



At reading this texture, you could also study the figures at pages 16, and 17 They shows e.g schematically the important pendulum movement of the hip. At right touchdown left hip and knee are in a low position. From here, the left hip swings (Pelvis side) forward in an oval-shaped moving . It is important to reach far forward with the hip at the knee lift.



Knee angle is the same in the pendulum phase mode (a ') as in touchdown 27. The muscles are then prestressed and the entire leg form a relatively stable lever (cf. experience of the bone, as elastic rod, page 46). Note the oval shaped motion of the Pelvis sides[2] and large elevating foreward and lowering of the shoulders, the latter typically specifically for Bolt. An important finding of the technique of Bolt and Asafa Powell is a tangible forward inclination of the trunkat foot touch down (15 °) followed by an elevating to about 5°. This short "rocking" motion[3] occurs rhythmically, so that both the trunk's center of gravity comes closer to touch down reducing the braking. The raising of the trunk also compensates forward rotation . The movement is accomplished primarily by a strong back muscle work, which also affects the Pelvis tilting against the ATP mode. The latter is described in more detail on page 55*

*) Mode (h) in the pictures at page 16 and 17

Fig. 11 *Analysis of maximum speed*

Maximum speed

Page 16, Figure 10 and 11 shows a sprint stride in maximum speed. Already after acceleraton 1 (“Drive Phase”, international designation) is the posture usually in the nearest or close fully upright. During acceleration II until the maximum speed is reached at 50-70m (elite) can still too many sprinters in the world elite of the videos see the hint of a slight, but still somewhat further upraised posture. The picture shows Henrik Olausson (pers.rec. 10.43) such a typical posture. A top sprinter can today with relaxed coordination and an extreme endurance implement the entire 100m race with minimal speed reduction. See more page
The challenge is to complete the 100m race at top speed with the concentration of detente. The muscle energy is discharged but good speed endurance coupled with mental concentration makes it possible to maintain the speed. The sprinter must concentrate on a long acceleration distance. Often starting speed overemphasized at the expense of the very long acceleration.
That during the first third part of the 100m race achieve high step frequency, the second third part obtain maximum speed and during the last third maintain momentum with speed endurance might be a good tactic. [1]

Focus 1: High step frequency and “float” with the help of large horizontal “driving force” from the beginning.

Focus 2: Accelerate to maximum speed, while maintaining high frequency, but with a powerful shoulder and hip work[2] (See fig. 11 with text.) produce a drive force in harmony with a “big wheel “- that is, long levers - Pelvis plus the whole ro tating leg in the hip joint (More about this on page)

Focus 3: When the maximum speed is reached, try to maintain it, without too large speed reduction, with fast endurance ability. During this final phase of the race, may relaxation also be extremely crucial. Among other things, to exploit the elastic energy and the stretch reflex (SSC)

1) John Smith, interview (Author-89)). Without losing focus on a job well done hip work with the large range of motion ((“Ovals”,(Author))

2) According to John Smith. important technique detail (Author-89)

3) Magnus Warfvinge 151212 (Described for the author, which enthusiastically confirmed iaktagelsen. Common conclusion: “A neglected technical detail.”)

Note again! The circled. The short ground contact and subsequent uplift of the foot (b - c) takes place so fast that a normal video recording rarely can show this. The common perception is that the foot contact is always on toe without the heel contact.

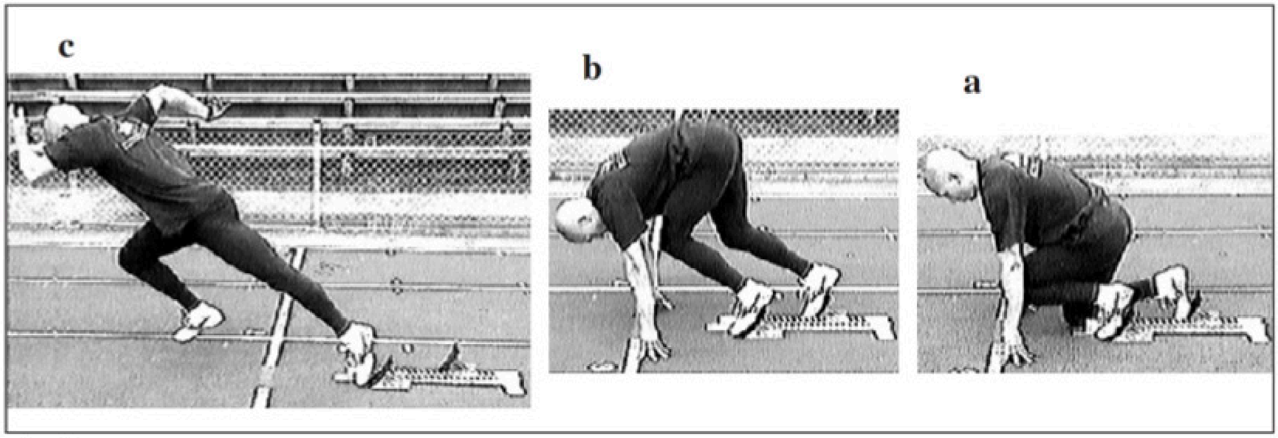
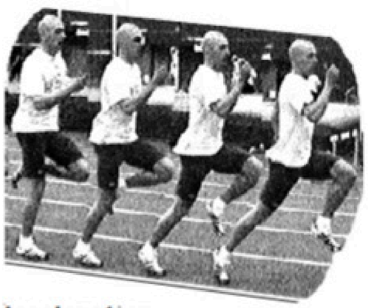


Fig. 12 *The start*

The importance of arm / leg pendulum. Impulse concept.

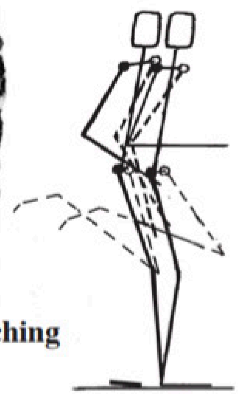
a



Rapid deceleration of arm and leg pendulum at the take off

When the arm and ben-pendlingens upward motion slowed, an impulse is transmitted through the body and an additional force is obtained. The faster the deceleration, the greater the impulse.

b



Drop down and elastic catching of hand and forearm in touchdown

Left hand and forearm (dashed in fig) is dropped down and "is catched" by an elastic biceps muscle witht an "open angle" in the elbow joint (in a phase of more realigned left arm when the hand passes the thigh in low position). The arm "bounce" up to a slightly smaller elbow angle. Right arm swings forwards upwards with a smaller angle (about 90 °) to coordinate with the left knee lift.

This rapid motion switching, the transition from extending to flexing of the arm, (Biceps muscle works eccentrically here and elastic) give a significant impulse and force.

Fig. 13 *Analysis of the importance of arm / leg pendulum, cont. (See fine text style page) **)*

The start.

The requirements for a good sprinter start is requiring some perfectly executed technologies details.

"On your marks".

At "on your marks" (Fig. 12), a few seconds for a final total concentration. Important details, such as: Vertical arms with shoulder width distance, fingers spread out, appropriate distance between the blocks and the starting line, the head possibly bowed.

"Finished"

Evenly distributed weight of the support points. The "finished" foot blades are pressed against the front and rear boot block so that a muscle preload is created. Important that both leg's muscles get the preload.

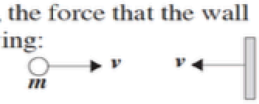
"The starting gun"

At the starting gun the sprinter push-off from the front block while at the same time a backlash is created through the body against the rear block. *) Henrik: "a bang on the block" (Occurs few hundredths of seconds before the pressure on the front block). The starting method lead to that the sprinter natural is running out from the block and quickly achieve high cadence. At the push off, Henrik Olausson is showing (see picture), a perfectly executed extension in a straight line through the torso and head. Below and in fig. 13 the arm / leg pendulum are analyzed. See also fig.11.

---

*) The mechanics explains this with the concept of impulse. The backlash through the body is an impulse **I** where **I = mv = Ft** force) (**t** = time) (**m** = mass, body weight) which can be written $F = \frac{I}{t}$
We see here that if the time may can be reduced at the creation of an impulse the force increases and $a = \frac{F}{m}$ then also the acceleration is increasing. Examples of rapid movement whose impulse is transmitted through the body are arm and leg pendulum in jump and sprint.
Study Figure 110a, b, and then do the following experiments:
a. Double arm swings sitting on the floor. The arms swings up and is braked.
b. Simple arm swings as in running. The arms upward movement slowed in the backward and forward swing. You "lift" from the floor. In the attempts feels increased pressure in contact with floor
c. The same experiments as a. and b. but standing on a wave.
d. Try standing on the wave arm technique described in Figure 13
The wave makes a strong response.

**) This movement can mechanically be compared to when a ball bouncing against a wall. Suppose that a ball with mass m and velocity v is on the way against a wall (picture below). If the ball after impact is going back with the same speed v, the force that the wall appeared against the ball becomes as following:
$F = (p2 - p1) / t = (mv - (-mv) / t = I / t$



Where p is momentum, defined as mass times the speed v. The $P1$ and $P2$ is the momentum before respectively. after the impact. t is the period of contact with the wall. The impulse is then $I = 2mv$ ie. doubled! This also applies force F if the time t is constant. The force always is increasing if time can be reduced (compare with a Karate strike - the same principle).

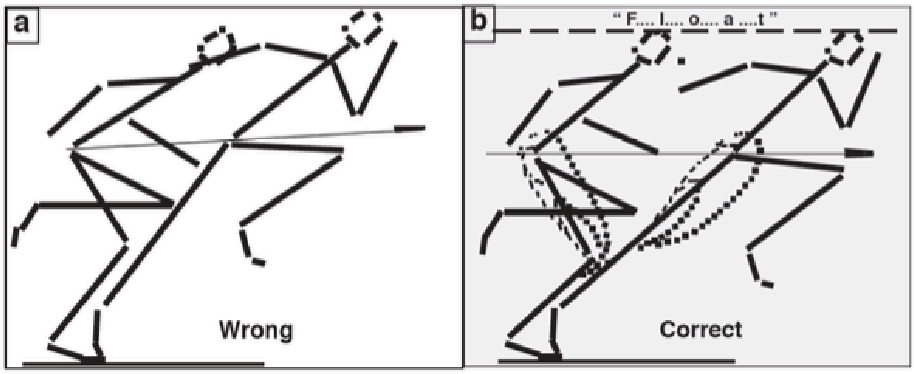


Fig.14 *100m race's first strides. Figure b) shows a perfect extension that drive the body floating forward.*
Figure a), the knee extension occurred too early.

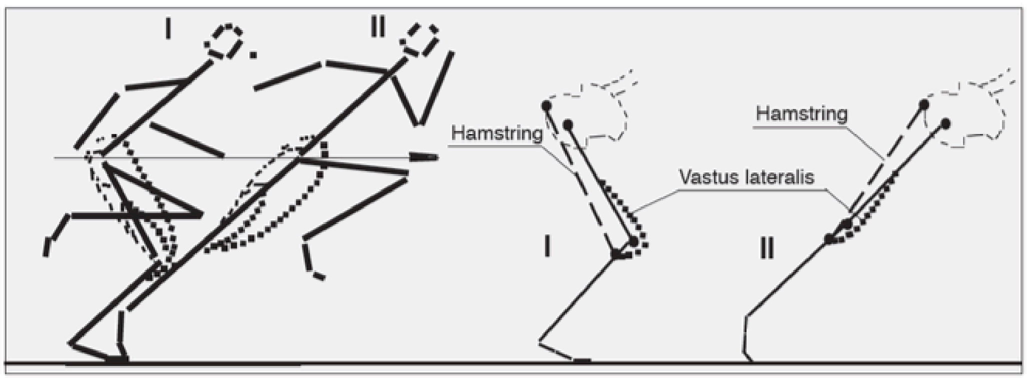


Fig.15 *(According to Wiemann)1*
From position I to position II (in the first accelerating strides from the start) rear leg muscle (hamstring) is working isometric (static) ie. is keeping against without being extended or shortened. The front thigh muscle (mainly m.vastus lateralis) is working concentrically and is involved forcefully to a knee extension, which also with help of the gluteus pushes the body flat forward.

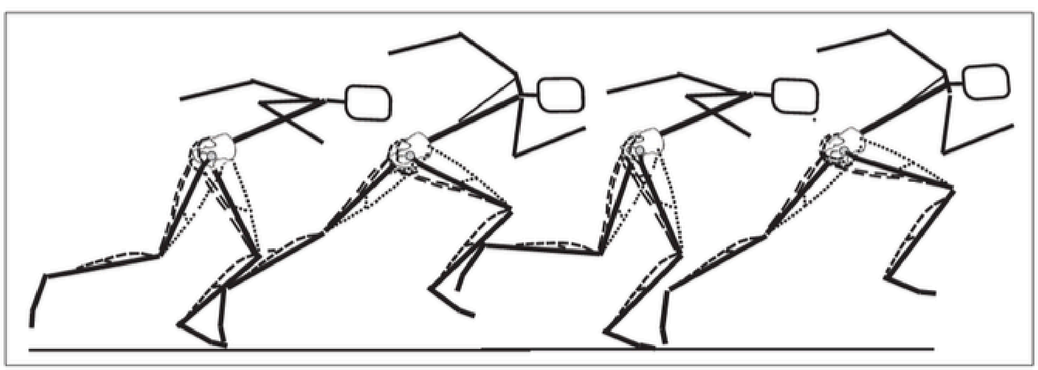


Fig.16 *Contemporary world class sprint technology the first tw steps, after a perfekt complete extension from the starting block. In these steps uncomple-ted extended knee joints, but more focus of hip power for better forward drive. The picture sequence that follows shows excellent "modern" starting technique by Johan Wissman, the Swedish record holder of 200m (20.30) also Nordic record holder of 400m (44,56)*

1) Modif. Wiemann, Leichtatletic nr.27-89

2. Which muscles are involved and how they work in the 100m-race.

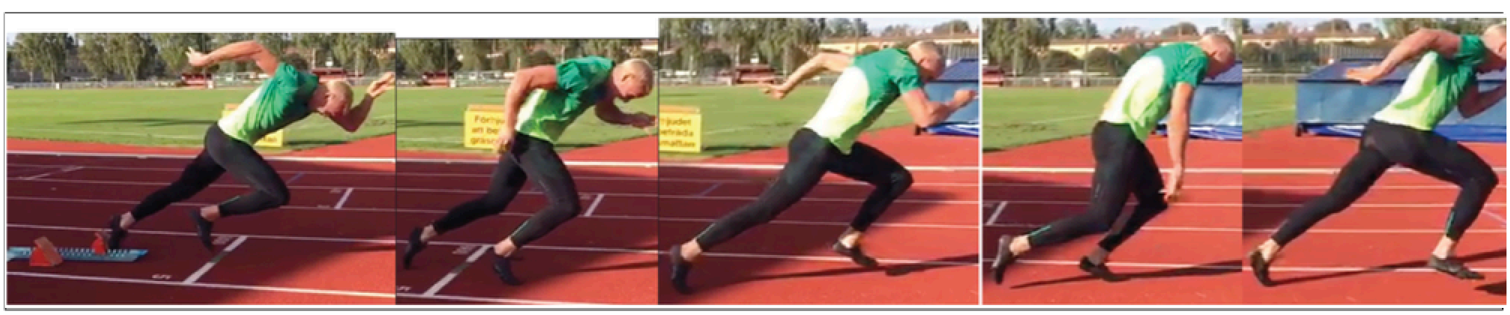
The following description of the 100m race's muscle work is a brief summary of what we will later show by biomechanical studies.

The start phase and Acceleration I.

As previously told, this process applies to sprinter in race first two accelerating strides to extend the ankle, knee and hip so that the pushing force is directed straight line through the legs, hips and the body's center of gravity (Fig. 14b). The condition of the front thigh muscle (m.quadriceps) to be able push the body flat forward ("liquid") is that the knee joint are not extended too early (Fig.14a). Therefore the rear leg muscle (hamstring) performs a powerful isometric work (Wiemann, fig15). The muscle brakes the extension of the knee joint *) so that instead the hip joint have time to extend (see Fig.15). Also the gluteal muscle (gluteus) has here a significant role in the pushing action.

New revolutionary starting and acceleration technique by world class sprinters.

A new revolutionary starting and acceleration technique is useing by world-class sprinters, perhaps mostly in Jamaica. In the first two steps, after a perfekt complete extension from the starting block (see page , fig. 1) it's an uncompleted extension of the knee joint (fig. 16), but instead more focus of the hip power for better forward drive. In the past, instead we have always tried to achieve complete extensions also of the knee joint during almost the whole distance of acceleration I.



Picture montage (Jan Melén) from videos (Håkan Andresson)

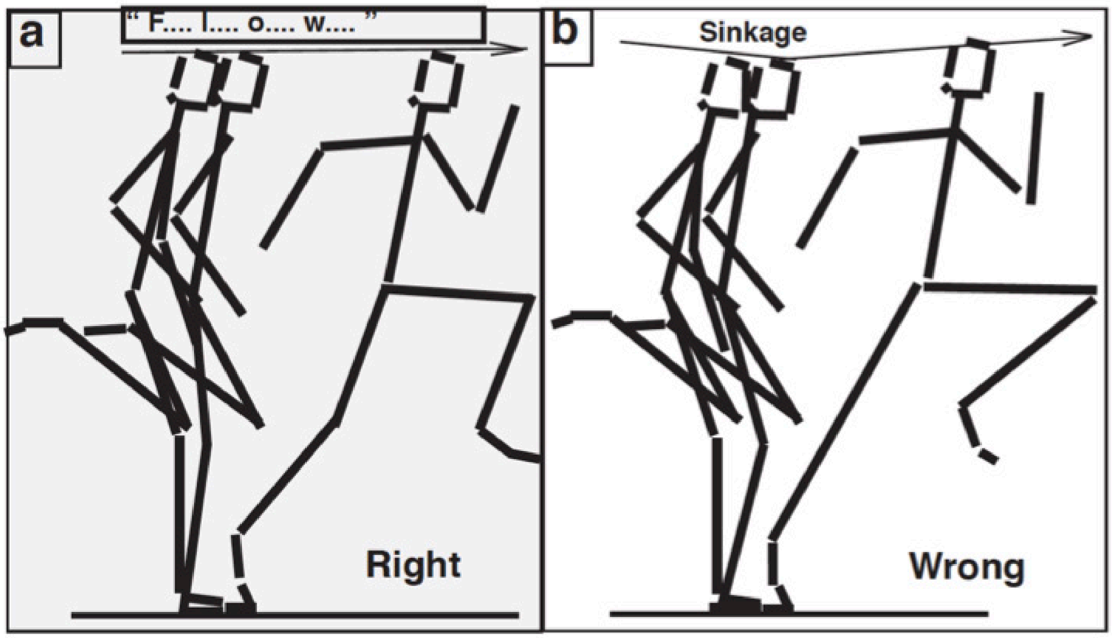


Fig.17

"Bouncy step", a flat jump ahead. The flatter the better "flow" in the run. The sprinter's up and down movement is hardly visible in top speed but is there biomechanically considered . Note the incomplete extension of the knee joint at the push action. Figure b shows an big sinkage at full and steep extension, which gives a bad flow (= too long strides and low frequence).

Acceleration II and Maximum Phase.

Bounce step and fluency sprint.

During the remainder of the race as a whole and during the long acceleration, with gradual upright posture to the maximum speed **) at about 60m, the legs are working as elastic rods. Front leg muscle, but also the ankle, "the elastic steel rail / catapult" gives a bounce effect.

As a whole, is created a "bounce step" or flat jump ahead, the flatter the better "flow". Just "fluency" is perhaps the most important feature of a well-developed technology sprinter. (Fig.17a)[1]. Here, both the anterior thigh and calf muscles have great role in preventing an excessive big sinkage in the ground phase (fig.17b), by among other things taking up the impact against the ground with elastic energy and stretch reflex. The whole leg forming a solid elastic lever from the hip joint, which both seem to ballistic ("bouncing") for stride length, and rotating with a speed crucial for the short contact time in the ground phase and thus stride frequence. Dominant muscle groups in the leg's rotation is the hip extensors gluteus and posterior thigh muscles during down pendulating of the foot towards the path and the latter muscles for the rest of the pushing action. This will be illustrated with summary of biomechanical analysis of sprint running

Tom-Kling Baptist multiple Swedish Champion of 100 and 200m

**) The most important part of the race. Here the greatest difference between the

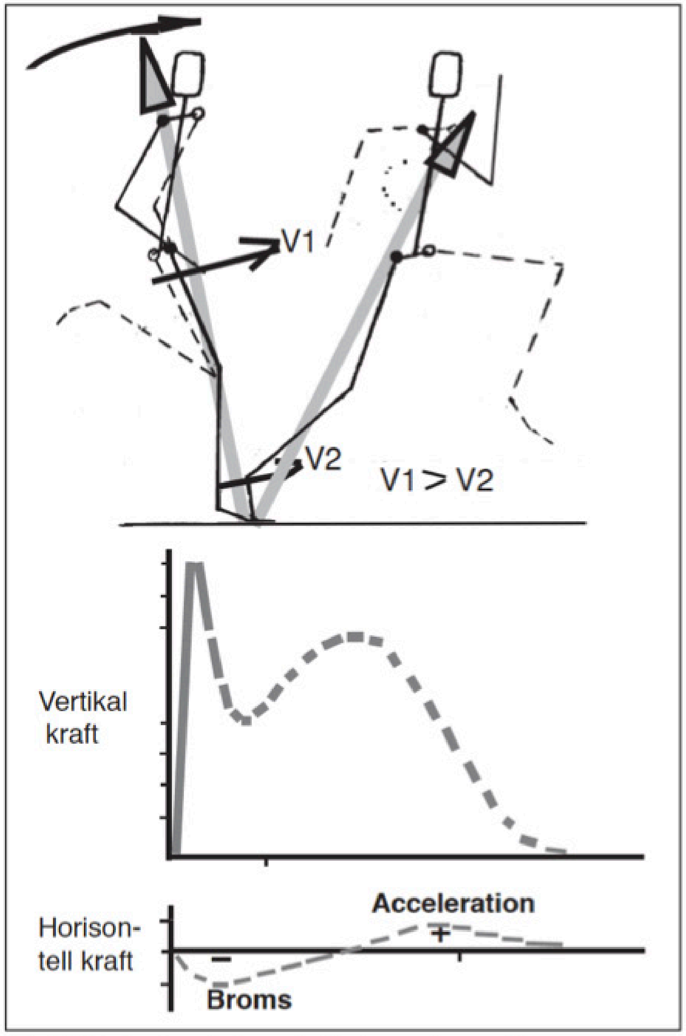


Fig 18 *At the touchdown in fast running and jumping, legand torso together can be like a springy rod*

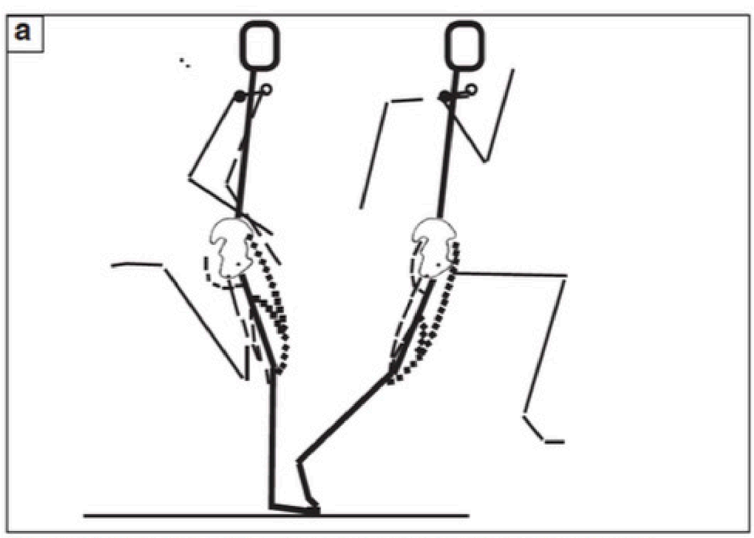


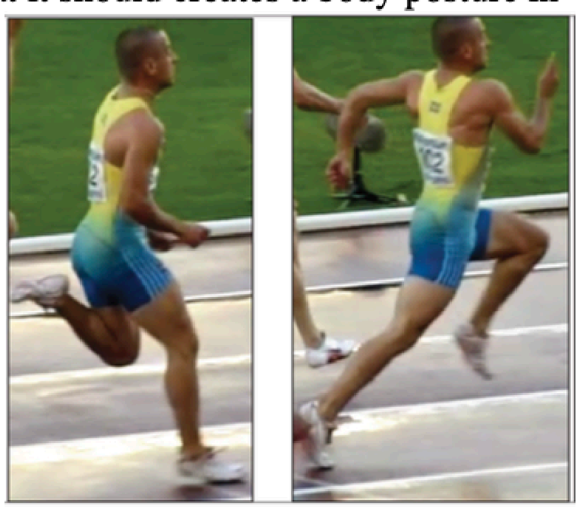
Fig 19 *Previously, the advise mostly has been an attitude for a neutral stance with slightly forward tilted pelvis.*

The rod as a lever and technology

In some positions in ground phase of the sprinter's stride and the take off in longjump the legs and the body together is like a springy rod (fig. 18). The rod is a lever with its support point of the ankle. The force from the ground throug the rod during the rotation forward-upwards, gives both a braking and by means of elastic energy, an accelerating force.
Upper parts of the rod have higher operating speed (V1) than the lower (V2) at the same rotational speed (so called angle speed). This would mean benefits with a high center of gravity position to make better use of the pole of rotation. The figure also shows the vertical and horizontal reaction force from the ground. The sprinter / Jumper creates among other things, increase in the external lever and higher CG position by that left shoulder is lifted higher when the right foot is landing in the ground and the opposite relationship right shoulder and left foot (see also fig.6 page 10). Furthermore the pelvic posture is impor-tant for the same reason. This especially true for sprinter model B (see below) with typically tall posture which creates long levers.

3. Body posture of the maximum speed. The Pelvis, different sprinter models

Previously, the view was that it should creates a body posture in neutral position (Fig. 19). Only with slightly forward tilted Pelvis (APT"(Ante-rior Pelvic Tilt)). This couldn't be the whole truth given the presence of world elite sprinters with signi-ficantly APT mode. With respect to Pelvis stance and the push- off leg motion during we can distinguish two sprint models.(continue page 27)



Stefan Tärnhuvud, in many years during 2000-centurary, the best swedish sprinter

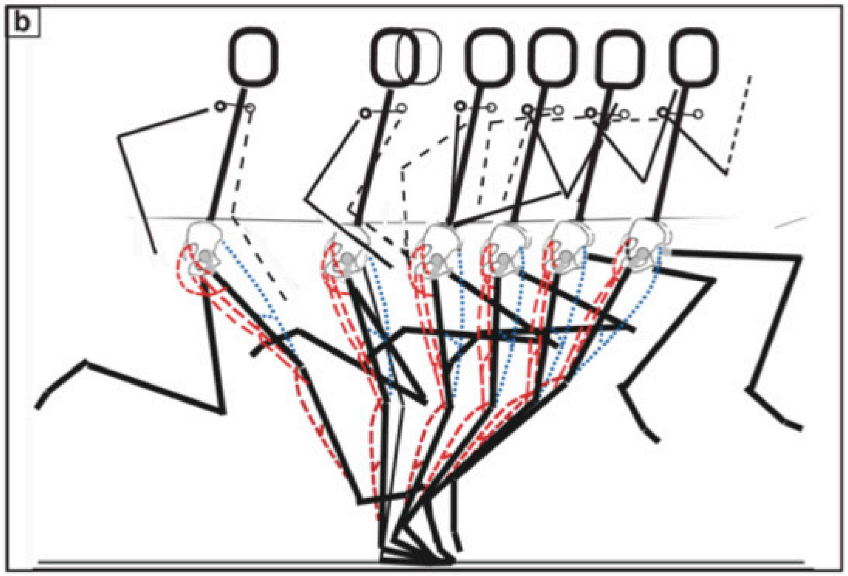


Fig 20 *Sprint Model: APT mode, "long rotation in the hip joint"*

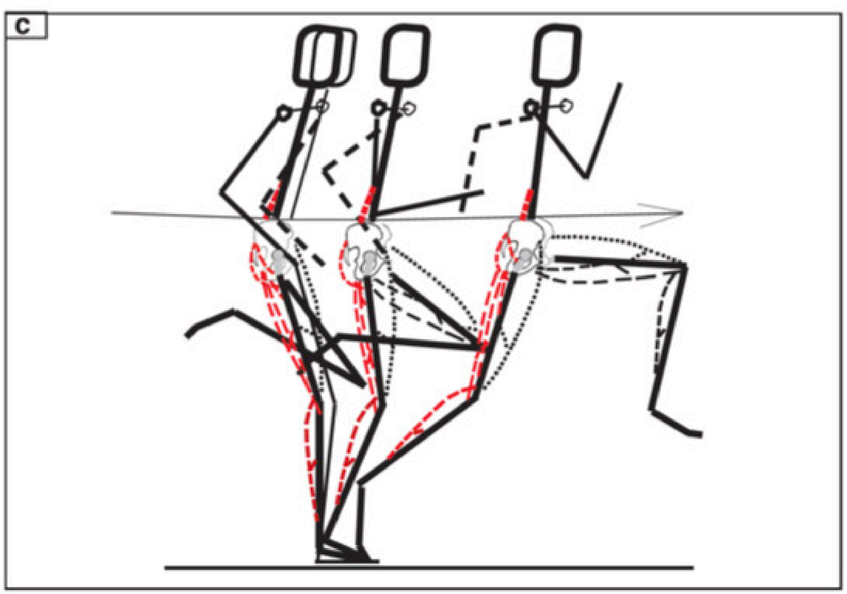


Fig 21 *Sprint Model: PPT-APT mode. Here "short rotation in the hip joint"(Long rotation, see page. and)*

A. APT mode. “Long rotation in the hip joint”[1]

(Fig 20, detailed description page. 55).
Pelvis forward tilted (“APT”
(Anterior Pelvic Tilt))
Advantages:

1. Long distance between muscle attachments of the hamstring gives the possibility to high horizontal force in the ground phase.
2. Contributes to a more “floating” running - an important basic principle for all sprinting.
3. Ability to extreme improvement of hamstrings horizontally force production.

Disadvantage:
Requires, which many lack, extra specifik strength
in the hip extensors, with a very well developed posterior chain
May be possible by training specific technically with Powersprint® (Author)

B. PPT-APT-mode. “Short-long rotation in the hipjoint,”

(Fig 21, detailed description page 57)
Pelvis first backward-tilted, PPT-mode
(Posterior Pelvic Tilt
Then individually to APT mode. Description page).
Two alternative:
Hamstring (Hip-dominance, Tidoff, Wiemann)
Quadriceps- dominance.
Hamstring: Isometric and antagonistic.
Advantage:

1. Tall posture with long levers is created (see above)
2. Energy saving way to develop great horizontal force, both during acceleration and maximum speed, as in final phase of the race.

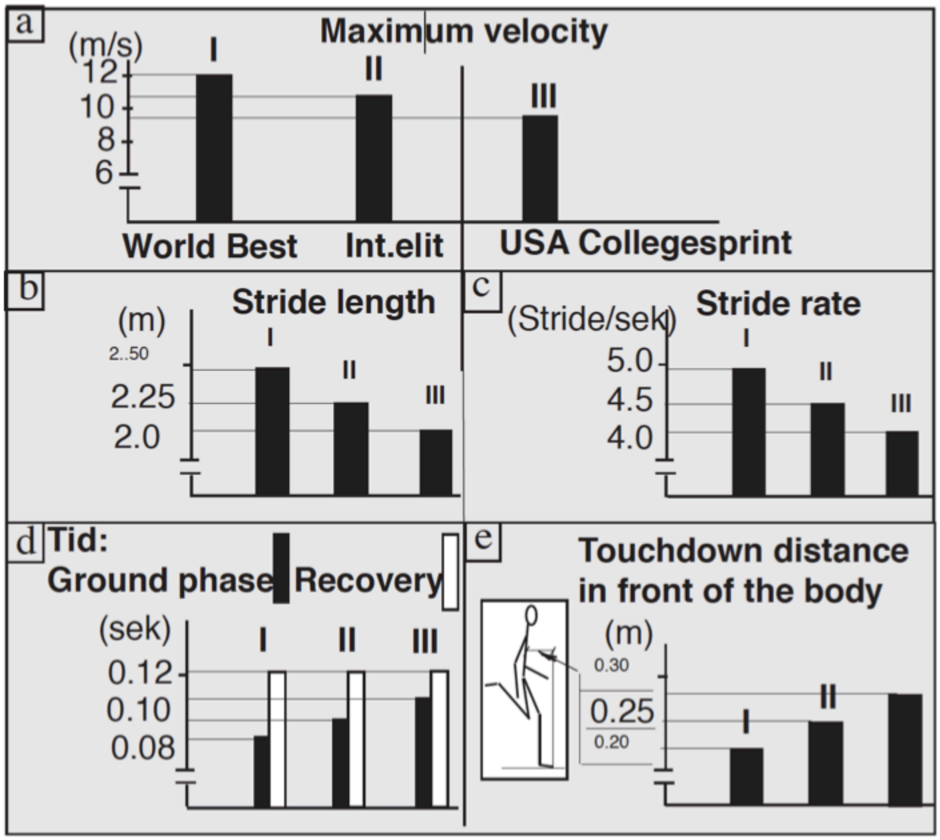


Fig. 22 *Biomechanical comparison :*[2] **I**. *World Best (9.8)* **II**. *Average (10.3)*, **III**. *College Sprint*

4. Biomechanical analysis of world best.

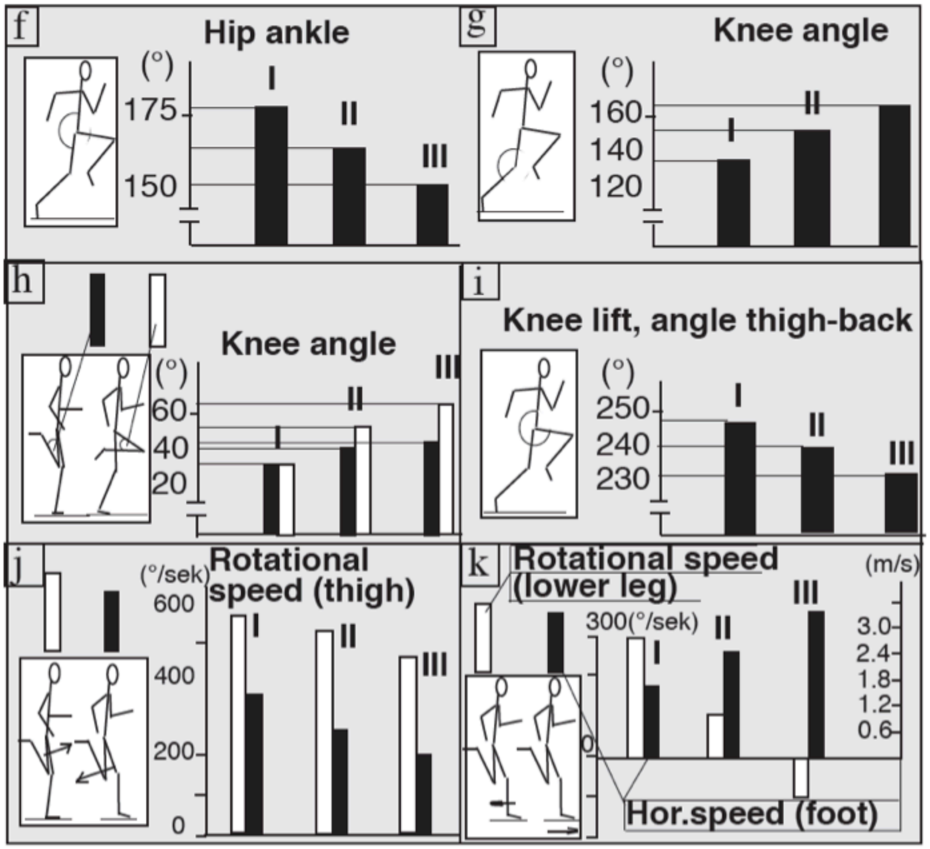
Maximum velocity, comparative of world-record holder, international average level and U.S. College Sprinter

Extensive research has been conducted in the United States to determine biomechanical differences between performance level equivalent: 1)

a. World record sprinters (Green, Lewis, Burrell and others (9.8s /100m),
b. Average international elite (10.3)
c. American College printers

We shall now briefly summarize what is characteristic for max speed running of these groups. In Figure 22 a-k, we can study:

Velocity (fig. a) **Stride length** (fig. b)
Stride rate (fig. c). World record sprinters achieves both higher benfrekvens as stride length (at body length 180cm, close to 5 steps per second respectively. 2.50m in stride length.
Ground contact and recovery phase time (fig. d). Better sprinters have less contact time, while the time of the recovery phase, interestingly, is equal for all levels.
Distance at touchdown between toe and body
(fig. e). Better sprinters makes the touchdown closer to the body. Note: But not too close, you have to find an optimal position for the stretch shortening cykle (SSC).
Continue page 31



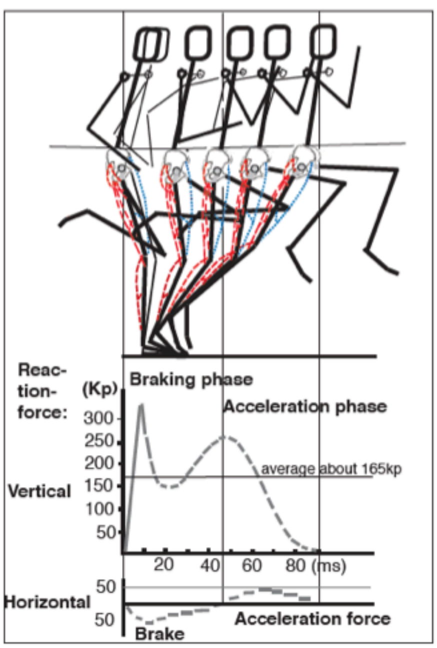


Fig. 23 2)
Max speed, vertical and horizontal reaction force from the runway.

The forces are measured with the pressure plate and This applies the world class sprinters with a contact time of only ca.87ms

2) Drawings: Diagrammet processed from Ralph Mann, -Leichtathl. train. 12/99, 24. Lower diagram processed from Ralph Mann, The Mechanics of sprinting, "2011/42

The angle between the trunk and upper leg on the takeoff (fig. f). Better sprinters quit the takeoff with upper leg nearly in line with the torso.
Knee angle at takeoff (fig. g). Better sprinters have a partial knee extension, thus with a small knee angle.
Angle, thigh and lower leg at the knee lift (fig. h) are for better sprinters less. Through a shorter lever, these will have a faster knee lift during ground phase.
Knee lift at takeoff (fig. i). The angle between the torso (back) and the thigh at knee lift is greater for the better sprinters.
Rotational speed (thigh) (fig. j). **and lower leg** (fig. k) Higher rotational speed of the better sprinters.
Foot horizontal velocity (fig.k). Foot speed close to zero at touchdown of better sprinters.

Max speed, biomechanical force for a world class sprinter

Fig 23 shows the vertical and horizontal so-called reaction force from the track for a world class sprinter. The contact time in the ground phase is only approx. 83ms and the vertical force as high as 450kp (= 4500N) in the tought down.
There is a brief "power spike", which shortly subside followed by an increasing force to approx. 350kp. The forces are measured with the pressure plate.

Film Analysis of 100m races at the Tokyo World Championships -91

A film analysis 1) of 100m races at the Tokyo World Championships -91 showed:

1. Changes in stride length and step frequency followed a patterns, which allowed to keep the speed to the finish.
2. In the final, Lewis had a shorter stride length and higher cadence than Burrell.
3. In order to achieve high speed sprint requires high speed in the leg backward movement before the touchdown.4.

High hip extension speed is more crucial than the knee or ankle extension shows a comparison between elite and university-level sprinter.

E.D. Lemain & D.G.E. Robertsson

High-speed filming (100bilder/sek) and computer processing [2] (speed, acceleration, momentum, energy and power) of the top-ranked elite printers from Canada and the U.S. showed (see Figure 24), among others:

a. Hip flexor worked concentrically during forward swing and then developed 4100w.
b. The power output was 3200w for hip extensors (concentric work), when the foot pendulate's downwards against ground.

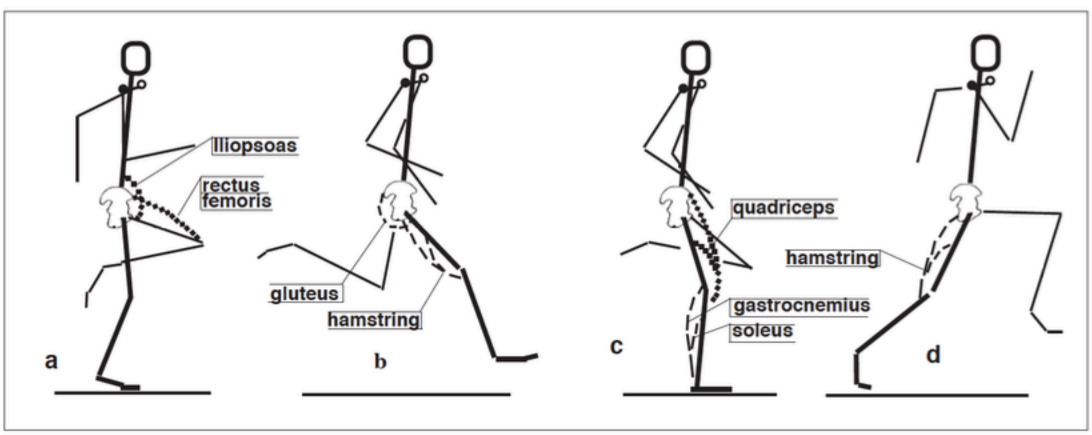


Fig 24 *Dominant muscle groups during the phases of sprinter stride*

c. Knee absorbs (eccentric) when the foot lands (the so called. foot-strike) with effect 2500W followed by only 200w at beginning of the knee extension .*

d. Knee flexors (hamstrings): 4800w in the takeoff! This muscle activity is needed, explains these researchers, in order to prevent knee hyperextension. **The researchers concluded of the the survey:

It should be higher priority than in the past for training of hip muscularity before training of the knee and ankle-joint muscles.

A.O.Korneljuk, National Coach U.S.S.R -81

113 sprinters incl. national elite participated in the survey which extensive 600 different biomechanical factors. It was found among others that at the foot-strike, and the first part of the ground phase (fig.24c), developed maximum force torque in the ankle and hip. Ankle will then take up the eccentric force***with the 8400w. The researchers concluded that the ankle had a crucial role.
Main technical requirements to achieve high top speed, according to researchers:

1. Reduction of the brake in the first part of ground phase
2. **Emphasize the role of hip extensor to reduce the speed loss in the ground phase.**
3. High acceleration of the thighs so that they cross each other with the highest possible speed ****

*) The last low value indicates that the quadriceps mainly have a dampening function ie. helps to prevent a large sinkage during braking phase

**) Wieman and Tidof have another more compelling explanation (page).

***) Is also called amortisation. The ankle suppresses elastic and prevents ex cessive sinkage (page.).

****) Heel kick close to the seat, among other things, contributes to this. see

1) Processed from a new stud. in Athletics, london 7(-92, 1, p. 47-52

2) Canadian study. Processed from Track and Field Journal, 13-17,-89

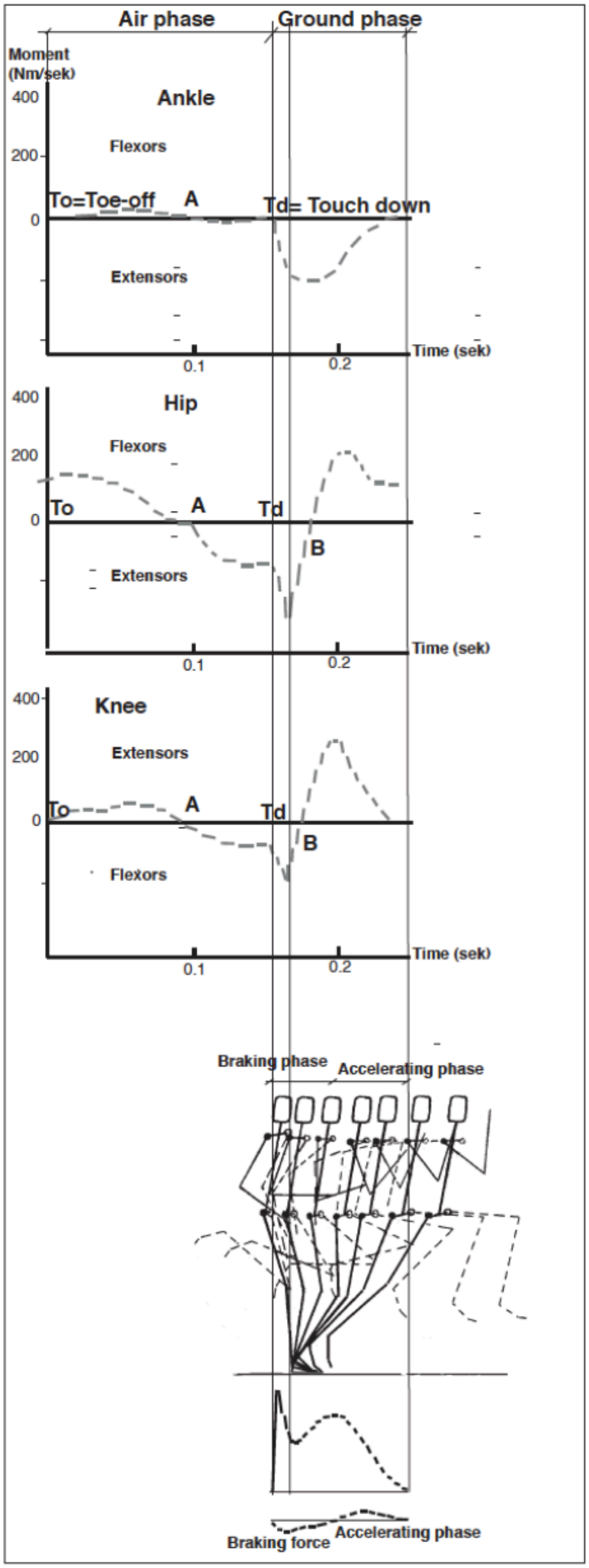


Fig 25

15 top-ranked U.S. sprinters were investigated in max speed[2]. Upper graphs show power moment and the lower reaction force from ground as measured by pressure plate.

Ralph Mann and Paul Sprague [1)]

15 U.S. sprinters of high class was filmed at top speed after 40m acceleration distance. Filming with 150bilder/sek and computer analysis revealed the following facts about muscles that dominate the different sprint phases

1. Hip extensors (gluteus, hamstring) and knee flexors (ham string) dominated when the leg pendulate's downwards (Fig. 25, A - Td) against the ground and during the ground phase's first part, Td - B. This suggests sprinter attempt to reduce the brake at the footstrike by these muscles pull the body over the touchdown point (**better: With these muscles rotate the legs so that thebody is driven over the touch- down point *)** To achieve this requires considerable muscular effort from the hamstring. Here is also the greatest risk of injury. Statistically has an elite sprinter greater risk of injury than a less good sprinter according to the researchers.

2. The ground phase's center (B) the hip extensors (gluteus) is changed to the hip flexors to rotate the torso forward, **) Hamstring dominate the end of take-off' to according to scien tists prevent knee hyperextension .***)

3. It was found that the contribution from the ankle extensors (the gastrocnemius and soleus) to the take- off power, is slightly less than previously thought. Ankle strength was namely also im portant for to suppress the foot-strike to prevent excessive great sinkage. Similarly seems knee (quadriceps) absorbing .****).

The researchers argued in summary that:

Hip extensors and flexors provides the greatest contribution to high running speed.

Important is also the body's location at fotisättningen, with an optimal distance, foot - center of gravity (see p.28, fig 22E). For just the right step length, the foot is placed in front of the body, giving rise to an inevitable brake. This can be reduced by the foot's horizontal speed in the running direction is re duced to near zero..

1)2) Processed from Exercise and Sport 2, -83 Drawings ()

*) Tom Tellez denies strongly the expression "pull", in his description of sprint technique occurs simple terms: "Naturally strike the ground and push," make cycling movements ", etc. In Houston they talked about Quadriceps as most important musclegroup - hamstring antagonist.

**) Iliopsoas is braking the rotation of the leg (femur), which lead to the trunk is rotated forward. (See also p. 50). Iliopsoas will also be stretch here reactive which speed up the swingleg after toe-off.

***) Wiemann and Tidoff explains instead hamstring muscle group with adduktor magnus starring role in the take-off. Hamstring works as knee and hip extensors. see page 54).

****) Ankle- and knee- extensors as such contributes to a floating run ning, see p. 49, fig 110. In order to have time to develop sufficient power during the short time touchdown occurs, contributing stored elastic energy and stretch reflex to this.

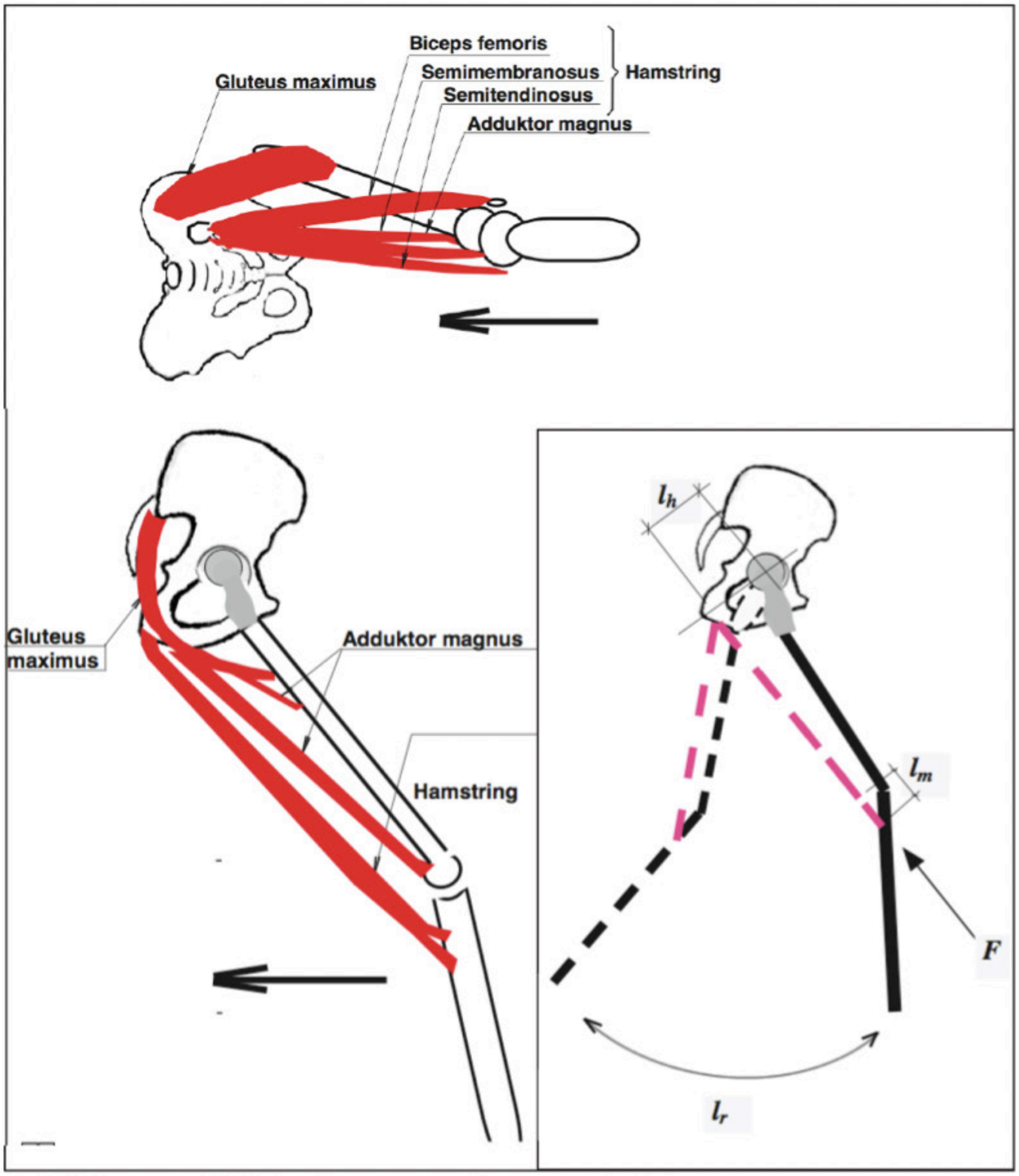


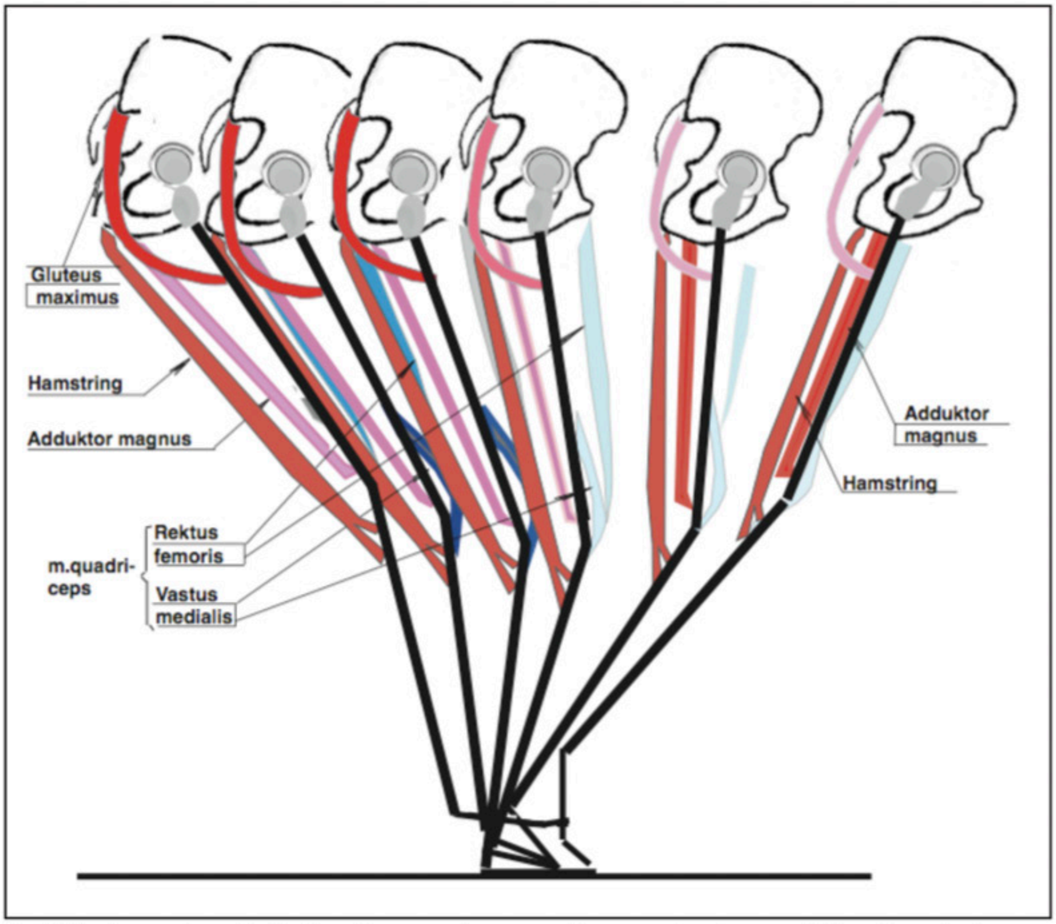
Fig 26 *Schematic model 2) of m.gluteus maximus, hamstring and adduktor magnus hip extending function.*

G. Tidow and K. Wiemann[1)]

Sprinter technique is explained in a simple way of Germa biomechanics, mainly thanks to a new anatomical approach. It has been demonstrated that the posterior thigh muscles **hamstring (ha) and adduktor magnus (am)**, in a natural motion works as hip extensors and that these muscles in the take-off at the upright running position also could extend the knee joint. A comparative study (see page 41) between sports students without specific training and elite sprinters showed that, among other things. Fig 26 shows a model[2] of **gluteus maximus (gm)** and the posterior leg muscles hip extension function[1)]. You can metaphorically think of muscles as "reins". If these be abbreviated, the leg is brought backwards and its rotational speed at touchdown increases. This reduces the horizontal deceleration at the front ground phase (see detailed analysis from page.51). The movement is accelerating during the support phase and hamstrings is continuing its work with the help of stored elastic energy all the way up to 'heel kick "after the take-off. When the foot lands in path **am** is disconnected while **gm** together with the front thigh muscles and ankle extensors are cushioning the impact and prevents excessive sinkage (ie. maintains "fluency", author.).

Recessed figure (Author.2): What an amazing design. Small leverage l_h gives with short muscle contraction l_m a relative large movement l_r when the leg is rotated backwards. Large force F is possibly produced because hamstrings also pennate design (biceps femoris and semimembranosis, unipennated [3]

1) Processed from Die Lehre der Leichtathletic, -94, 8
2) modif. Wieman. Die Lehre der Leichtathletic, -89, 27
3) Unipennated: Biceps femoris long head och semimembranosis. Parallel-fiberd: Semitendinosus and Biceps femoris short head, (Kubota, Jun 2008: Architectural and functional properties of the semitendinosus muscle.) (Woodley, Mercer. Hamstring muscles: Architecture and Innervation.) 54



2

4 **Fig 27** *The figure schematically show the stance phase at maximum speed sprinter model Long "rotation in the hip joint"+"Push". Pelvis tilted forward, the APT position (see pag 50). The principle of the hamstrings and adductor magnus.*[2] *The more gray muscles, the more it is activated. For example:*

1. *Hamstring with darker tone is active during touch down and the whole stance phase. Its muscular attach ments approaching each other ie. muskeln shortened throughout stance phase. If you look at it as a simple mechanical machine it will feature: The whole leg, which forms a lever with hip as rotation axis, is and rotated (screwed) backwards by the muscle power.*
2. *Gluteus and quadriceps is active in beginning and adduktor magnus in the late stance phase.*

Tidow and Wiemann continue.....

Figure 27 provides a further description of muscle function. Here you can clearly see how **ha** and **am** are shortening (please measure by yourself with a ruler, author.) While the model shows the muscles that dominate the work. (Darker = more toned dominance). At the end of the stance phase **am** is connected and help **ha** to extend in both hip- and knee joint. The front thigh muscles (**rf** and **vm**) take part only slightly, which overturns all previous ideas of an accentuated role of these muscles, as extensors in the upright sprint position (except first accelerating section of the 100m race (see page 51).

Fig 27b *Hip strength training in a powersprint machine*

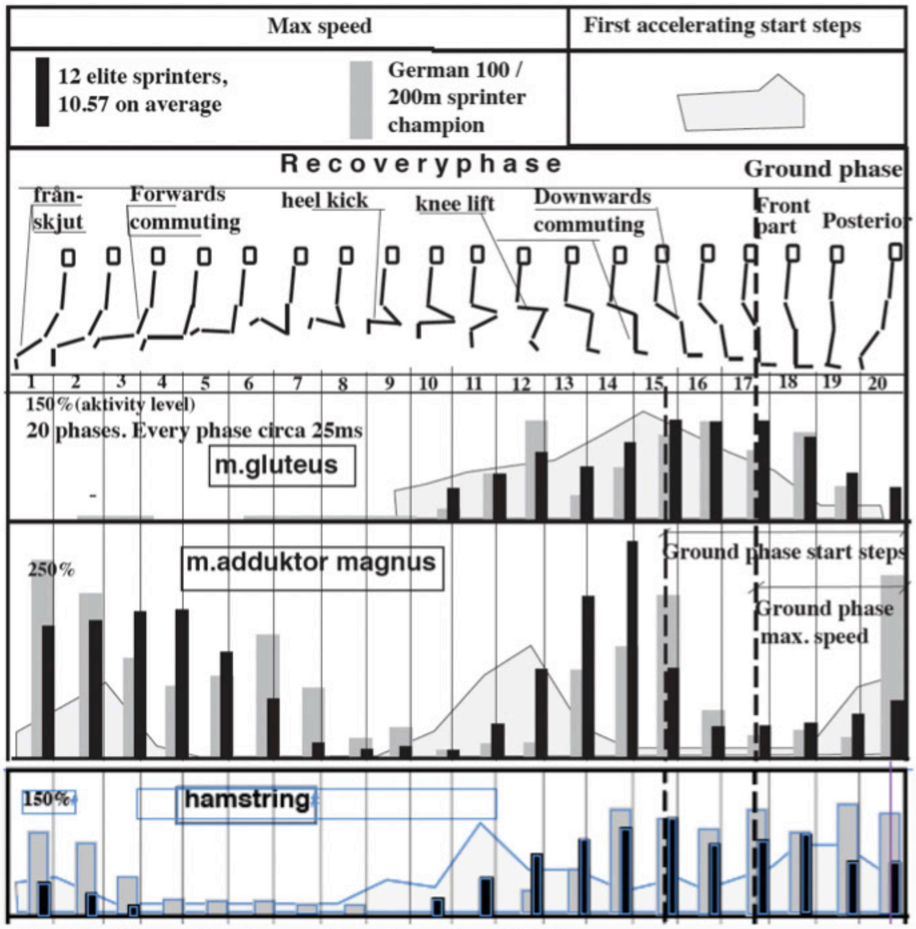


Fig 28a *EMG test of 12 German elite sprinters (p.rec.10:57 on average), black bars. German champion (p.rec. 10:40), gray bars. The first sprint steps from the start, light gray fields. Activity Level (= effort) was measured as % of isometric ref. test value, 100% för the muscles below (see Fig. 28b at page 42)*

Interesting older German EMG analysis of sprinting (Wiemann and Tidow) [1]

EMG test *) to indicate “muscular effort” was performed on 12 sprinters of the German elite class incl. German champions The compilation
(Fig. 28a) in graph form, we will now analyze[1].

Phase 1-8: Large activity remaining in the adducts magnus (**am**) and hamstring (**ha**). This and mechanical energy leads to an automatic hälkick .**)

Phase 4-12: Front thigh muscle, m.rektus femoris (**rf**) and **am** giving force to the knee lift

Phase 5-9: Ankle flexor m.tibialis anterior (**ta**) is activated to bend the ankle at heel kick. The foot’s center of gravity will then more close to the axis of rotation of the hip joint which lead to higher rotational speed at the forwards com muting of the knee

Phase 9-16: The knee joint is “opened” with a “relaxed” help of m.vastus medialis (**vm**)

Phase 12: Gluteus (**gl**), **am** and **ha** brakes the knee lift and start the downwards commuting.

Phase 12-16: Knee joint is opened by the lower leg’s inert- ness ie. the movement of the thigh leg is transfered to lower leg***)

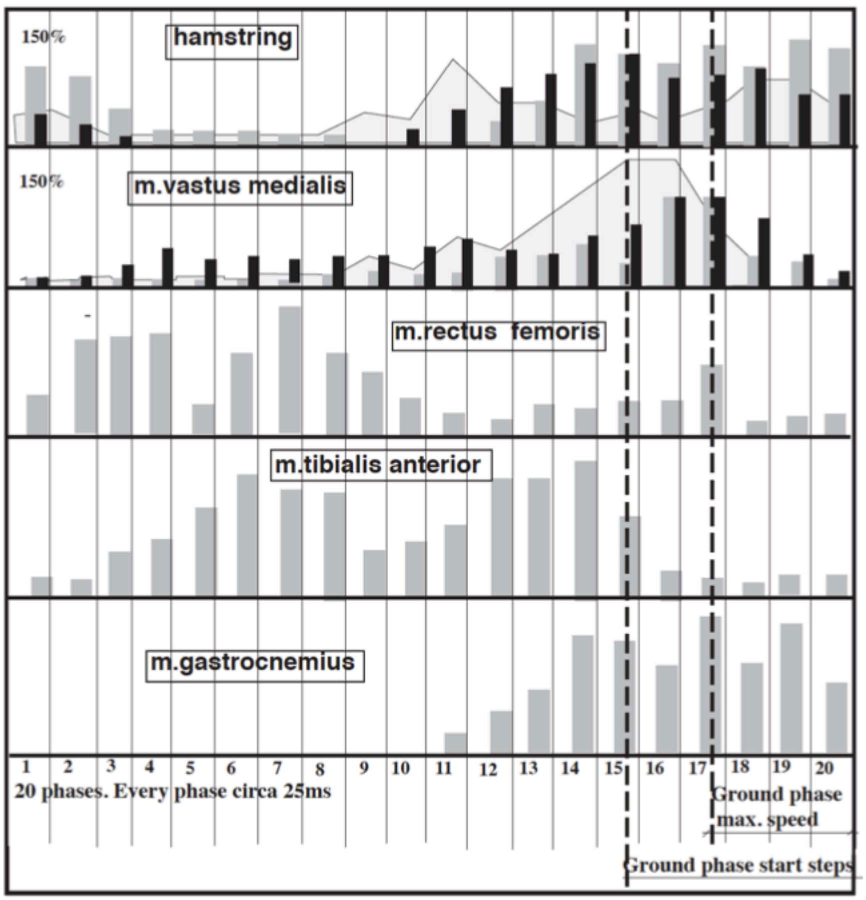
*) Interesting of the reason that even adductor magnus is EMG tested and that hamstrings are active during the entire ground phase. Would love to see the corresponding EMG test of Jamaica’s elite today.

**) Thus you should not deliberately emphasize this. This would only imply a tight race. The diagramme indicates a relaxed running by the German champion. Muscle effort is sparingly optimized and occures in the right contraction’s succession ie. with better coordination than other sprinters.

***) Here it is important with relaxed knee joint (according to Tom Tellez). Commuting out of the bone is then faster, which when it will be braked since just before landing creates an intense “stretch shortening” (p. 15) for force to backward speed increase of the foot.

1) Processed from Leichtathlethic -94, 7 och -94, 8 samt Schöllhorn, 95, 41-42

Fig 28 EMG test of 12 German elite sprinters continueing........



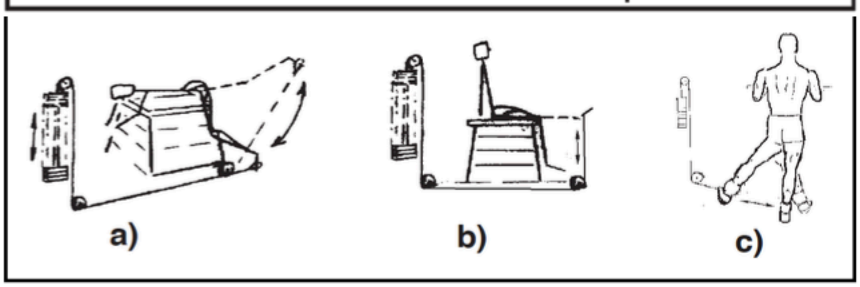


Fig. 28b *a) m.gluteus maximus och hamstring. b) m.vastus medialis c) m. adduktor magnus All these four muscle groups were activated more than 100%. (M.adduktor magnus 250%!)*

Analysis of sprinting (Wiemann and Tidow) Continueing

Fhase 16: Stabilized (fixed) of the knee joint explosive by **vm** assisted by **am** and **ha**. An important technique detail means that just before touchdown **ta** bends the ankle and the gastrocnemius (**ga**) becomes tense.

Phase 17: **ta** relaxes and **ga** extends ankle so outer edge of the footplate is dipped in the track.****)

Phase 18: At ground phase front part **gl, vm, rm** and **ga** is dampening and avoid excessive sinkage.

Phase 14-20: **ha** rotates the leg back down and gives the foot a speed close to zero prior to landing. **ha** is continuing work throughout the ground phase. see fig. 27, page.38)

Phase 19-20: Ground phase's posterior with the take-off. **ha** get help of **am** and these muscles also ex-tends in the knee joint.

Phase 13-17: During the start steps before the upright posture the quadriceps dominates as the knee and hip extensors (Wieman, fig 15, page20) with **vm** as representative from the vastus muscle group in this EMG study.

Down commuting of the leg occurs with an accelerated motion, but with the "feel of waiting on the runway" before the explosive action just above the runway and "Naturally strike the ground" according toTom Tellez is excellent education to learn the correct rhythm in the recovery phase. The commuting must be very relaxed but with a clear accelerated movement at end. This seems the German champion succeeds excellent in contrast to the others (which seems among others to have an overactive **am**) which possibly violent whipping in his leg from a very high elevated position. To do that is increaseing the risk of injury dramatically, according what Tom Tellez told author -99).

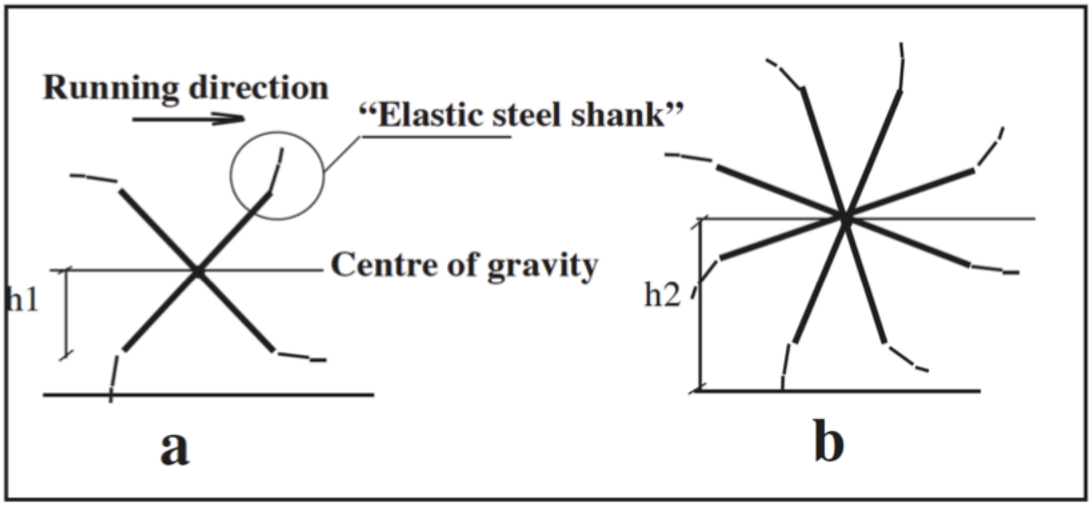
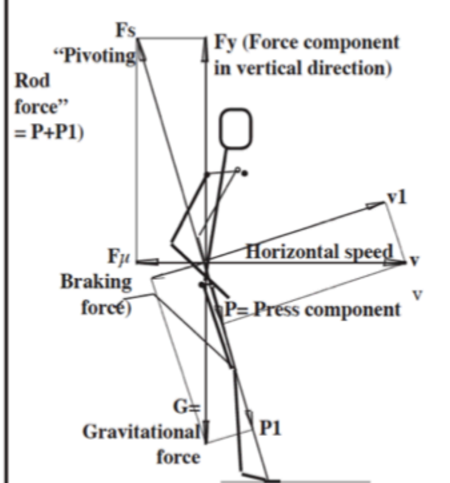


Fig 29 *Wheelmodel for sprinter running*



When the foot is landing in the track ("touch down") we have the following components to study:

Fμ = Braking horizontal friction force
Fs = Force (from "pivoting rod"), reaction force from the track
Ft = Reactions force at touch down
Fp = Reaction force from pendulum leg
Fy = Force component in vertical direction
G = Gravitational force P = Press komponent
v = Horizontal speed
v1 = Rörelsekomposant

Fig 30a *shows emergence of the brake power (Fμ) .*

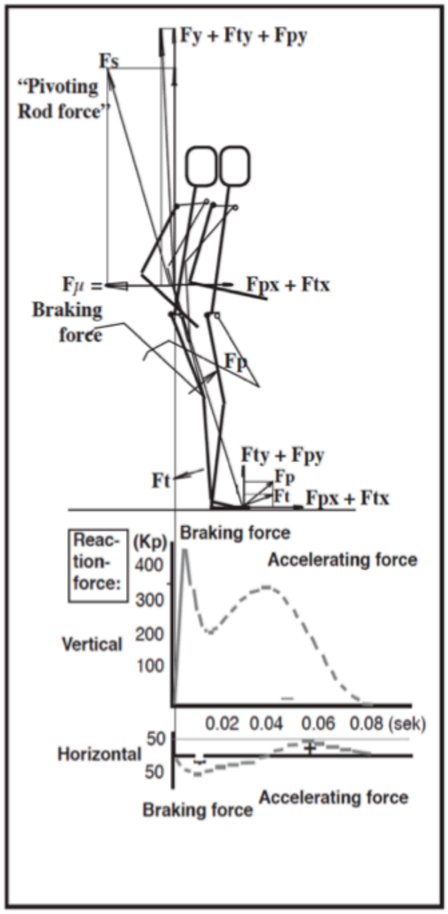


Fig 30b *shows the importance of pendulum leg impulse (Fp) and the foot force against the track (Ft), at touch down. Below we can as comparison also study a pressure-graph of maximum speed sprint.*

Important conclusions by biomechanical research of sprinter running.

The biomechanical researches about sprinter running from different countries like USA, UK, Russia, Canada and Germany, which we have treated here, have been consistent conclusions that:

Hip extensors and flexors are most important for the development of high speed running.

You should find specific training techniques to train the strength particularly in the posterior thigh muscle group (see example fig.32a-d, page 47 and page 50-67).

Wheel model for sprinter running (Proposal, Author)

The wheel can be used as a model for the sprint race. With our previous sense of elastic rods that rotates in the hip and ankle made of elastically "feather steel" should we construct our model as Figure 29 shows.Higher situated wheel axle (h2) is equivalent to a higher center of gravity mode and multi-spokes higher step frequency (Fig29b). The pendulum rhythm in sprinter running, with a rapid and accelerating touch down and ground phase followed by a calmly gathering pendulum phase *) (see p. 28, fig 22D) correspond to a gear wheel, som step by step cogs around.**)

Vector Force Analysis. Technique and muscle specifik strength (Proposal, Author)

The figure 30a below shows occurrence of the brake force and fig 30b the importance of the pendulum leg impulse (Fp) and foot's force (Ft) in the "touch down". In fig.31, page 46
the braking force have been created by the weight resistance at specific training of strength for sprinter running. kj

**) Called. "Recovery phase" **) "bicycling movements", "Naturally strike the ground", "Wait for the ground", "relax your shoulders and kneejoints" excellent teaching tips by Tom Tellez about the perfect pendulum rhythm acc. our

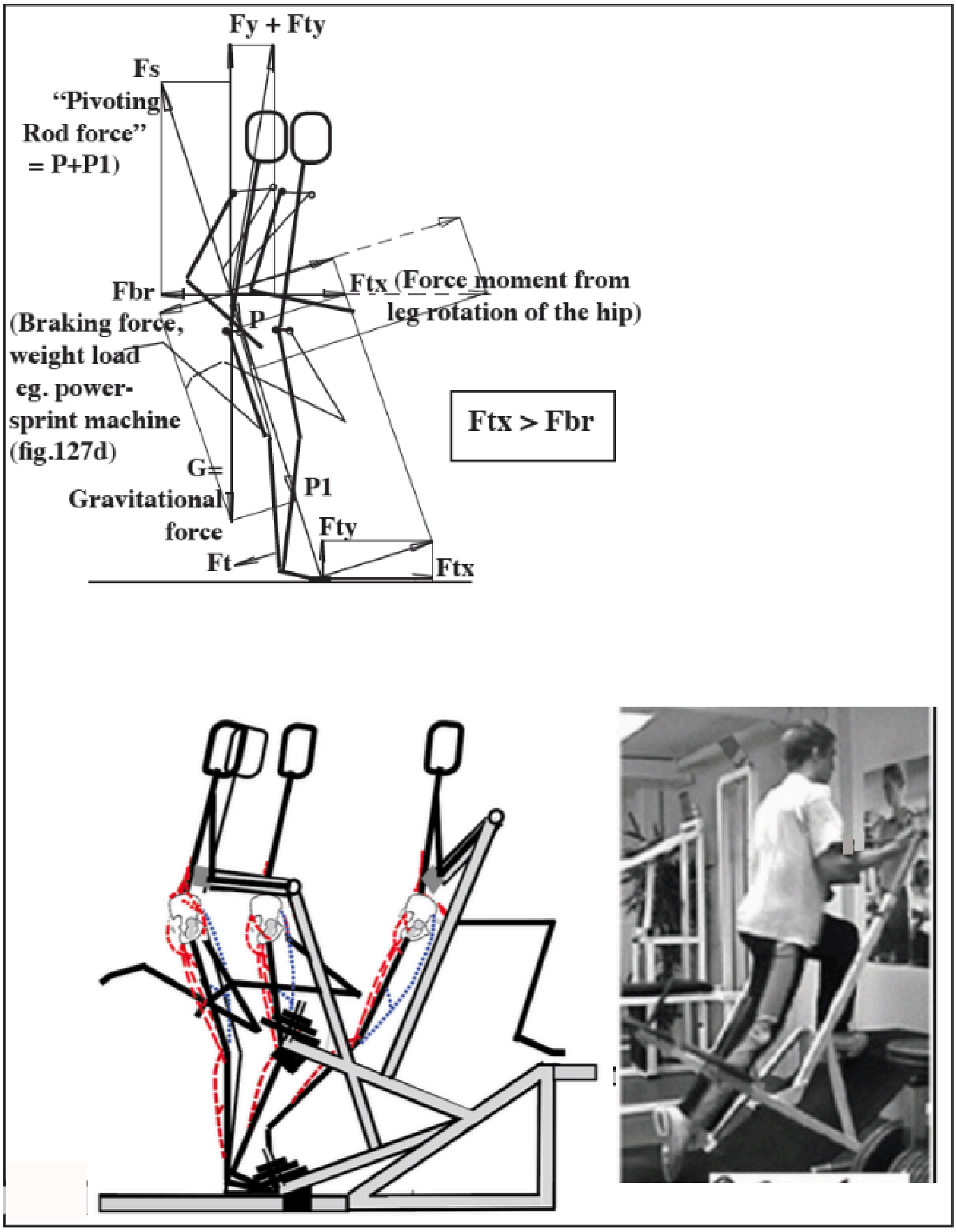


Fig 31 *This shows analysis of the forces in muscle specific weight training. Example: Resistance running or as here sprinter running in a* ***Power sprint machine****.*

Resisted running or muscle specific training with a Powersprint machine (Proposal, Author) for strength and technique

The horizontal braking force (Fμ) has been replaced by a weight resistance (Fbr) eg barbell weight in powersprint mashine.(Fig 31) Now the force torque from the leg's rotation in the hip must be greater than the weight's braking torque to create a running movement. With optimal load (maximum and speed strength training with a power sprint machine can mimic the ground-contact phase of a sprint stride and effectively train the hip extensors specifically.

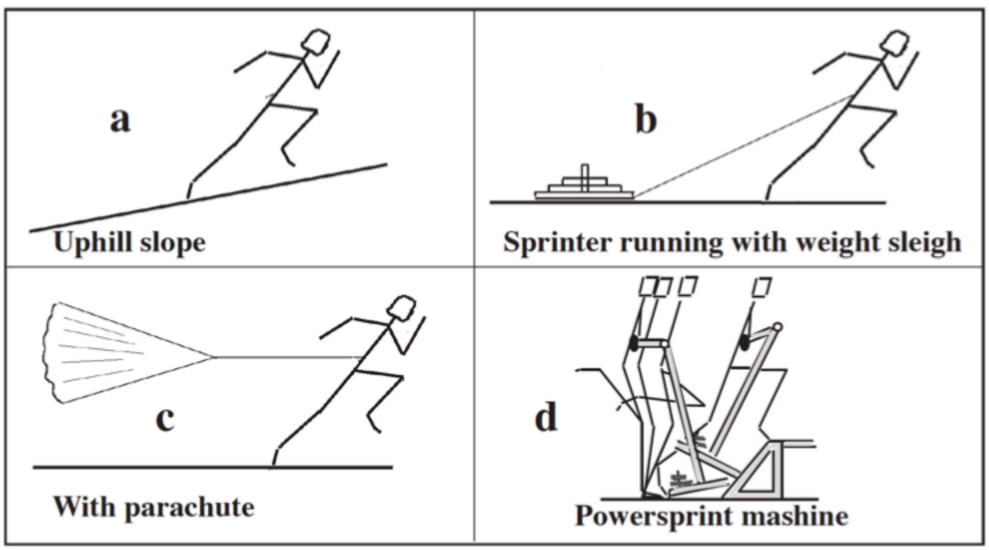


Fig 32 *Some specific strengthening exercises for the sprinter speed*

Fig 33

International elite sprint (Andrew Fisher Jamaica) at high level, "Wind Sprint" in Sundsvall, Sweden in 2013. Note how the heel is pressed down and a short moment, here captured by the high speed camera, is touched the ground.

Fig. 34 *Stefan Tärnhuvud, showing a very fine start technique.*

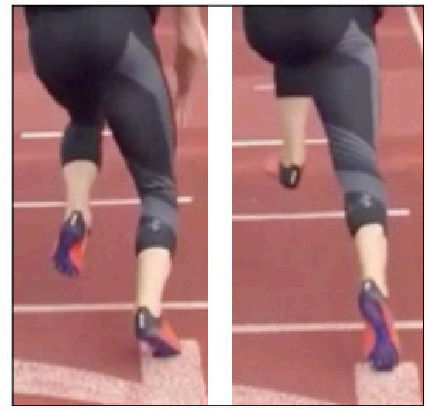


Fig. 35 *"Skating)"*

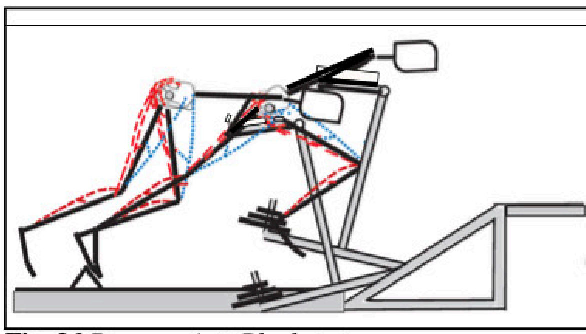


Fig. 36 *Powersprint: Blockstart.*

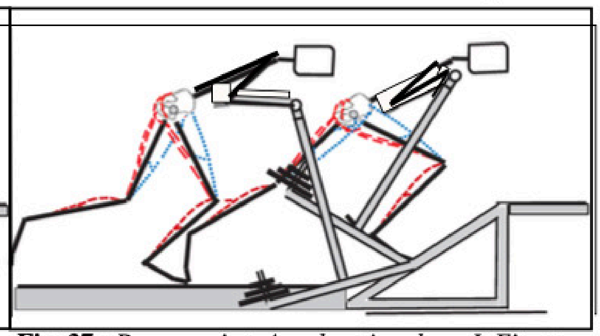


Fig. 37a *Powersprint: Accelerationphase I. First two steps*

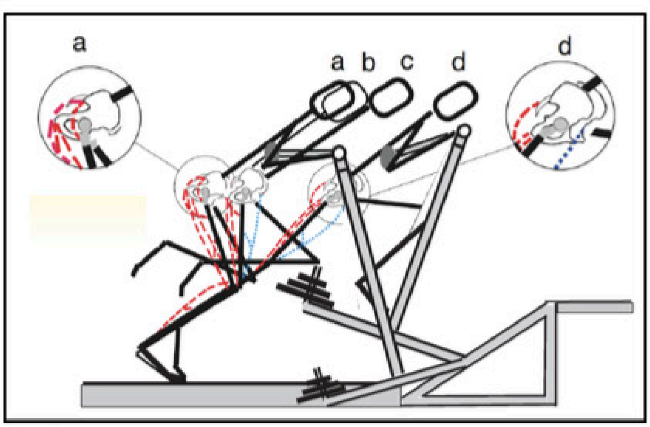
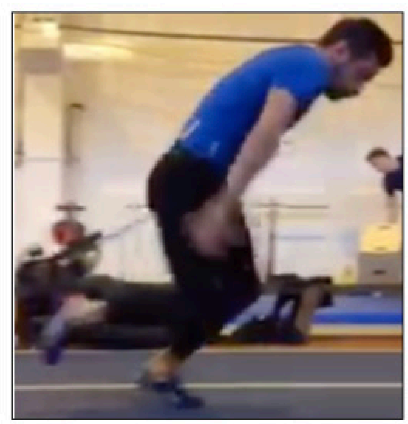


Fig 37b *Powersprint, Acceleration I*



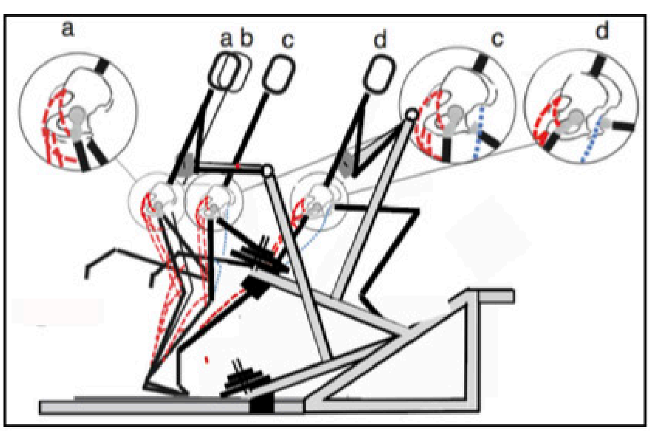
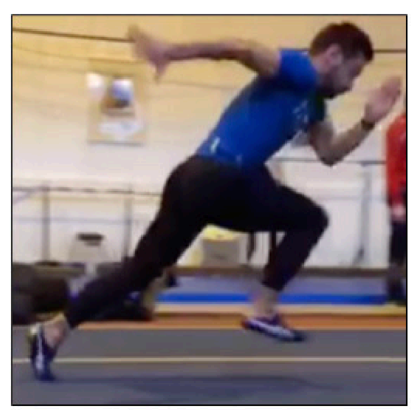


Fig 37c *Powersprint, Acceleration I - II*



Picture montage (Jan Melén) from videos (Håkan Andresson)

5. Tactics example för100m. Sprint models. Pelvis posture. Powersprint, specific strength training for sprint and jumping.

Start and Acceleration I

Fig.36-37c Illustrate the technique with Powersprint.
Fig.34-37a shows training of the Start and acceleration phase in the deep position during the first two strides. The foot is inserted just behind the center of gravity with trunk in 35-45 ° inclination. Typically the foot hits the track easily turned outwards , with so-called. "Skating" (see color image), the foot sole first meet the track with the inner edge (Note the gradual foot insertion to the outer edge toward the midline). The push-off occurs first with the leg, after the foot edge insertion and heel contact, is inward rotated over big toe possibly help of the adductor magnus. Pelvis tilts backwards explosively to PPT position (see page 50). Muscle work is switched to the quadriceps, which ending the push off with hamstring as antagonist (acc. Wiemann works hamstring here isometrically. (Page 20, fig 15). In this very short and rapid steps (a-b) stretch-shortening phase function works in which the elastic energy together with stretch reflex and muscle-specific force brings about the "start force" in the push off. During acceleration I (15-25m), the following running strides occurs with the foot insertions gradually closer to the lower body center of gravity (Fig. 37b, 37c). Following occurs from the second step gradually:

1. Opening the angles in the knee, hip and ankle joints.
2. Lower leg angles to the track are moving towards 90 °, ie, vertical position.
3. The upper body is lifted to a raised position.
4. Pelvis tilted more towards the APT mode in the push off, which already from step two is done with relatively uncomplete knee extension, (page 20, 21)
5. The hip extensors, primarily hamstring gets progressively more dominant function

---

1) Tom Tellez recommendatio. Individual deviation can probably also be useful
2) Individual touchdown may be slightly longer in the front CG. Applies Primarily to extreme hamstring strong sprinters (Please see the youtube movie with Christophe Lemaitre's 9.92s race, (author))

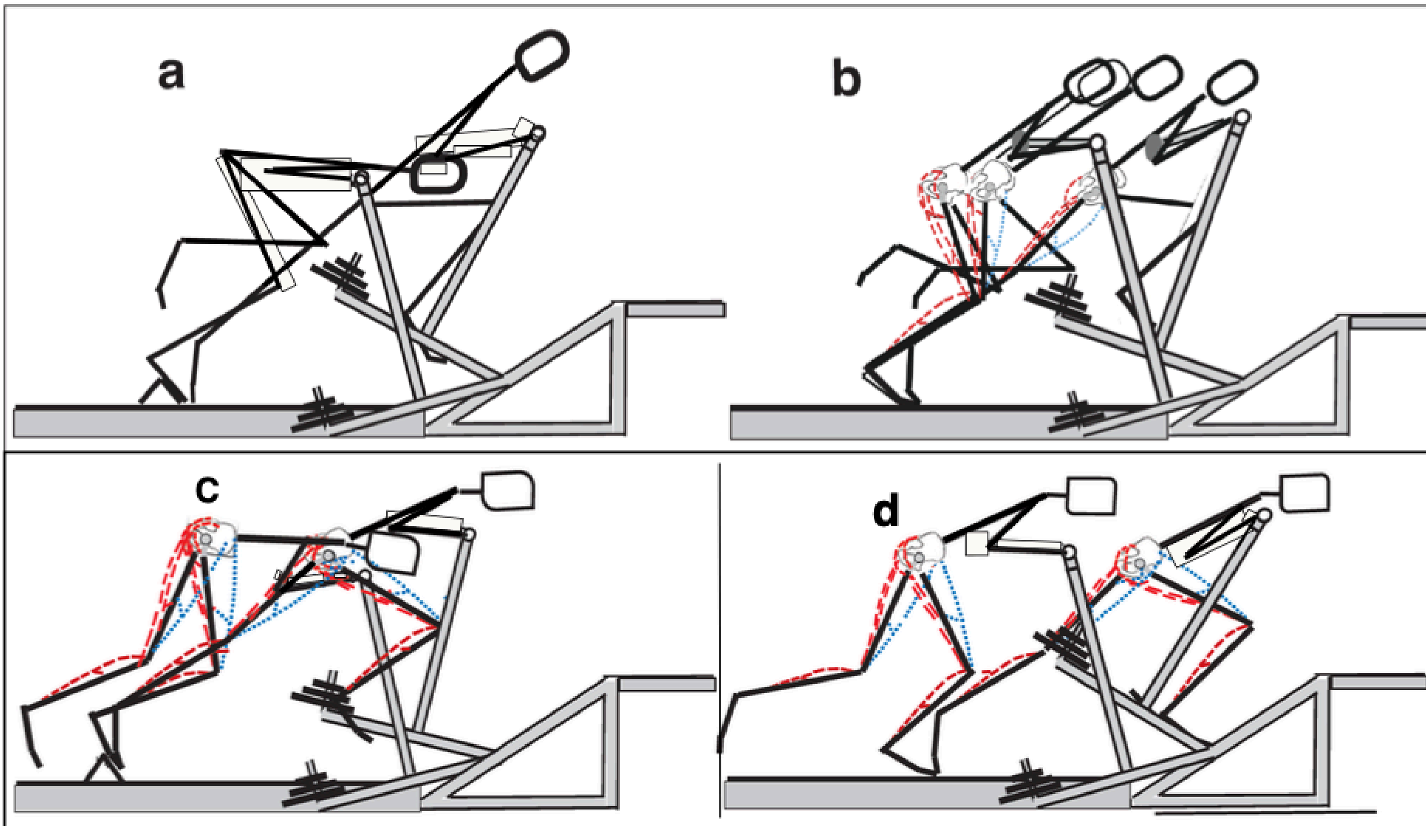


Fig. 38 *Powersprint:*a. *Blockstart (Start block)* b. *Accelerationphase I. First two steps. alt.* c. *Advanced deeper start,* d. *Acceleration I, first two steps*

Block start , the first two steps of Acceleration pfase I.

Fig 38 shows strength training for block start and first steps of the acceleration: Acceleraton I. This exercise gives mainly a basic specific strength for quadriceps, gluteus and hamstring, but also for plantar flexors soleus and gastrocne mius. In addition, hip side and adductors will be trained if the typical "Skating"is used (See again page 50, fig 35). Figure 40 also shows how to use a platform and a start block for block start. Figure 38 c and d illustrates an advanced deeper "elite" block start, using the powersprint ma chine. You then need a platform, which easily could be built of wood, exemple by fiber board.

Fig. 39 *Powersprint: Accelerationphase I. First two steps (Stefan Tärnhuvud)*

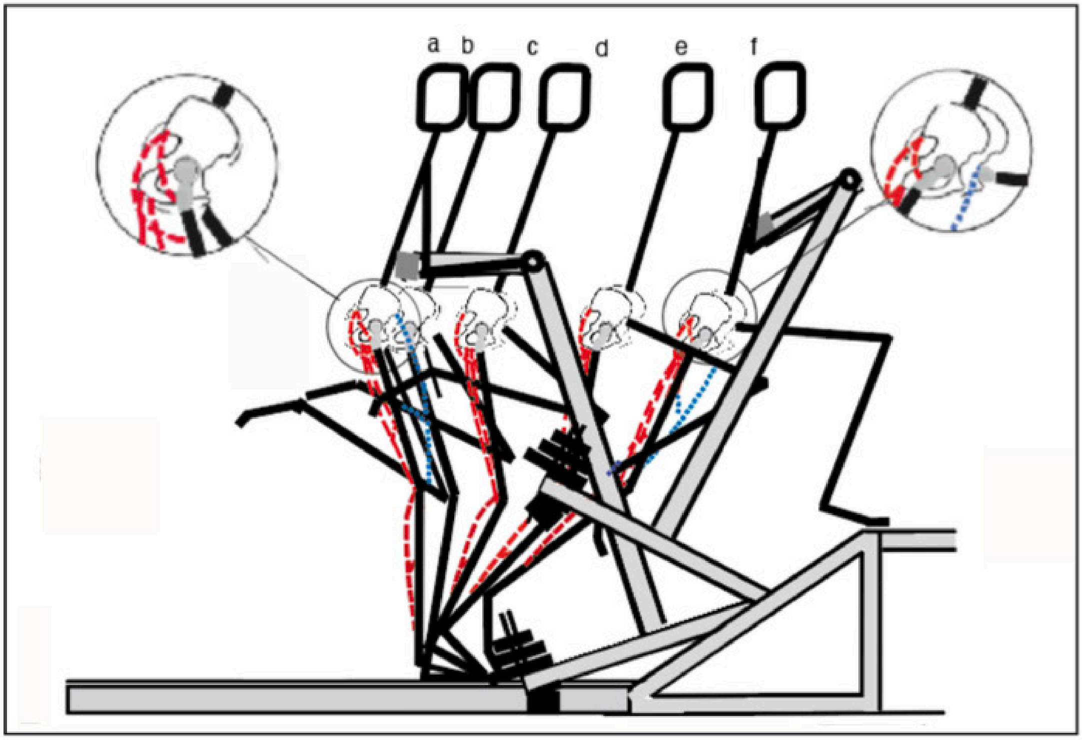


Fig. 40
Powersprint. Acceleration II and max phase, sprint-model: APT-mode. "Long rotation in the hip joint".

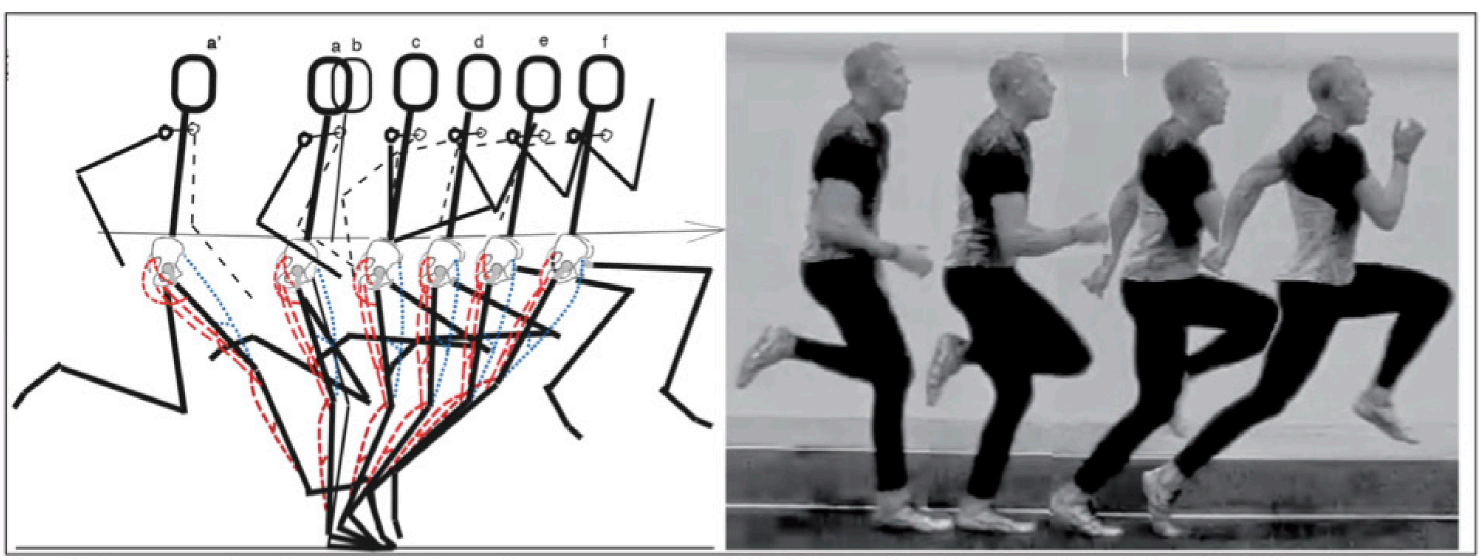


Fig. 41 *Powersprint. Acceleration II and max phase, sprint-model APT-mode. "Long rotation in the hip joint".*

Johan Wissman shows here a similary technique. Possible against a some PPT to ATP model according to the description of fig 43 at next page. A very powerful hip work from hamstring. Note the uncomplete kneeextension. The leg work perfekt as an elastic rod.

Acceleration II and Maximum speed:

Sprint model: APT-mode. "Long rotation in hip joint".

Figure 40, 41 shows the technique in "Acceleration II" and Maximum speed with upright posture and lower leg in the vertical position at touchdown. Maximum speed is built up by that touch down is done with a sense of "waiting for" the ground smoothly while step frequency and speed increases. The foot should not be flogged from an elevated position in the ground[1]. At low altitude starts the "natural strike" against the ground with muscle preload for imparting elastic energy ("elastic catapult" charging). At relaxed sprint the foot naturally is turned angled down and out and the edge of the foot meets the track first. It applies to during the Acc.I will find a position at touchdown ie with optimal Tpkt position where the foot successively meet under and finally in front of CG. During acceleration II to maximum speed (Elite: At 50-70m) and the rest of the race, foot optimally is landing in front of CG[2]. Muscle Work can now also occur as technology model: **APT-mode. Long rotation in hip"**(fig 40 - 42

a-f: The whole leg is Rotated backward by the force of mainly gluteus,hamstring and the adductor magnus. Hamstring ex tend hip in such a rapidly rotating and accelerated motion as possible. Then Pelvis all the time are forward-tilted (APT mode, page 27), the leg, using the posterior muscular chain force, is rotated long behind the hip even with a certain -al beit incomplete final knee extension. This applies particular in max pfase Some sprinters also in the world elite level, is using this technology throughout the race. This and following tech nique model use relatively high knee lifts with early knee forward swing (early heel passage of the support leg knee).

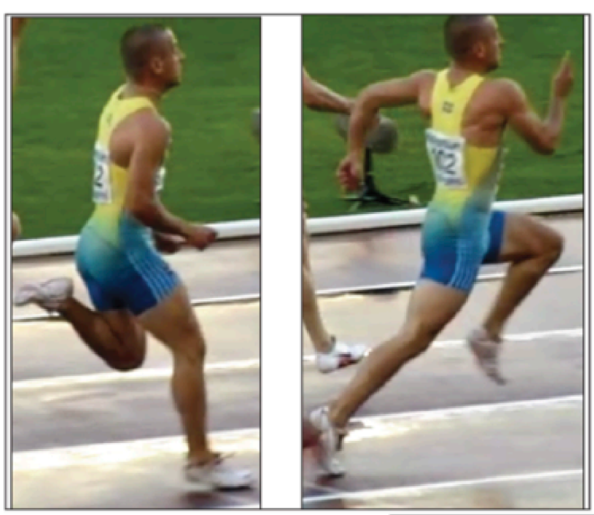


Fig. 42
Stefan Tärnhuvud, in many years during 2000-centurary, the best swedish sprinter. He shows her a typically Sprint model APT "Long rotation in

1) Tom Tellez recommendatio. Individual deviation can probably also be useful
2) Individual touchdown may be slightly longer in the front CG. Applies Primarily to extreme hamstring strong sprinters (Please see the youtube movie with Christophe Lemaitre's 9.92s race, (author))

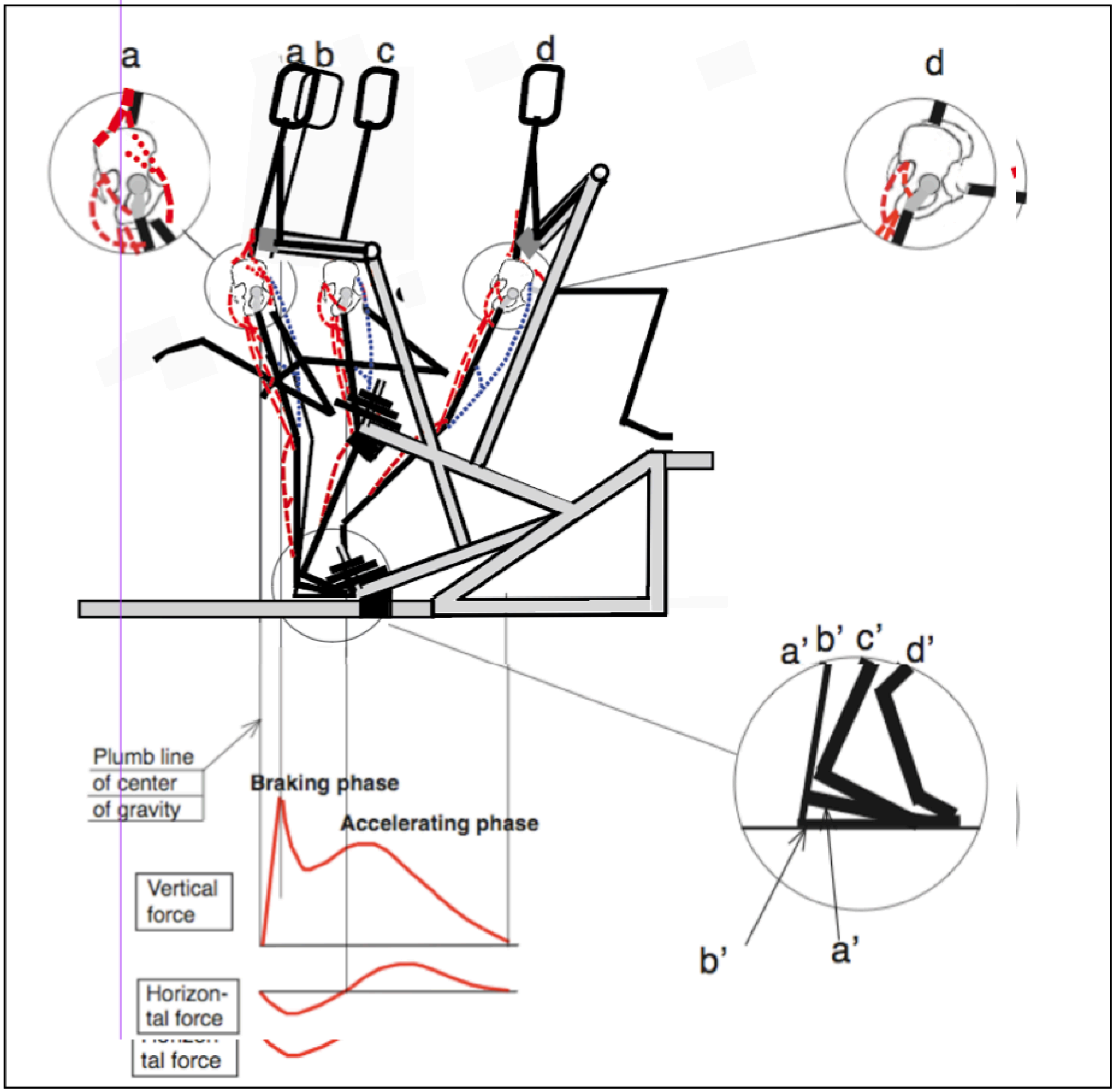


Fig. 43 *Analysis of the maximumspeed. Here Powersprint. Sprint model:PPT-ATP mode.*
At touch down the heel is pressed quickly down by the high pressure (a'-b') and touches the track.

Sprint model: PPT-ATP mode.
“Short or long rotation in the hip”.

This technology model (Fig. 43 and 44, the upper figure at page 58) can be described as follows:

e-h: In the swingphase Pelvis is backward tilted from APT to PPT mode in the touchdown (a-b). The movement pro- vides a “Stretch Shortening Cykle (SSC)” in the ham-

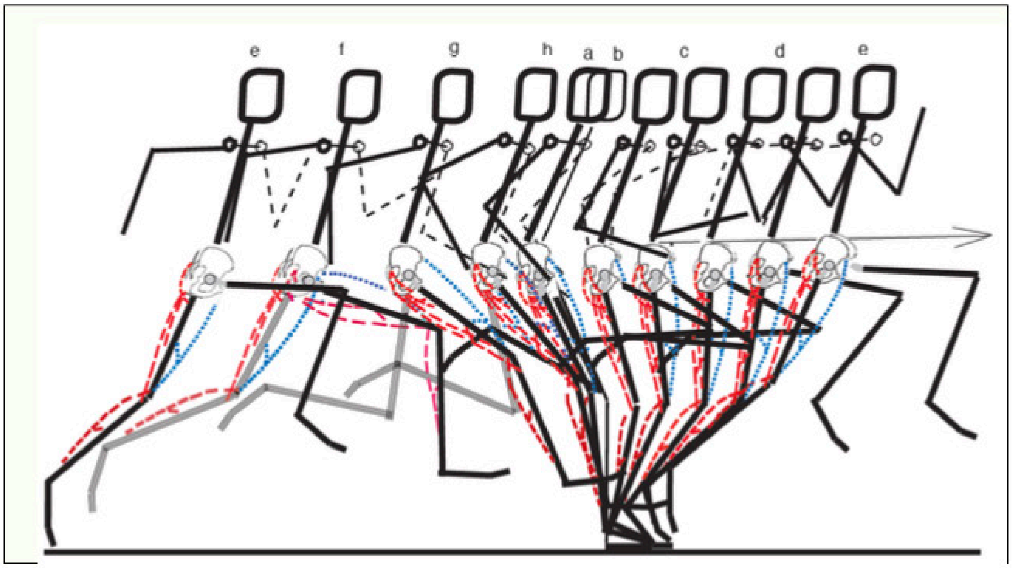
string for increased rotational (angular) speed.

a-c: In the touchdown (a-b) is also a SSC in hamstring which first is working isometrically with stabilization of the knee joint and the femur in conection to the pelvis. With a focus on PPT location it now will be a short slower ro- tation of the leg with Pelvis as an “extra extended” lever. The back (erector spinae) and gluteus driving the leg backwards, together with the pelvis forward tilt, as a high lever (With a high positioned axis of rotation above the pelvis).

c-e: The back and iliopsoas muscle work also causes that Pelvis is tilted even more towards the ATP position, the hamstring then will be stretched some (“as tighten ing a bow”) which again provides an SSC with finishing accelerated rotation in the hip joint. However, this back ward rotation of the leg can also as an alternative be per formed in a longer distance to produce large horizontal

force.

a-b: Because of the the high pressure (see diagram fig. 43) that occurs when the machine is attacked the fixed ankle joint (should be seen as a “stiff” elastic steel shank) will be slightly compressed. The heel is (see the picture in fig 43) pressed against the track an touch it.



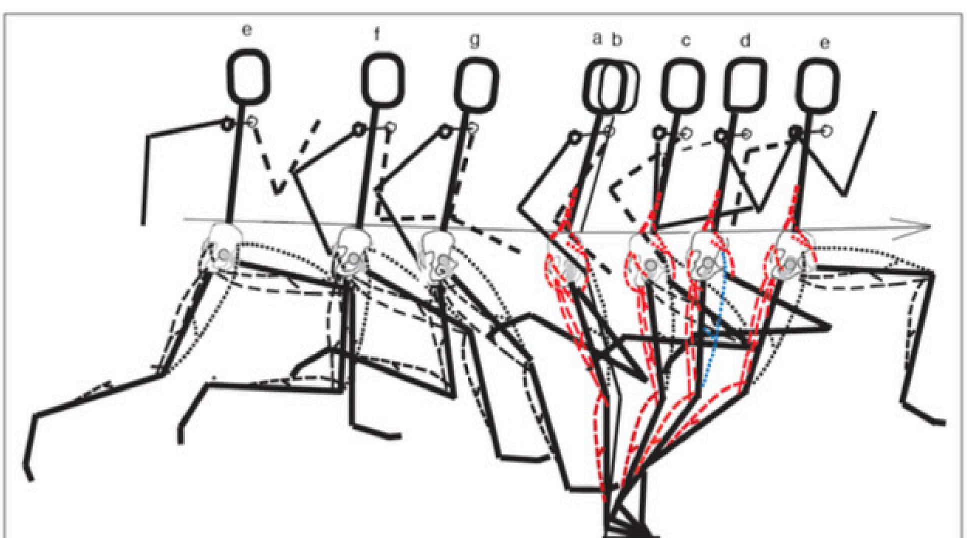


Fig. 44 Above sprint-model: PPT-APT-mode. "Long rotation in hip joint" .(See also page 43 and Appendix 4, Powersprint). In the middle Swedish elitesprinter Stefan Tärnhuvud At bottom sprint-model: PPT-APT- mode. "Short rotation in hip joint"

Continueing sprint model: PPT-ATP mode. "Short or long rotation in the hip".

b-e: Pelvic that extra leverage, starts tipping forward toward the APT mode. The final push-off is done as previously during the drive phase, with that the leg, after the foot edge insertion and heel contact, is inward rotated over the big toe - this possible with help of the adductor mag nus. A slightly more forward tilting of the pelvis now allows place in the hip joint for a longer accelerated rotation, where great power can be developed mainly by hamstring and adductor magnus. Important is a cer tain "locked knee-joint", so that leg forms an elastic lever before final push-off. See also fig. 44, appendix 4. Note the "rocking" motion of the trunk as previously described on page 16.

Quadriceps dominance.
Hamstring, isometric antagonistic function.

The vertical pressure in touchdown and front support phase may also require a certain eccentric muscle work of the quadriceps. Fig. 44 at bottom shows PPT-APT mode with short rotation in the hip. Here could also that hamstring works isometric as an antagonist during the entire ground phase. As in the "drive-phase" then muscle work can be done by the quadriceps dominance in the extension of knee and hip in the push off. This tecnique has been most common in the US and is probably also the traditional, which most coaches still is teaching. It also corresponds well with the activation of the quadriceps in clean alt. snatch hanging. As Figure 45 shows, it also can be applying with Power Sprint excellent with the advantage that even coordination in the hip side can be trained specifically. Focus on the horizontal force also applies here with powerful isometric ham string work.

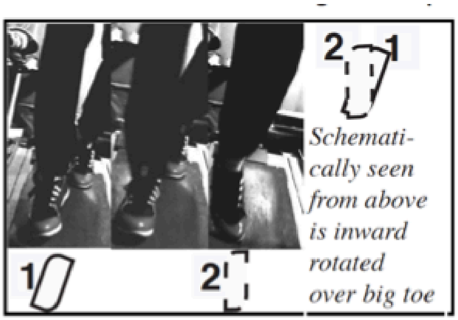


Fig. 45 *Inward rotation of the foot with help of adductor magnus.*

Sprint training in Jamaica the year 2019. Pictures from videoclip, (Håkan Andersson, Sweden)

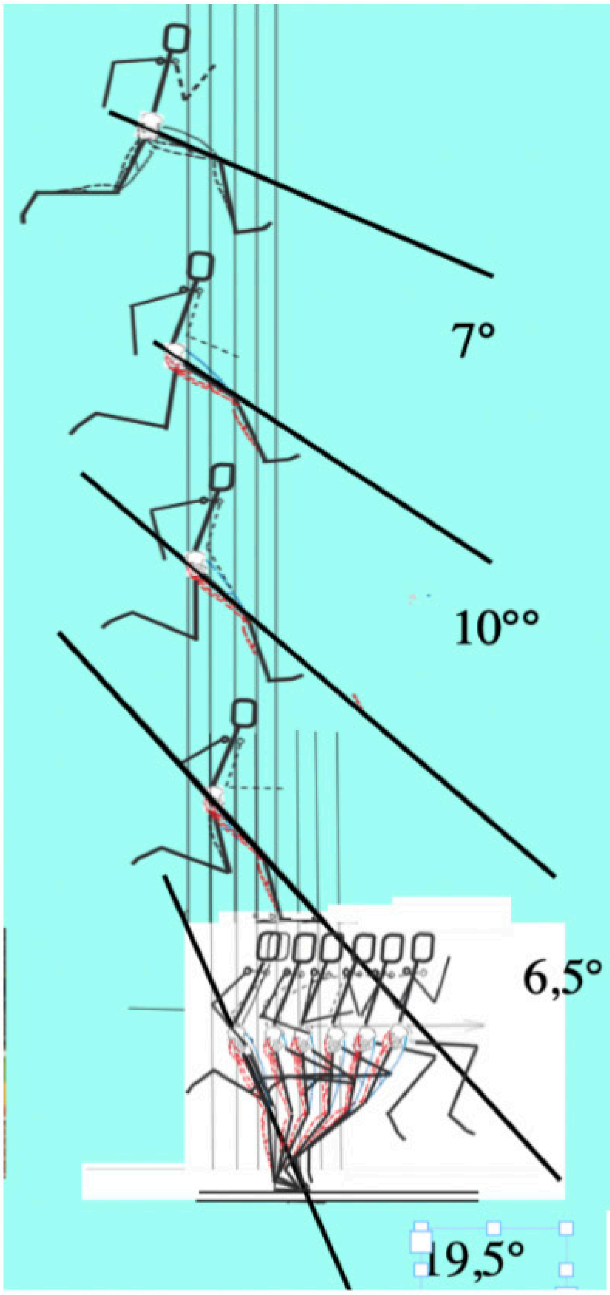
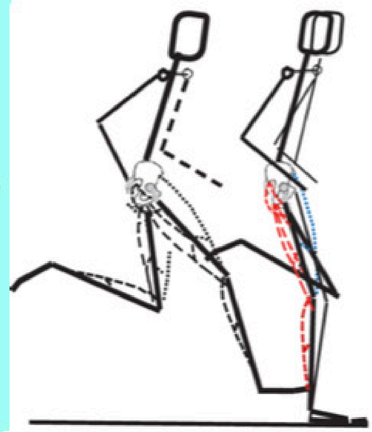
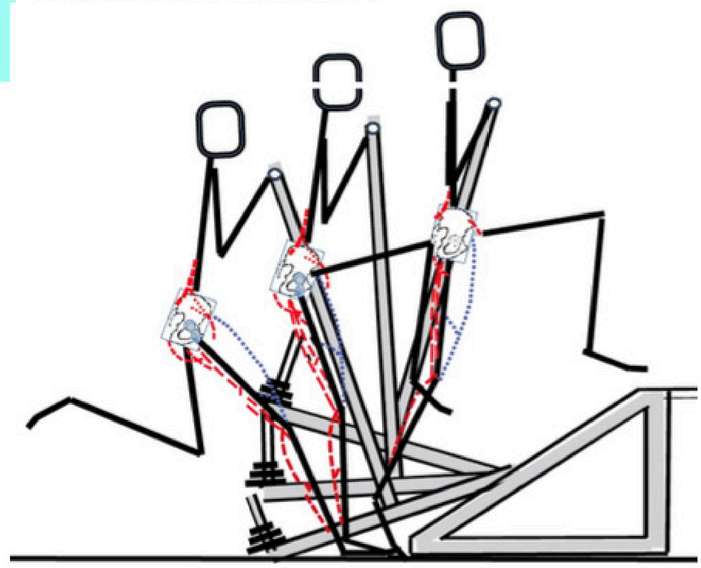


Fig 46 *Here the author's analysis of one of the world's foremost sprinters to understand the rhythm of the leg in the down rotation against the track. It shows approximately three times the angular velocity at the leg"natural strike" from a low place near the ground. This movement last part of the leg rotation can be compared to a whip. The lower picture shows how this can be trained with a exercise for the hip extension (basic I).*





Powersprint . The ”natural strike”. Basic and specific exercises.

Fig 46 at page 62 shows the author's analysis of one of the world's foremost sprinters to understand the rhythm of the leg in the down rotation against the track. It shows approximately three times the angular velocity at the leg"natural strike" from a low place near the ground. This movement last part of the leg rotation can be compared to a whip.

The lower picture shows how this can be trained in the first preparing periods with an exercise for the hip extension (**basic I**). Might as well be a great muscle specifik exercise for a long jump take-off.

Fig. 47 shows (**basic II**) a muscle specific exercise for the take-off in a horizontal jumps. It’s an extremly great exercise specially for long jump, used by worldbest jumpers. Can be performed as an explosive concentric movement or concentric - excentric ”pumping” rytm. Mostly is performed explosivly concentric, but also in a concentric - excentric”pumping” rytm .

Fig. 48 shows the maximum sprint phase, here used as both specific explosive concentric or as a basic exercise (**basic III**) with a concentric - excentric performance. In both these exercises, (Fig 47, 48) the movement with the machine starts slightly lifted from the ground

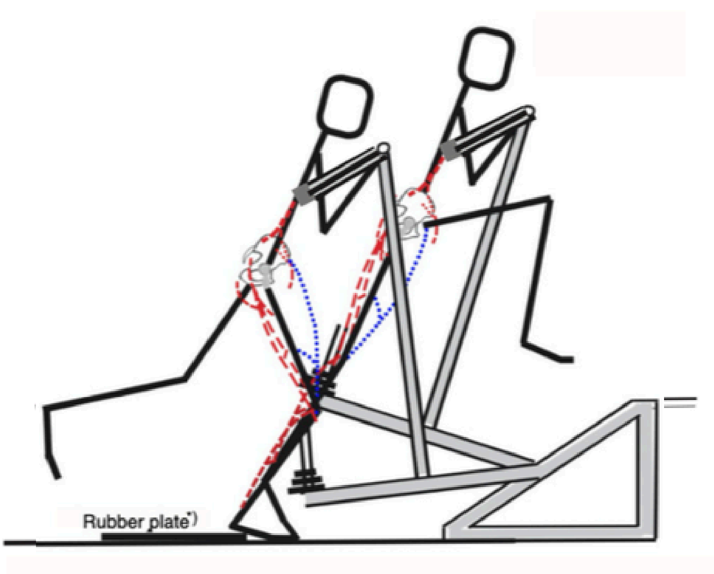


Fig 47 *shows a muscle specific exercise for the take-off in a horizontal jump. It’s an extremly great exercise specially for long jump, used by worldbest jumpers. Can be performed as an explosive concentric movement or concentric - excentric ”pumping” rytm.*

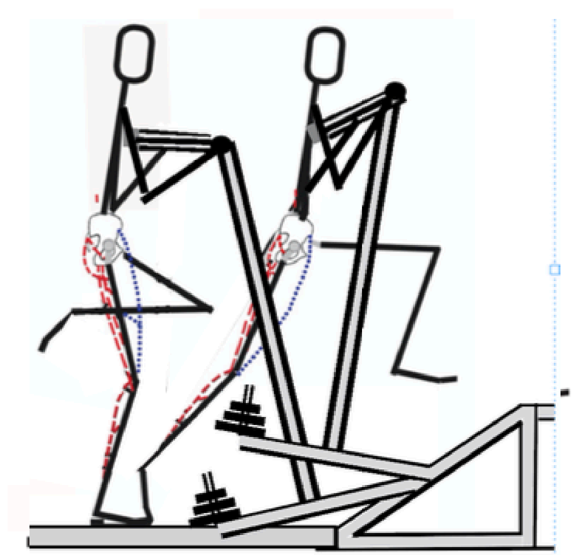


Fig 48 *Here the maximum sprint phase which could be used as both specific explosive concentric or as a basic exercise with concentric-excentric performance.*

*) Just like safety to protect over stretch achilles tendon

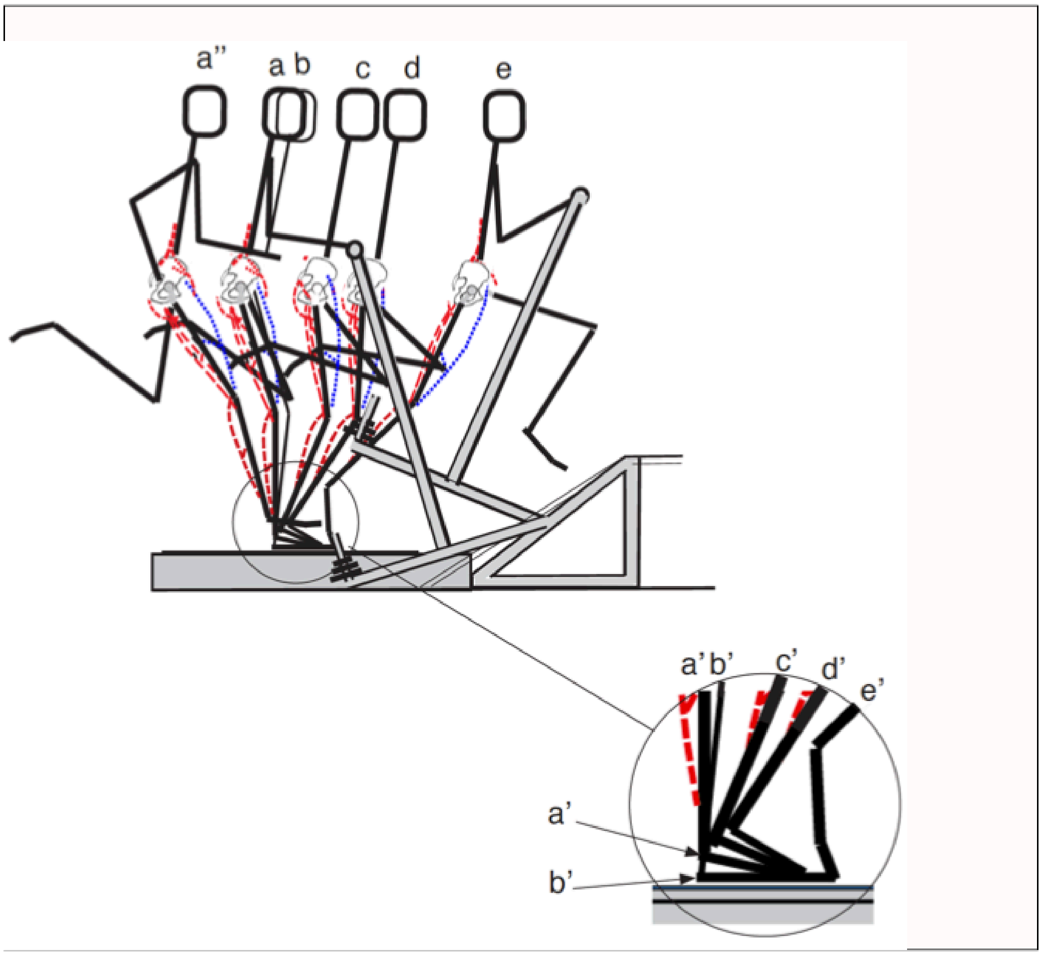


Fig. 49 *Powersprint: Sprint model,here could be represented here by a female world class sprinter. For exemple ATP pelvis post and lower knee lift. Extremly powerful hamstrings- and ankle- extensions . The last really as a "catapult".*

Sprint Technique represented by female world class sprinter

Maximum phase technique represented by female world class sprinters. The fig 49 - 50 illustrates a sprint technique used by many of the world best female sprinters. A typical strong pelvis ATP- posture, a lower knee lift. The leg is fixed as a very solid elastic rod.in the whole support phase. This is is rotated backwards with a tremendous power from gluteus but mostly from hamstring and adductor magnus. Then also with the ankle functioning, really as a "catapult" which was mentioned in the beginning of this book.

The strength exercises for this technique could be the be performed as fig 49 shows. For the shorter female sprinters it is recomended to use such a platform as you see here.
(see fig. 50):

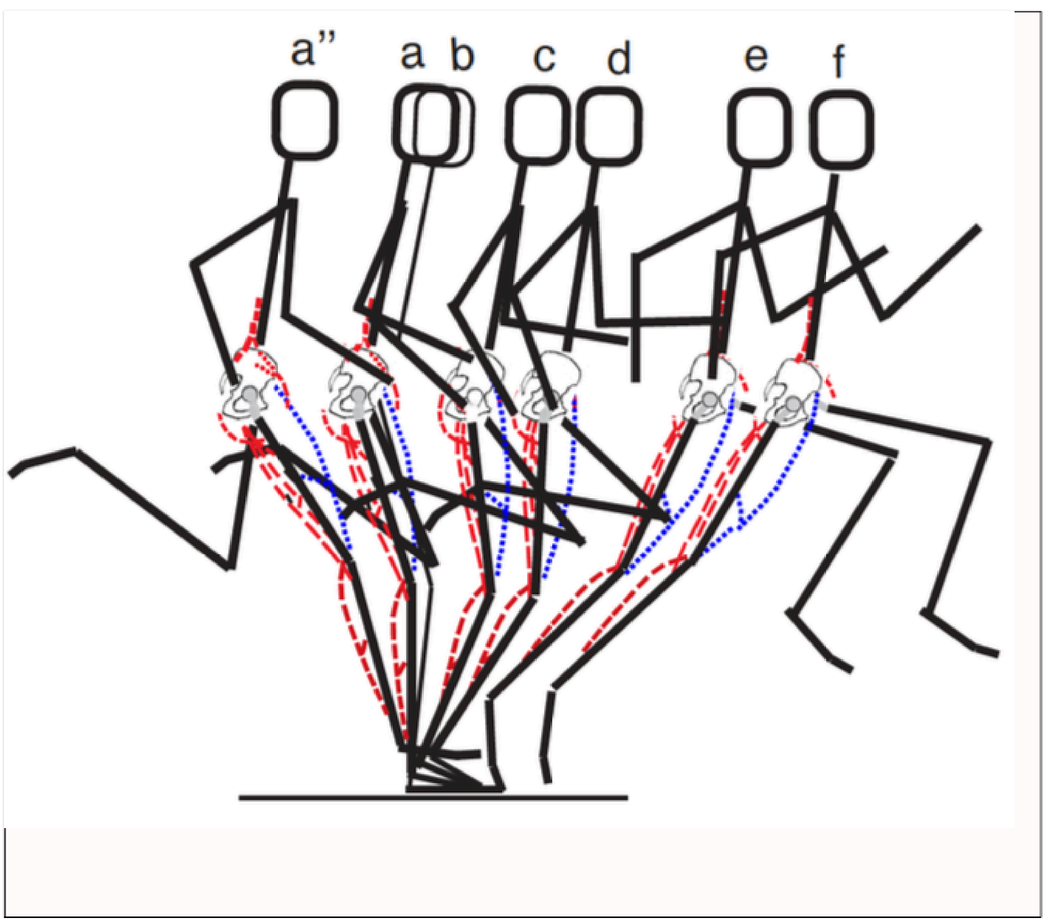


Fig. 50 *Sprint model, female sprinter with ATP pelvis posture and lower knee lift.*

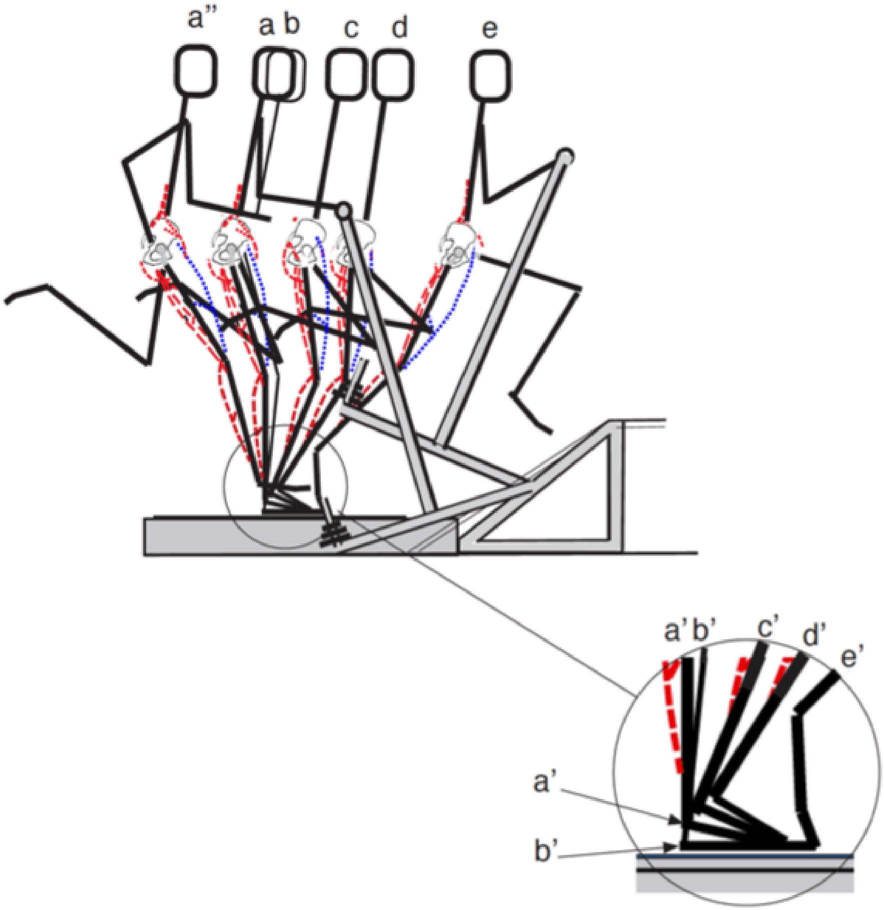


Fig. 51 *Powersprint: Sprint model, here could be represented here by a female world class sprinter. but it could also illustrate a male high frequense sprinter with trendly*

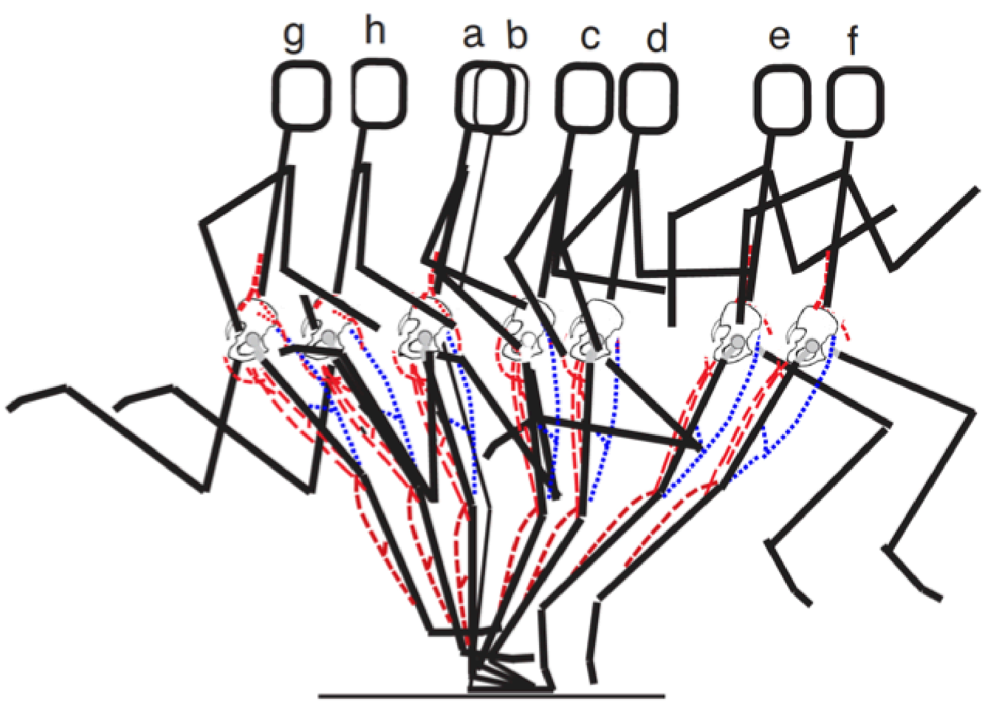


Fig. 52a Above sprint-model: APT-mode. “Long rotation in hip joint” Hip dominant tecnique with certain heelcontact.

New trend for male sprint - lower knee lift and higher frequence.

New trend for male sprint among, perhaps mostly shorter sprinters - lower knee lift and higher step frequency.

It also seems to use the quadriceps dominant technique with more "stiffness" in the ankle joint (fig. 52b) in combination with more hip dominance, which, after all, meant elastically softer ankle with some heel contact (fig. 52a). After studying filmclip (Author) it then seems to occur ”alternating” (left-right-left-right.) A hypothetical explanation of the technology's advantage might be better energy distribution across different muscle groups and thus better fast endurance.

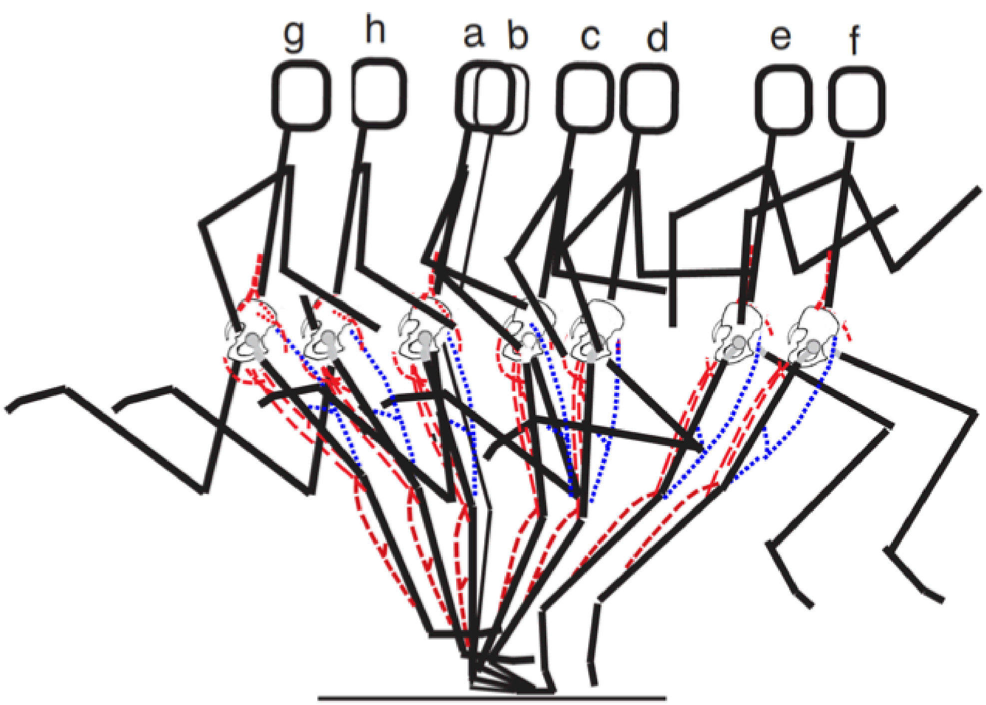
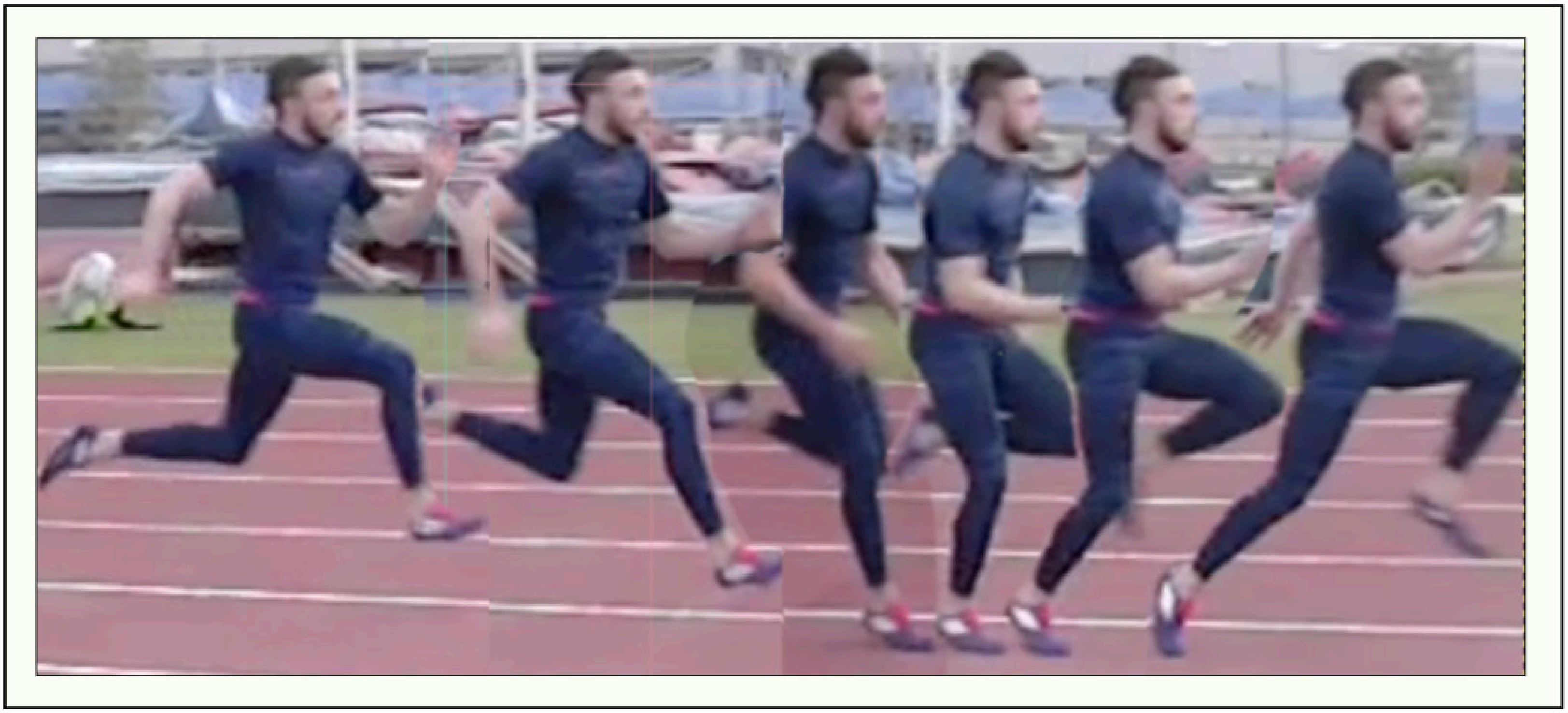
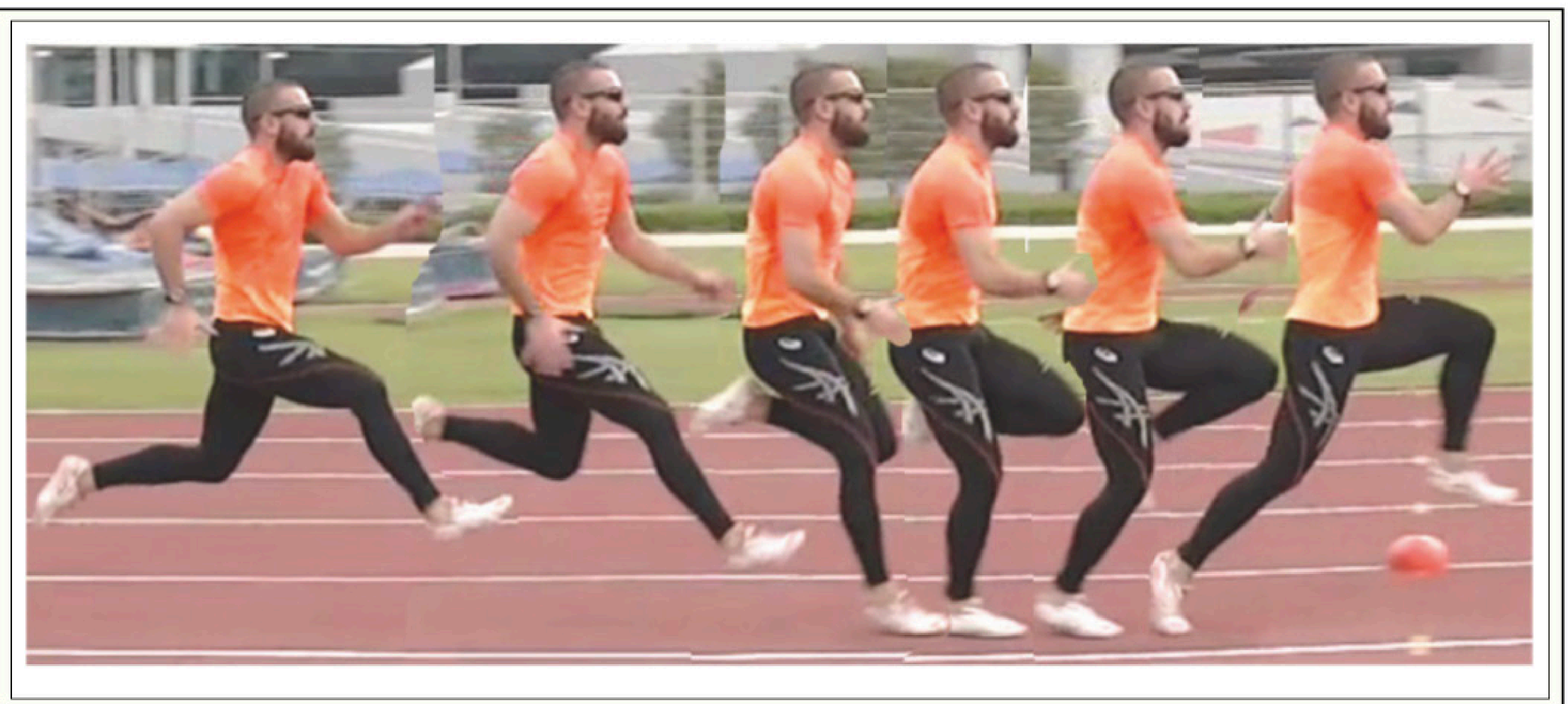


Fig. 52b Above sprint-model: APT-mode. “Long rotation in hip joint”. Quadriceps dominant with more ”stiffness”.



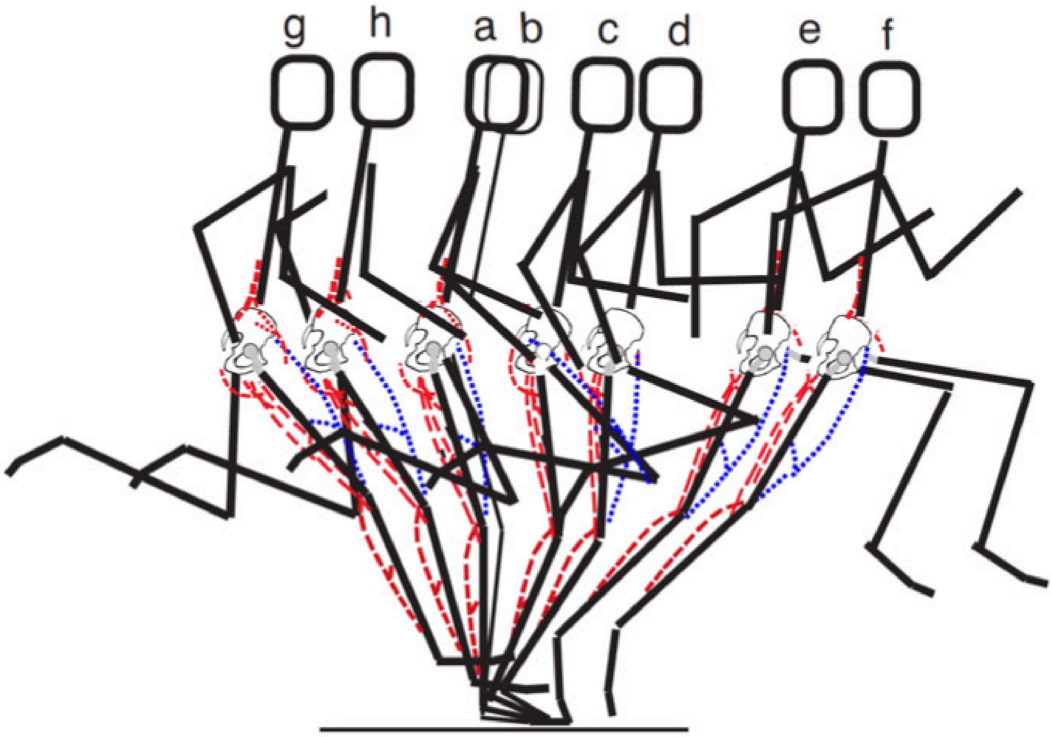
Tom-Cling Baptist

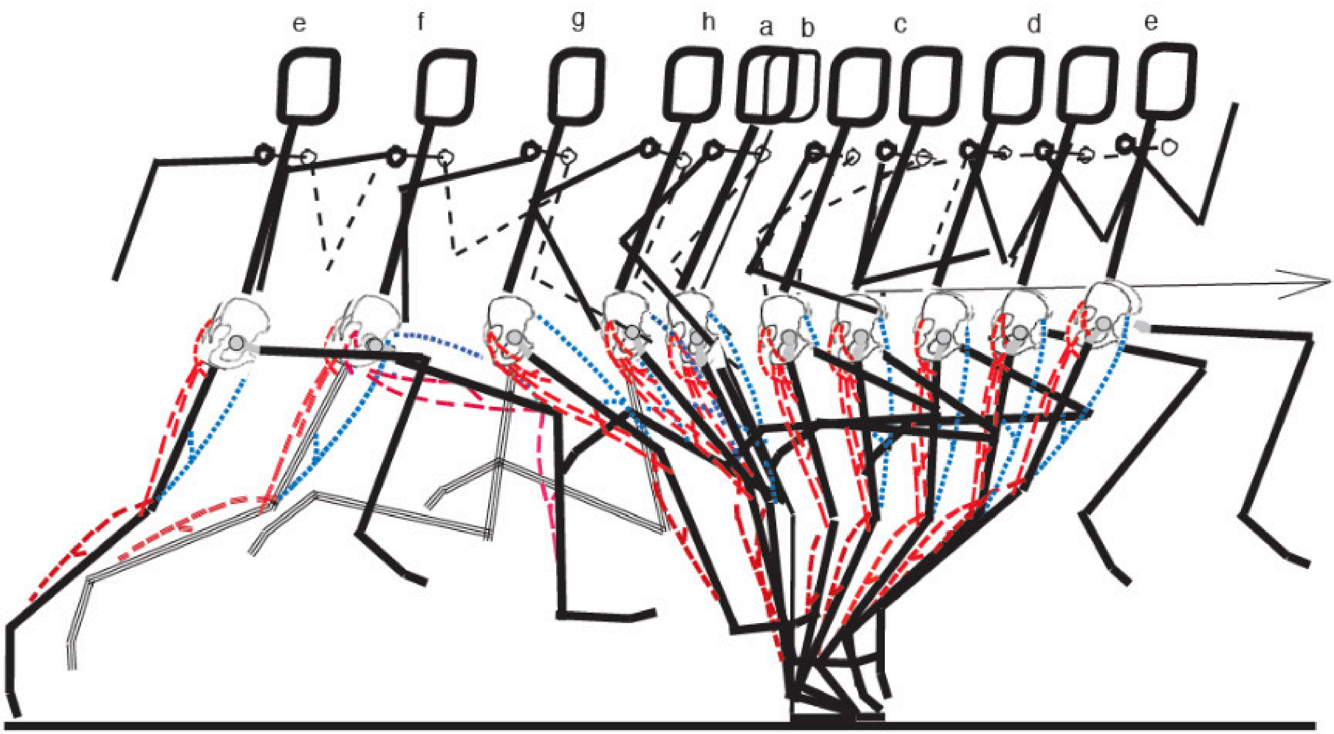
Picture montage (Jan Melén) from video (Håkan Andresson)

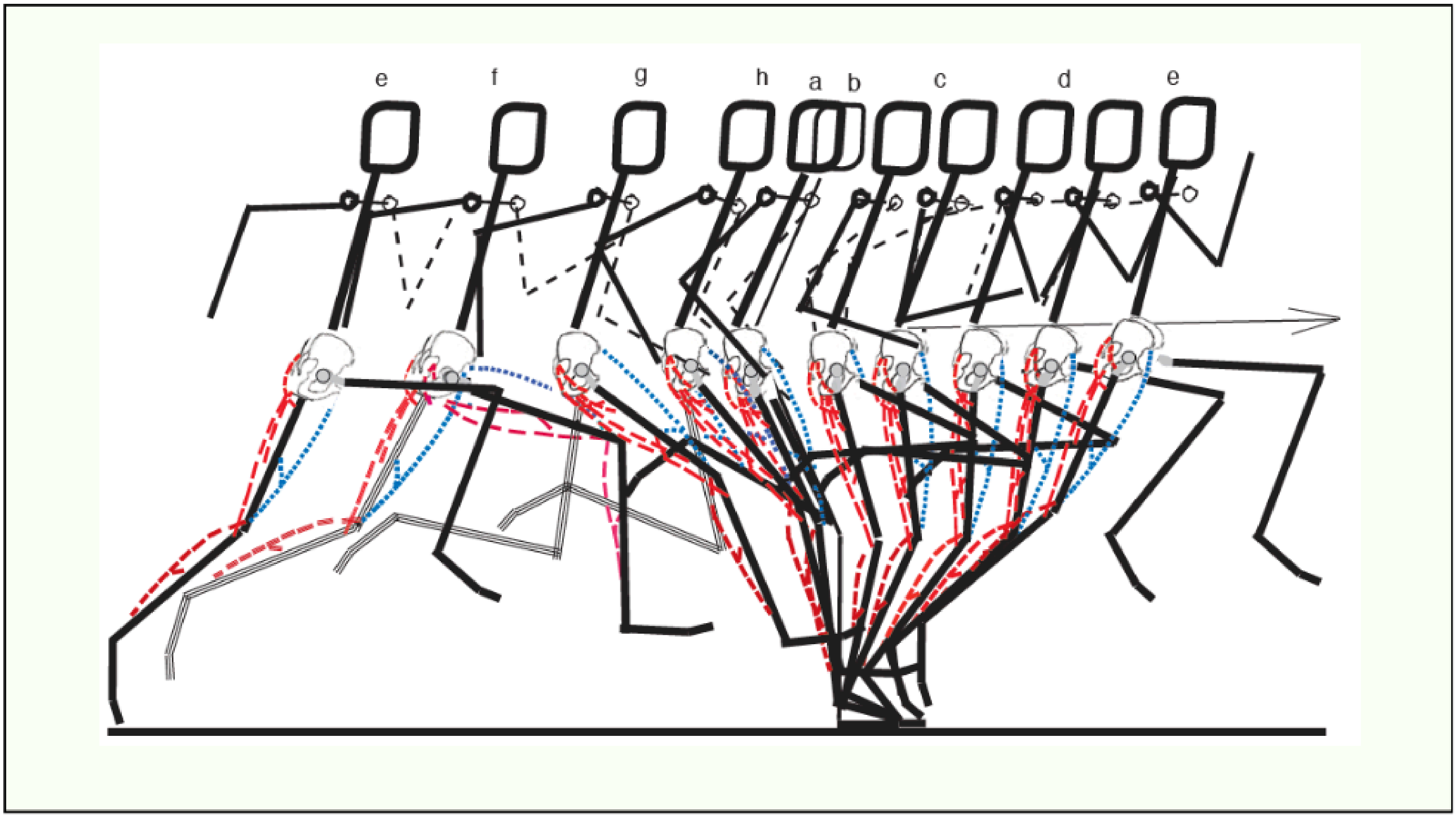


Stefan Tärnhuvud

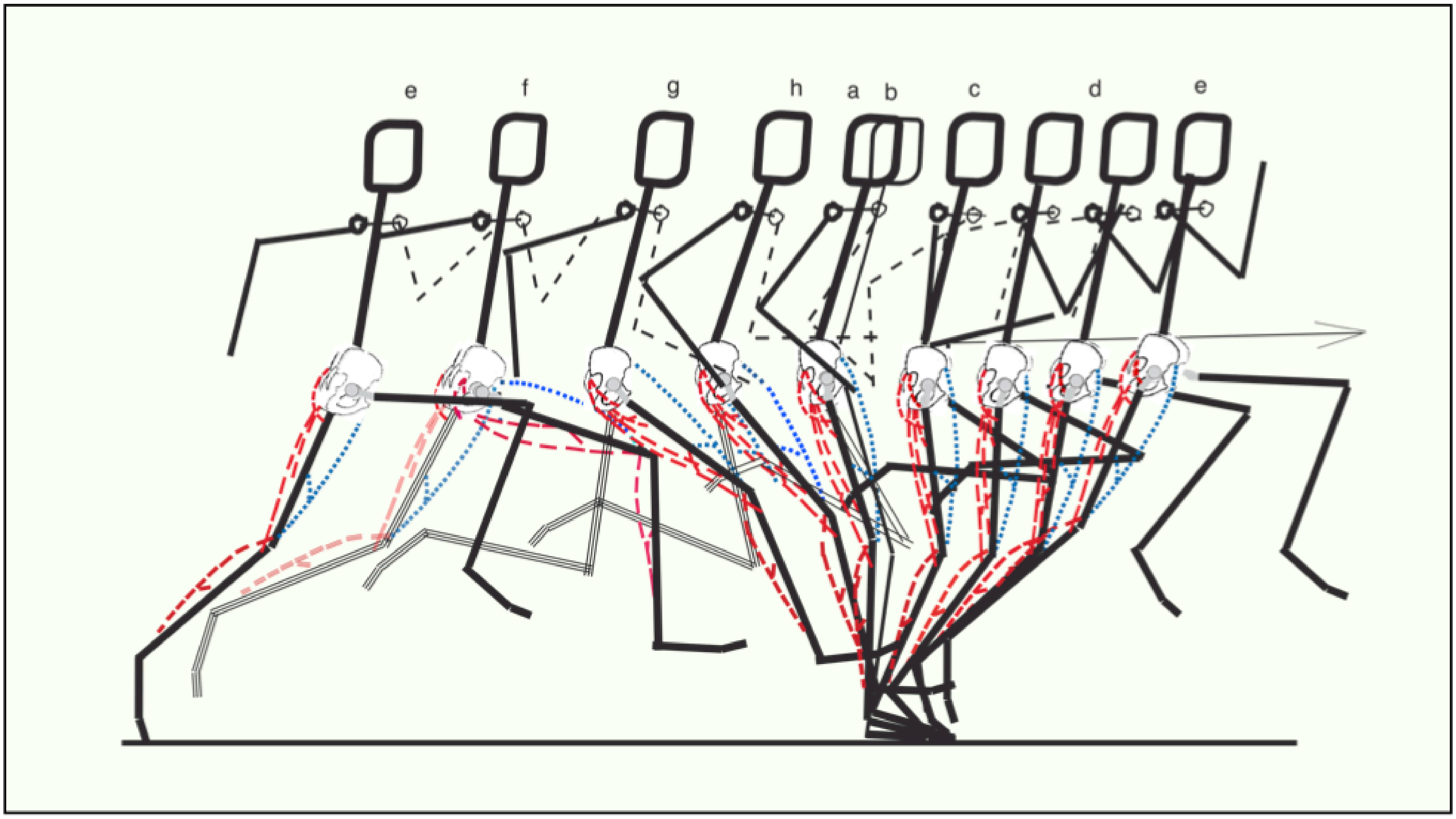
Picture montage (Jan Melén) from video (Håkan Andresson)


g
h
a
b
c
d
e
f

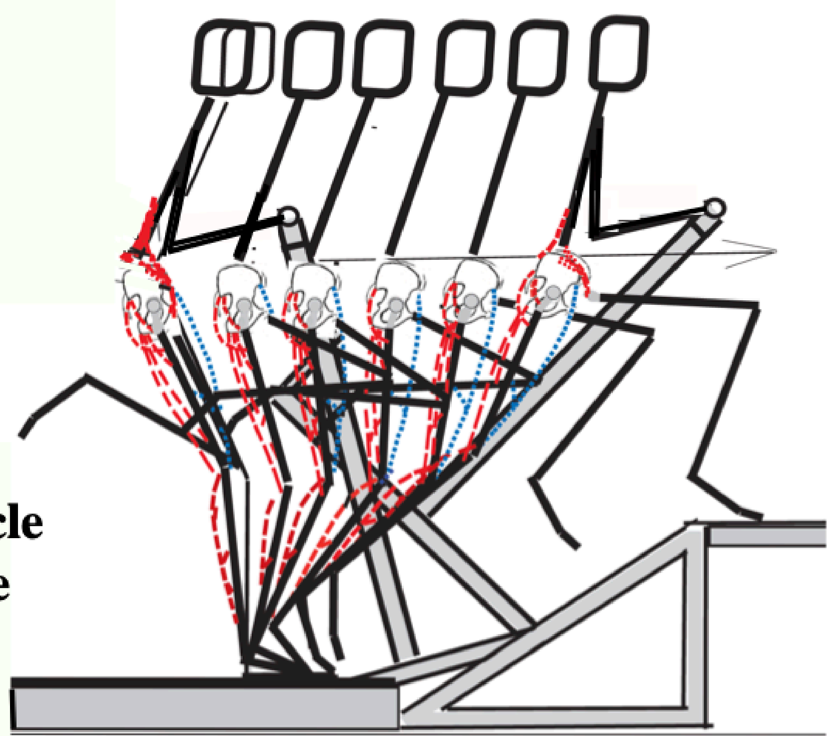

e
f
g
h
a
b
c
d
e



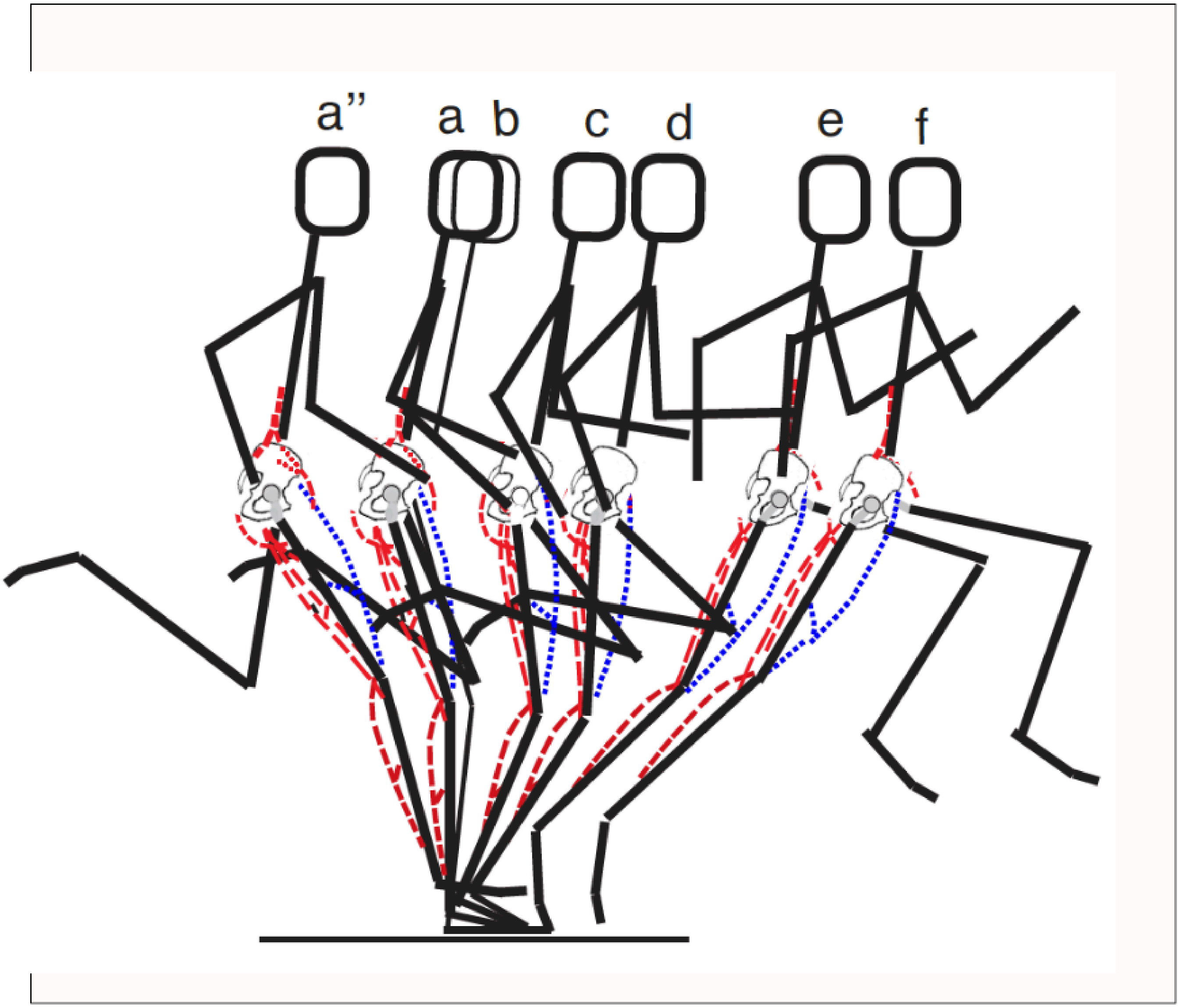
Acceleration near maximum speed



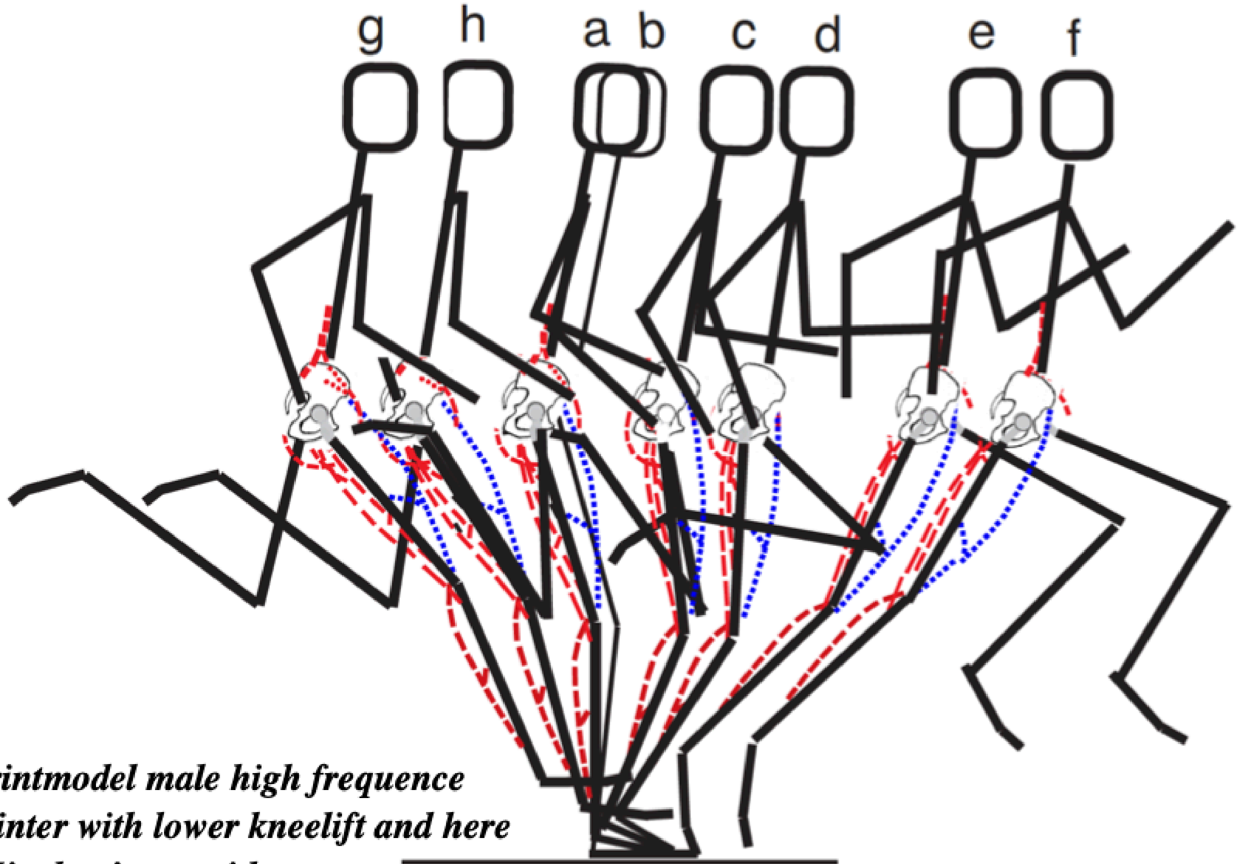
Maximum speed



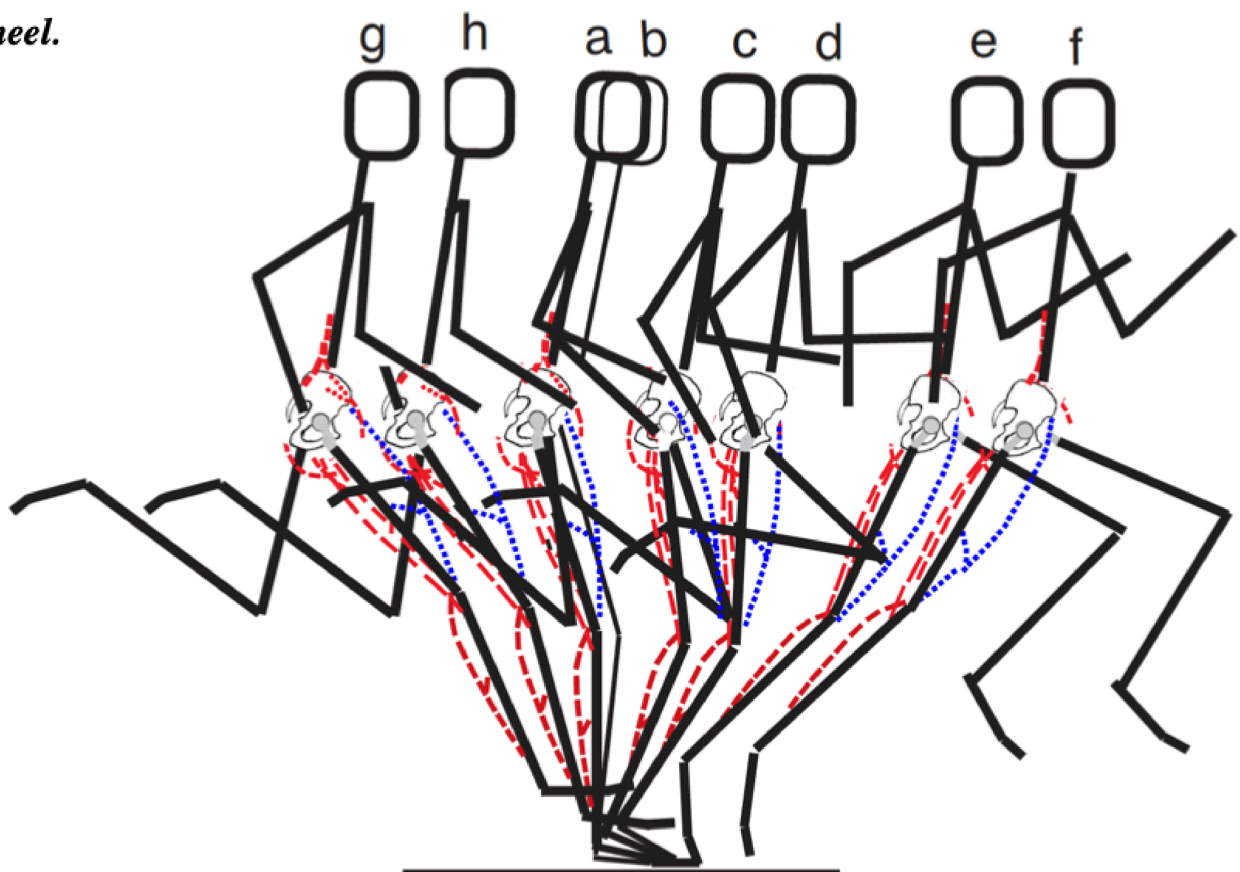
Powersprint, for complete muscle specific sprint technologie at the support phase.



Sprint model, female sprinter with ATP pelvis posture and lower knee lift.

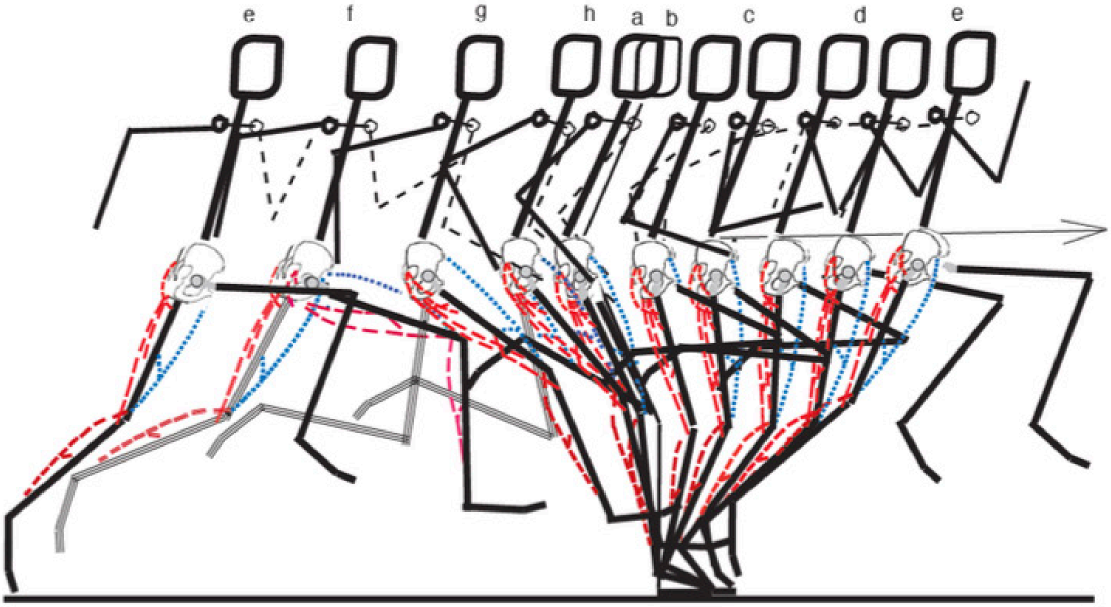


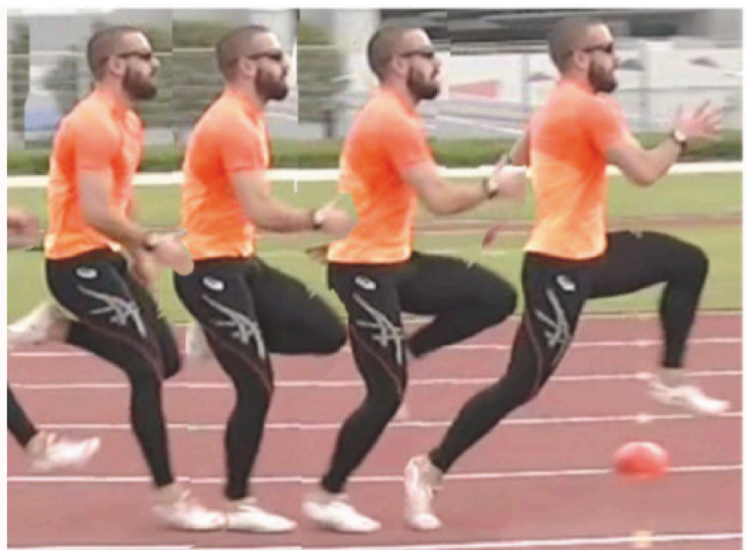
Sprintmodel male high frequence sprinter with lower kneelift and here a Hip dominant with low heel.



The same male high frequence sprinter here with quadriceps dominant with more stiffness.

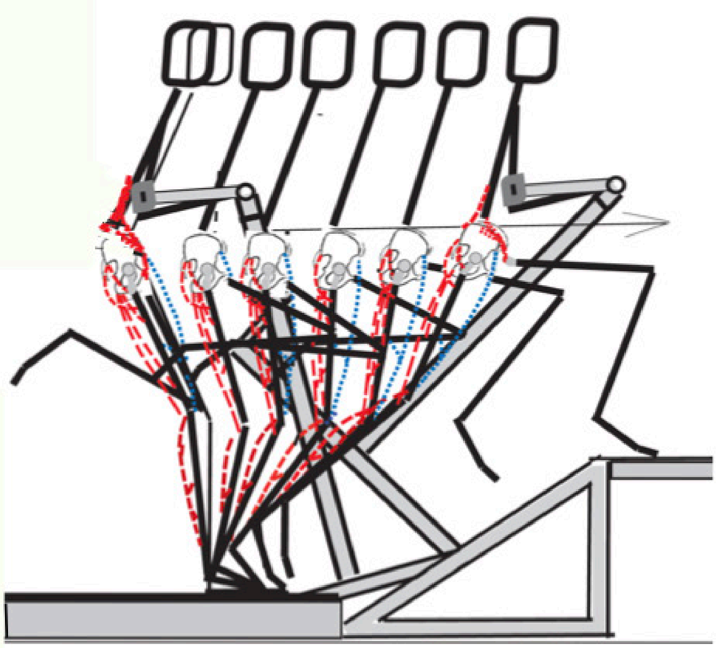
Appendix 7



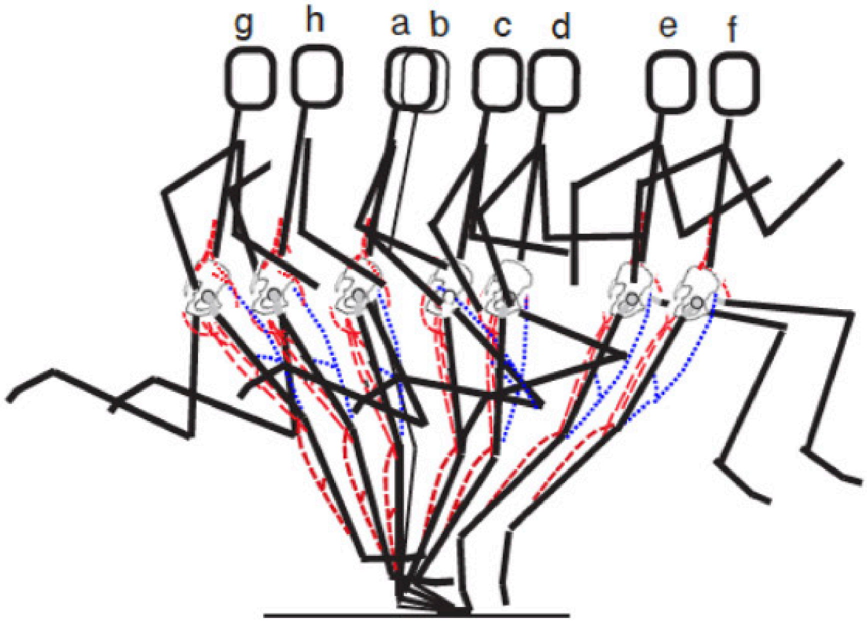


(Stefan Tärnhuvud)

Picture montage (Jan Melén) from video (Håkan Andresson)

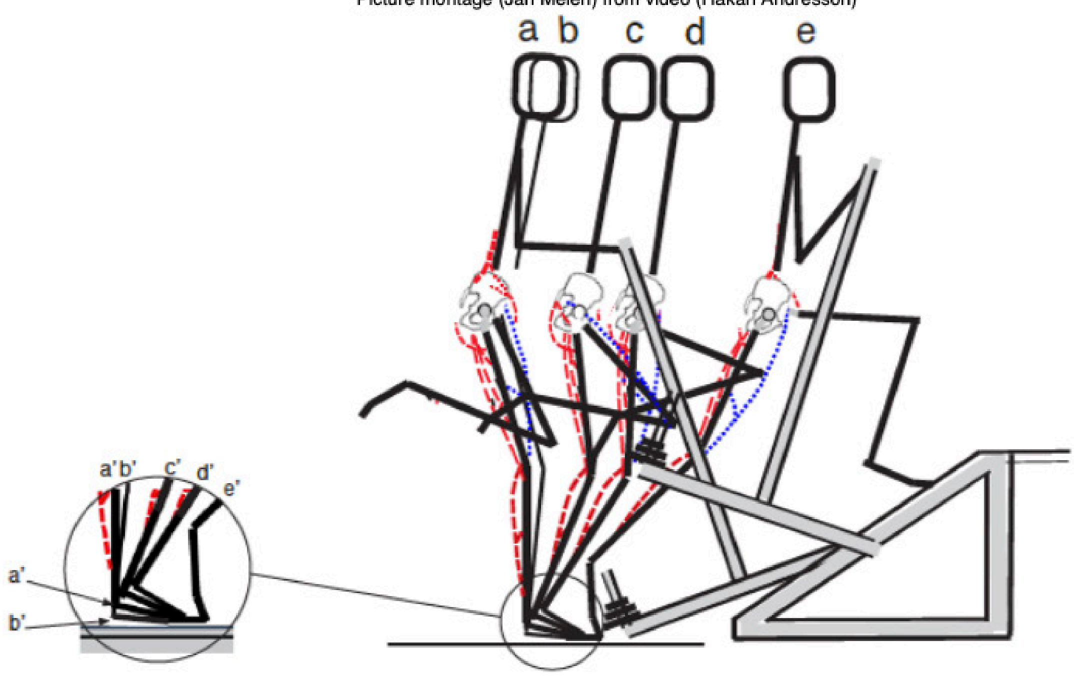


Appendix 8



(Tom-Kling Baptist)

Picture montage (Jan Melén) from video (Håkan Andresson)

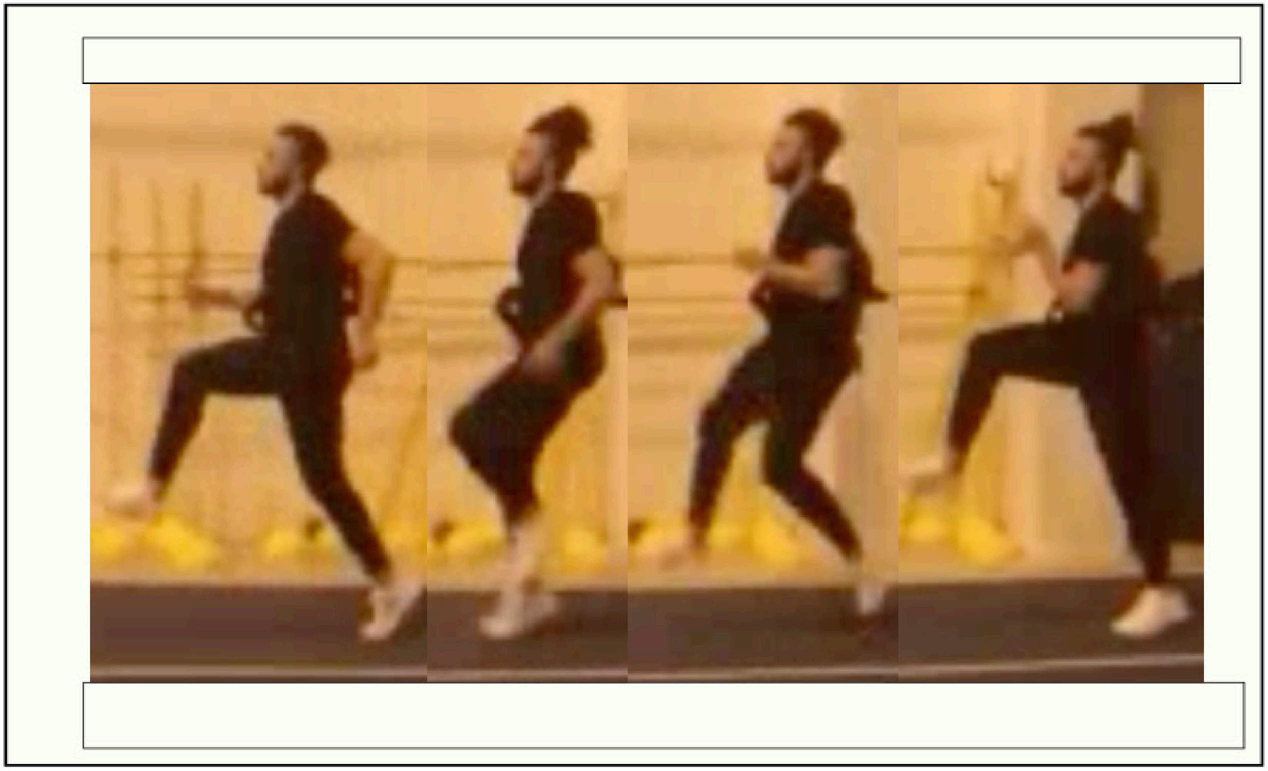


In the following, some examples of exercises that can contribute to design the best sprint technology are presented with the focus on horizontal forces for improved acceleration and maximum speed.

I. Resistance running and plyometric jumping

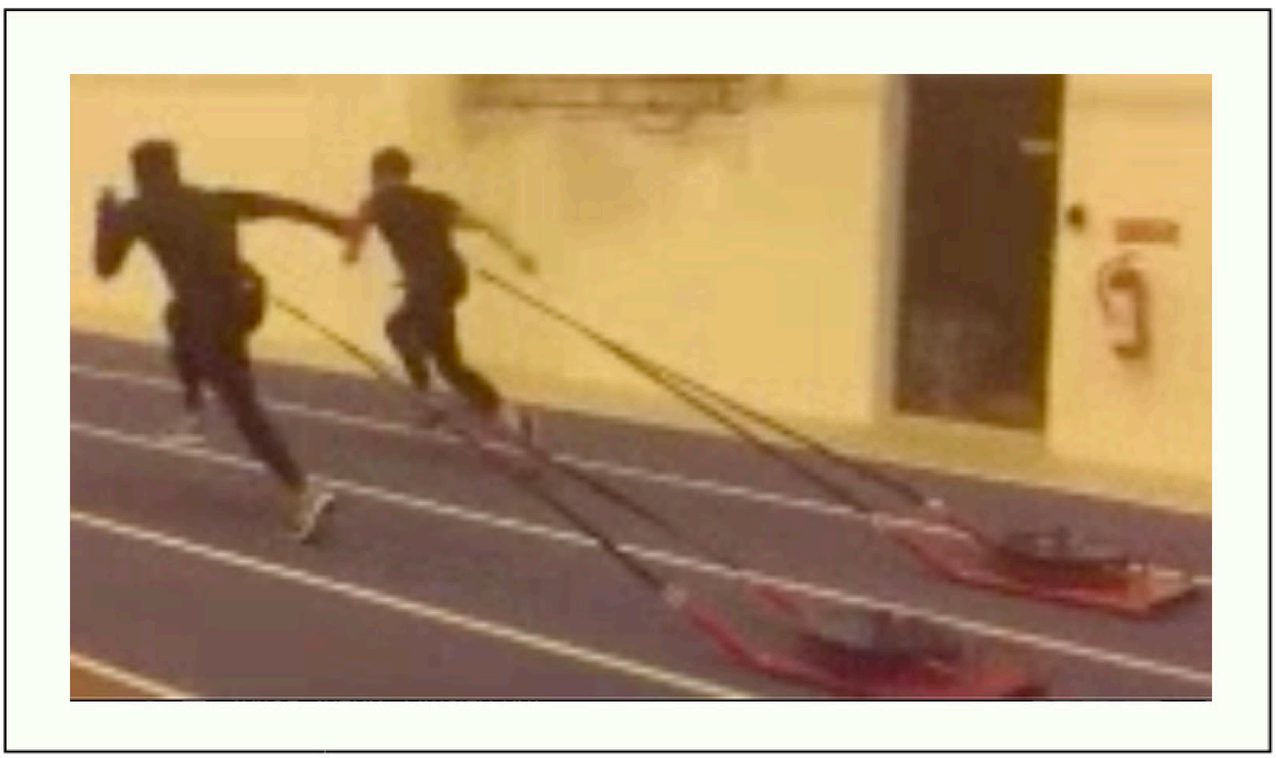
Resistance running with weight ladder (Tom-Kling Baptist)

Picture montage (Jan Melén) from video (Håkan Andresson)



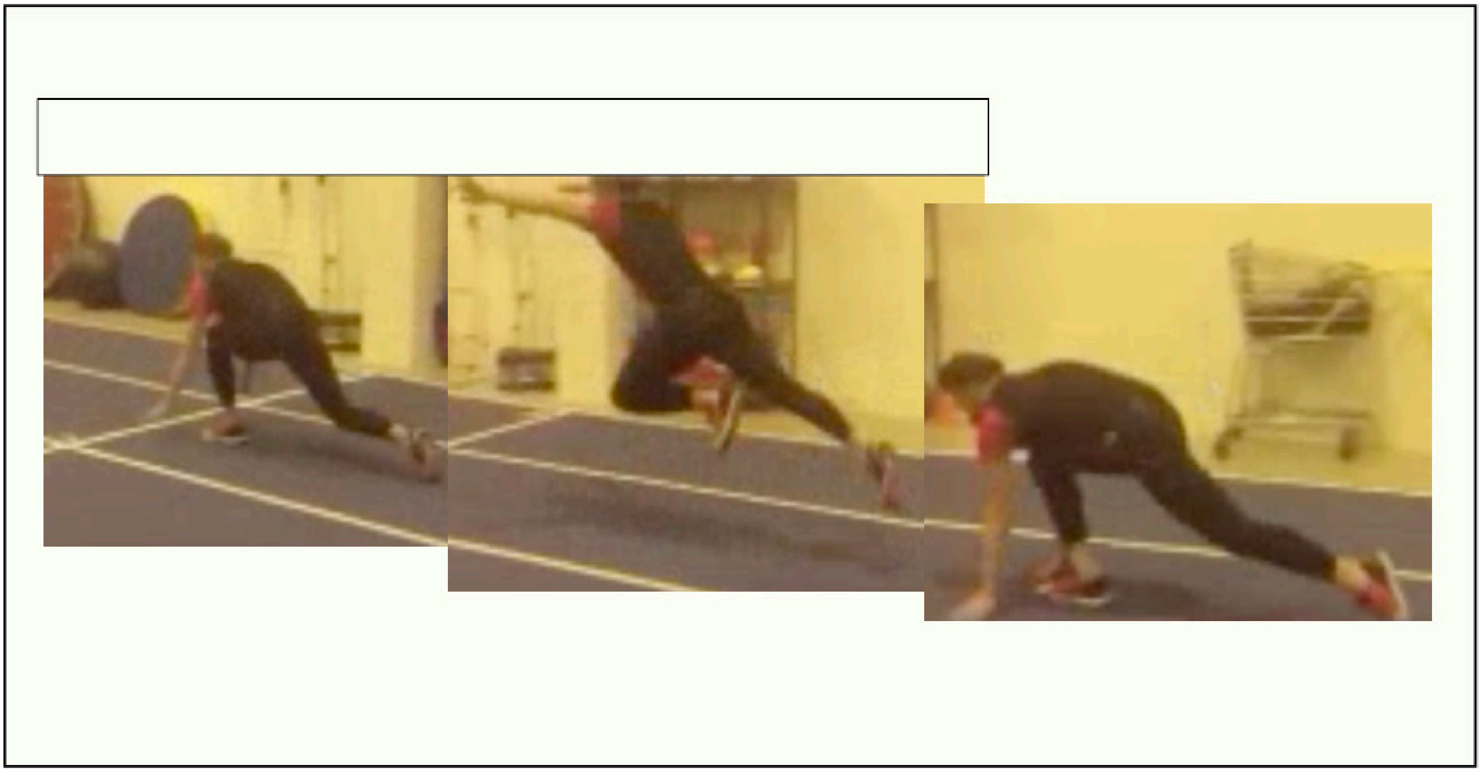
Resistance running (Skipping with locked knees).

Picture montage (Jan Melén) from video (Håkan Andresson)



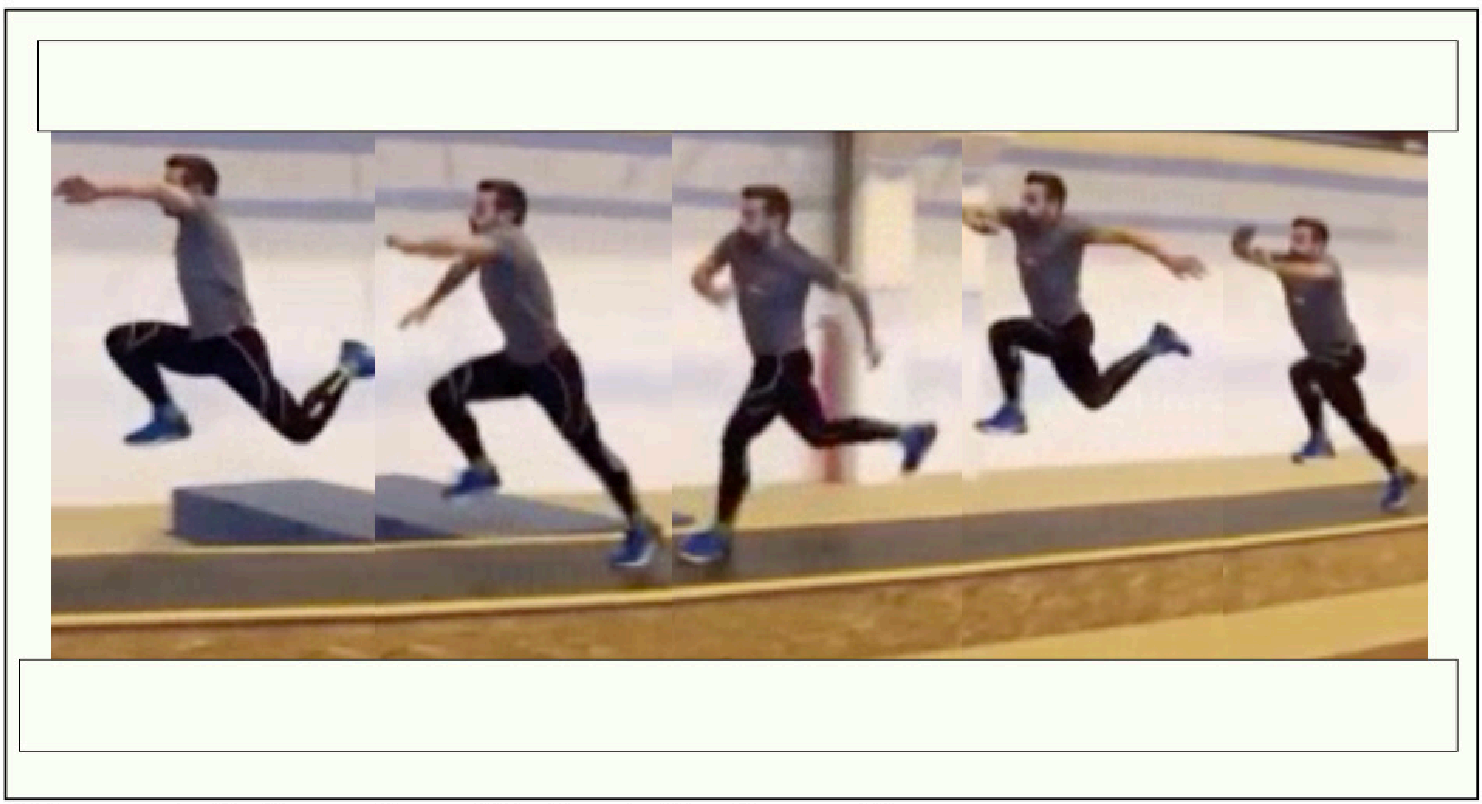
Resistance running with weight ladders

Picture montage (Jan Melén) from video (Håkan Andresson)



Borsov jumps

Picture montage (Jan Melén) from video (Håkan Andresson)



Plyometric jumping (Stefan Tärnhuvud)

Picture montage (Jan Melén) from video (Håkan Andresson)

Plyometric jumping ”box jump” (Mike Marsh, Houston -99)

Video (Jan Melén -99)

Hurdle jumping (Stefan Tärnhuvud)

Picture montage (Jan Melén) from video (Håkan Andresson)

4.3 Program for sprinter running, with powersprint® strength training

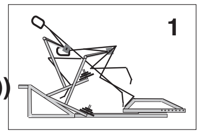
Strength training program

General Period I

Day 1 (Tuesday):

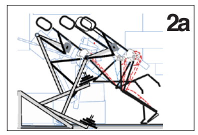
1. Specifik "Base. 

Powersprint B3, B4 (Se picture och appendix. 1))
2-3x6-10/60-77.5% Metod II



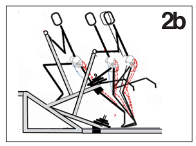
2. General "Base"

Exercise E - J (See pictures down)
2-3x6-10/60-70% Method II
(Sit-ups:2x15-20/40-55%, Method I)



Day 2 (Friday): Specifik Speed strength*

1. A1 (Blockstart) alt. A2a,b (Acc. I) 2x6-8/55-60%*
2. A3 (Acc. II) alt. A4 (Max phase) 2-3x6-7/55-60%*



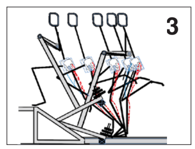
Specifik Preperation Period II

Day 1 (Tuesday):

Specifik maximum strength. *(NmC)***

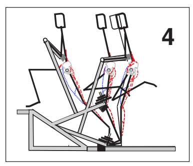
Powersprint C3, C4 (See picture och app. 1))
2-3x2-3/82,5-87.5% NmC-method

**) Inter/ Intra musculary Coordination



Day 2 (Friday): Specifik Speed strength*

A1 (Blockstart) alt. A2a,b (Acc.I)1- 2x6/55-60%*
A3 (Acc. II) alt. A4 (Max. pfase) 2-4x6-7/55-60%



Performance Preperation Period III .

Day 1(Tuesday) Specifik maximum strength.(NmC)*

Powersprint C3, C4 (See pictures and Appendix 1)
2-1x2/85-90%*** NmC-method **2x3/70-75%** NmC-"Explosive"method

Day 2 (Friday): Specifik Speed strength*

A1 (Blockstart) alt. A2a,b (Acc.I)1- 2x6/55-60%*
A3 (Acc. II) alt. A4 (Max. pfase 2x5-6/40-45%"Speed strength method

Performance period IV. (See appendix 1)

The program is designed for sprinting. To understand the purpose of the program and use the powersprint, sprinter technology (Chapter 4) and exercise performance with powersprint (pages 58-60) should be studied. A full year's planning with periodization and propose to training volume and intensity, see appendix 1

Note small framed tables to the right of Appendix 1b with proposals for progressive dosing volume. Important to choose a careful escalation for youth and juniors. For junior and senior elite is increasingly higher intensity and volume usually difficult to fit in micro cycles with only 7 days. For this reason it is recommended that during the period II and III, if possible, rather comply with appendix 2a and 2b now 10-10-7 day meso cycles. You can also alternatively only use 10-10-7 meso cycles during the spring, from week 11 (appendix 2b). **Now, with more time for rest and recovery - along with Power Sprint training this is also ideal for masters (Author).

Period I: Anatomic adaption Method, volume and intensity:

Method I	**Method II**	**Rest:1-2min**
2-3 x 40-60% set 15-	2-3 x 60-80)% set 10-6rep	

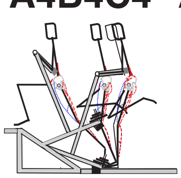
Period II:
Nerve-muscle coordination training (NmC),
Maximum strength

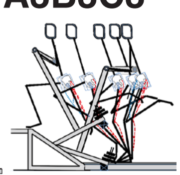
NmC-method			**Rest : 3-5min**
2-6 x 80-90% set 3-2rep	**Alt.**	2-4 x 70-80% set 8-6rep	(Max. "explosive" force, quicker movements

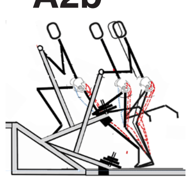
All periods:
Speed strength training (Ss)

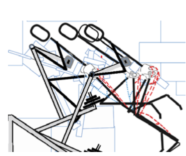
Muscle power method	**Speed strength training (Ss)**	
2-4 x 55-60% set	2-3 x 30-40% set	**Rest : 3-7min**

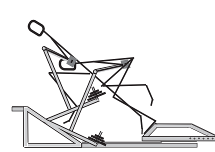
All the exercises with letter designations, which are found in the planning schedule
Specific: Blockstart (A1) Acc I (A2a, A2b) Acc II (A3 B3 C3) Max pfase (A4 B4 C4)
General: E - J Purpose of which is Anatomical adaptation (maintain regenerating).

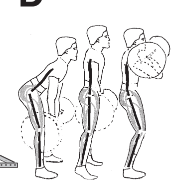
A4B4C4

Max pfase

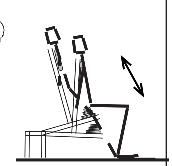
A3B3C3

Acc II

A2b

Acc Ib

A2a

Acc Ia

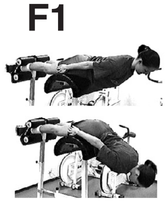
A1

Block start

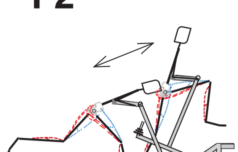
D*

*Clean from knee. **

E1

Squats "Hacklift"

E2

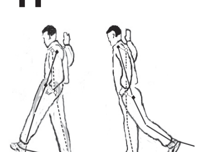
Leg extension (Övn. alternativ)

F1

Back raise

F2

Powersprint, total exercise Koncentric - excentric.

G

Sit-ups, coupled

H

Forward kick, straigth leg

I

Bench press

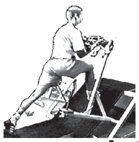
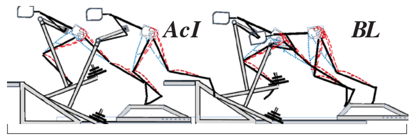
J

Lats

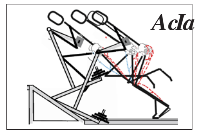
*) Ol- lift (D) alternative to Powersprint

**) Sprint training takes place when the principle "short to long"

4.4 Program for grown up sprinters. Focus NmC.*

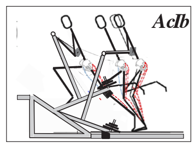



Powersprint: Specifik sprint strength
Maximum "Explosive" strength (NmC)*

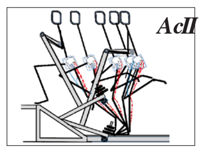


Period I

Day 1: AcIb AcII Max Sprint push
4-2x5/70-75% Rest: 7min
G I J during the rest, 4-3x3-5/70-75%
(See pictures and appendix 3)

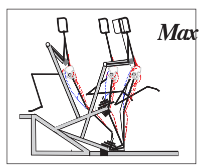


Day 2: "Circle Training" E1/E2 F1/F2 H
3-2x 15-25/ 40-60%



Day 3: BL AcI AcIa
4-2x5/70-75% Rest: 7min
G I J during the rest, 4-3x3-5/70-75%

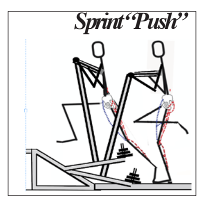
Period II



Day 1: AcIb AcII Max Sprint push
4-2x5/70-75% Rest: 7min
G I J during the rest, 4-3x3-5/70-75%

Day 2: "Circle Training" E1/E2 F1/F2 H
2-1x15-25/ 40-60%

Day 3: BL AcI AcIa
4-2x5/70-75% Rest: 7min
G I J during the rest, 4-3x3-5/70-75%



Period III

Day 1: AcIb AcII Max Sprint push
2x5/70-75% Rest: 7min*

BL AcI AcIa
2x5/70-75% Rest: 7min*

*) Processed from the Swedish coach Kenneth Riggberger's idee and recommendation from his test results of Nerve-muscle coordination training (NmC (Inter/ Intra Musculary Coordination), see page 31) with "Maximum speed and force", 70-75% 1RM load. Program proposal (Author)

The program is designed for sprinters with an already solid basic physics for sprinting and jumping. To understand the purpose of the program and use of the powersprint, sprinter technology (Chapter 4) and exercise performance with powersprint (pages 58-60) should be studied. A full year's planning with periodization of volume and intensity of the sprint training together with this strength training plan, see also appendix 1. For long-jumpers see Appendix 3

***Period I - II: Day 1**(Mo) **Day 3**(Fr)*
***Period III: Day 1**(Mo)*
Nerve-muscle coordination training (NmC),
(Inter/ Intra Musculary Coordination)
"Maximum speed and force" with 70-75% RM
= "Explosive sprint strength"
"Leg and Hips" Spccific sprint strength Exercises. Volume and Intensity:

4-2x set	70-75% 3-5 rep	Rest : 7min Max. "explosive" force,

Period I - II: Day 1 and 3: "Maintaining."
"Upper body". Execises **G**, **I** and **J** during the the first 3 min of the rest. Volume and intensity:

3-1x set	70-75% 3-5 rep	Max. "explosive" force,

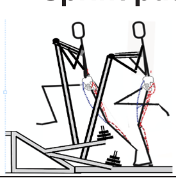
Day 2:
Quadriceps, Gluteus, Hamstring and Back. Execises as circle training : ***E1/E2, F1/F2, H*** Volume and intensity:

2-3 x set	40-60% 15-25rep	Max. "explosive" force,

All the exercises with letter designations, which are found in the planning schedule
Blockstart: BL Acceleration I: AcI, AcIa, AcIb Acceleration II: AcII Max pfase:Max
General : E1/E2 F1/F2 H G I J Purpose of which is Anatomical adaptation (maintain, regenerating) II.

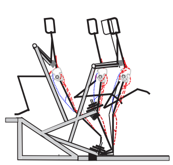
Period I - II: Day 1 **Period III: Day 1**

"Sprint push



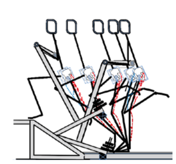
Concentric - (Excentric)

Max



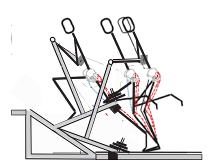
Max pfase Concentric

AcII



Acceleration II Concentric

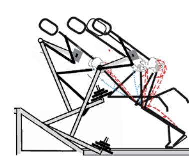
AcIb



Acc Ib Concentric

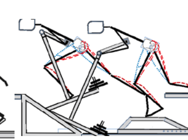
Period I - II: Day 3 **Period III: Day 1**

AcIa



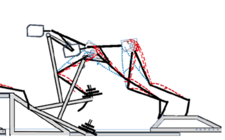
Acc Ia Concentric

AcI



Acc I. The first two steps Concentric

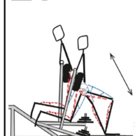
BL



Block start Concentric

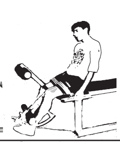
Period I - II: Day 2

E1



Leg Extensions Concentric - Excentric

E2

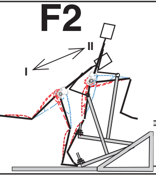


One-leg Legpress Concentric - Excentric

F1

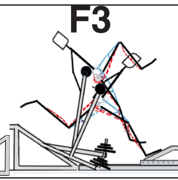
Back raise (Alt.) Concentric - Excentric

F2

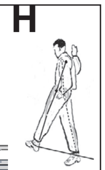


One leg RDL (Alt. Plyom.) Concentric - Excentric

F3



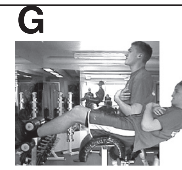
H



Forward kick, Concentric - Excentric

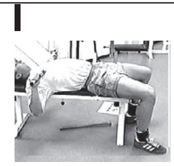
Period I - II: Day 1 and 3 **Period III: Day 1**

G



Sit-ups, coupled Concentric - Excentric

I



Bench press Concentric - Excentric

J

Lats Concentric - Excentric

Periodization[1]		General preperation period I	Specific preperation Period II	Competition preperation Period III	Competitions Period IV
Training factors	*Anatomic adaption*(Aa) *Nerve-muscle coordination*(NmC) *Speed strength*(Ss) *Reactive strength*(Rs) *Technique*(Te) *Speed*(Sp) *Endur-*	Aa Ss Rs Te Sp	NmC Ss Rs Te Sp	Te Sp Rs Ss	Te Sp Rs Ss
Month		OCT / NOV	NOV / DEC	JAN / FEB	FEB / MARCH
Week		40 1, 41 2, 42 3, 43 4, 44 5, 45 6, 46 7, 47 8	48 9, 49 10, 50 11, 51 12, 52 13	01 14, 02 15, 03 16, 04 17, 05 18, 06 19, 07 20	08 21, 09 22, 10 23
Daily[1] loading (Schematic illustrated) 100% H M L		Heavy / Medium week; Light week	Heavy / Medium week; Light week	Heavy / Medium week; Light week	Light week

Weight lifting

A. Speed-strength (Ss)
B. Anatomic adaption (Aa)
C. Nerve-muscle coordination(NmC)

Set x %RM rep/tr.day

Period I: A3A4 2x 55% 6/Fr; A1A2 2x 55% 6/Fr; B3B4 2x 70% 8/Tu — A3A4 2x 60% 7/Fr; A1A2 2x 60% 6/Fr; B3B4 2x 75% 7/Tu — A3A4 3x 60% 6/Fr; A1A2 2x 60% 8/Fr; B3B4 2x 77,5% 7/Tu — A1A2 1x 40% 6/Fr; B3B4 1x 70% 6/Fr Test — A3A4 2x 55% 6/Fr; A1A2 2x 55% 6/Fr; B3B4 2x 70% 8/Tu — A3A4 2x 60% 7/Fr; A1A2 2x 60% 6/Fr; B3B4 2x 75% 7/Tu — A3A4 3x 60% 6/Fr; A1A2 2x 60% 8/Fr; B3B4 2x 77,5% 7/Tu — A1A2 1x 40% 6/Fr; B3B4 1x 70% 6/Fr Test

Period II: A3A4 2x 50% 6/Fr; A1A2 1x 55% 8Fr; C3C4 2x 82,5 — A3A4 2x 55% 7/Fr; A1A2 2x 55% 6/Fr; C3C4 3x 85% 2/Tu — A1A2 60% 6/Fr; C3: 85% 2/Fr Test 3RM — A3A4 2x 55 6/Fr; A1A2 1x 55% 8Fr; C3C4 2x 85% — A3A4 2x 60 7/Fr; A1A2 2x 55% 6/Fr; C3C4 3x 87,5 2/Tu — A1A2 60% 6/Fr; C3: 85% 2/Fr Test 3RM

Period III: A3A4 2x 45% 5/Fr; A1 1-2x 40% 6/Fr; A1A2 2x 55% 6/Fr; C3C4 1x 40% Tu — A3A4; A1A2 55% 6/Fr; 70% — A1A2 2x 60% 6/Fr; C3: 85% 1x — A3A4 2x 45%; A1 1-2x 40% 6/Fr; A1A2 2x 55% 6/Fr; C3C4 2x 75% Tu — A3A4 45%; A1A2 55% 6/Fr; 2x 70% — A1A2 60% 6/Fr; C3: 85% 1x

Period IV: C3C4 1-2x 85% 2x; A1A2 45% 5/Tu — C3C4 1-2x 80% 2x 85%; A1A2 2x 80% 40% 1x — C3C4 1-2x 80% 2x 80%

Per 1: General.ex. (Tu): Method I: 2x15-25. Method II: 2-3x6-10
Per II-IV: (Tu) (Regenerating, maintain)

A1A4= 40-45% Speed strength m (Ballistic)
A2, A4=55-60% Effect method.
B3,B4= 60-70% P "Anatomic adapt (Bompa).
C3, C4= 85-90% Maximum streng
C4= 70-77,5% "NmC-Explosive"

Reactive strength (Rs) Low Intensive (RsL)

Period I: 3x12, 4x15, 5x15, 2x10, 3x12, 4x15, 6x15, 2x10 (RsL)
Period II: 2x12, 3x10, 2x10, 2x12, 3x10, 2x10 (RsL)

Reactive strength(Rs) High Intensive (RsSh)

Period I: 2x4
Period II: 3x5, 4x5, 4x6, 2x4 (RsH)
Period III: 4x5, 3x5, 2x5, 4x5, 3x5, 2x5 (RsH)
Period IV: 2x5, 2x5, 1x5

Speed (ASp)[2] Start training, acceleration ability 10-50m

Period III: P: 5-6min Sp: 8-10; 2x3-4; 2x3 >98%; 1x3 >98%; 2x3-4 >98%; 2x3 >98%; 1x3 >98% (SnAc)
Period IV: P: 5-6min Sp: 8-10; 2x3-4 >98%; 2x3 >98%; 1x3 >98% (SnAc)

Speed (SpAlc)[2] Alactacid capacity (p. 62) 60-70m, 60-80m
Speed (SpAlp) Alactacid Power (p. 62-63)

Period II: P: 3min; Seriep.: 10; 2x 2x70 <94%; 2x 3x70 <94%; 3x60 <94% (SpAlc); 2x 2x70 <94%; 2x 3x70 <94%; 3x60 <96% (SpAlc)
Period III: P: 5-10min; 3x120 2x120 >98%; 3x120 2x120 >98%; 3x100 >98% (SpAlp); 3x120 2x120 >98%; 3x120 2x120 >98%; 3x100 >98% (SpAlp)

Speed Maximum [2] Maximum (SpM)60-80m Supra (SpS) 70-80m

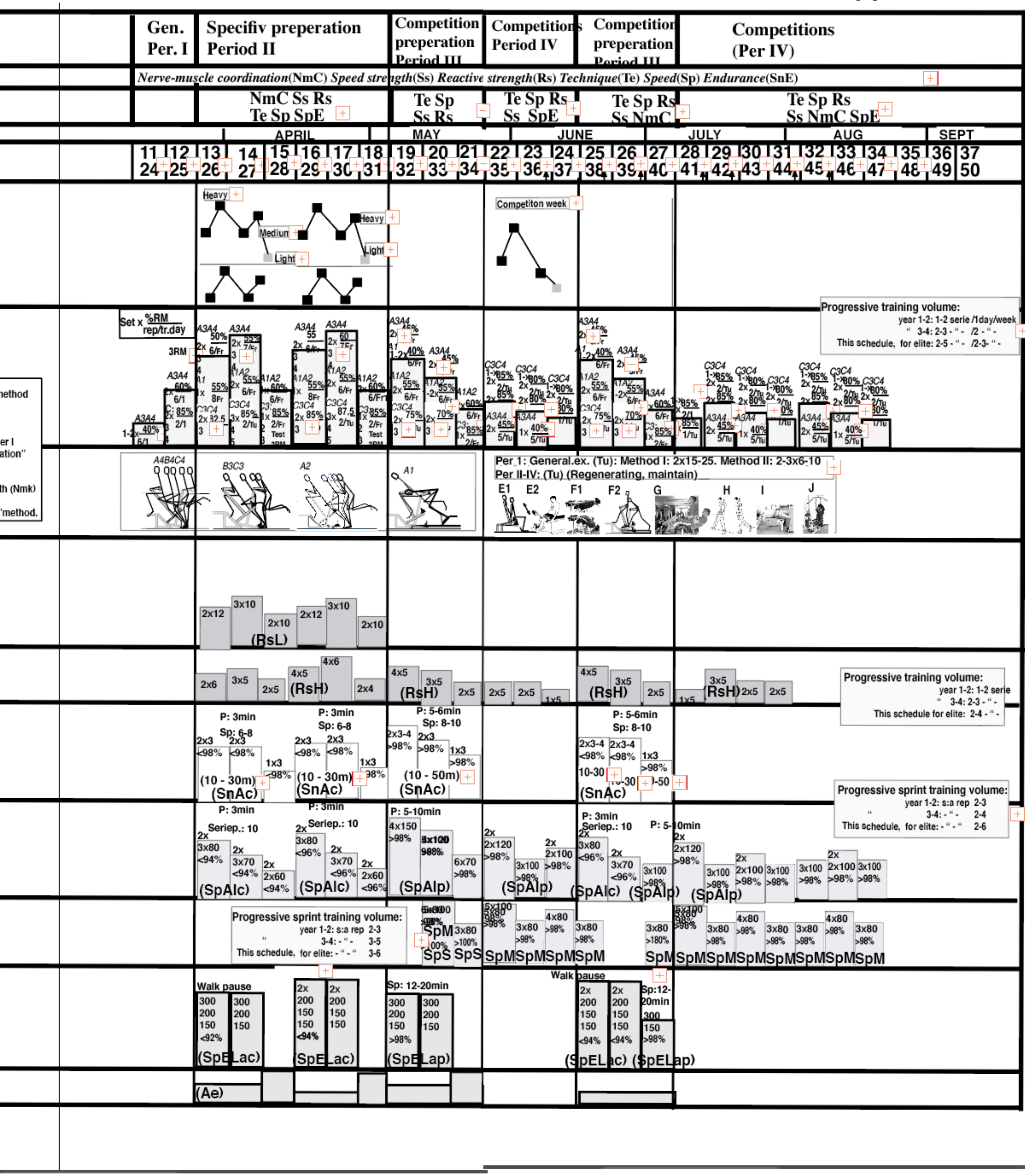
Period IV: 5x100 2x80 >98%; 3x80 >98%; 2x 2x80 2x60 -80 — SpM SpM SpM

Speed Endurance(SpE):[2] Lactacid Capacity(SpELac) 150-300m, 150-200m (sid 62) Lactacid power (SpELap) 150-300m, 200-300m (sid 62)

Aerob endurance(Ae) [2] (Ae) (Ae) (Ae) (Ae)

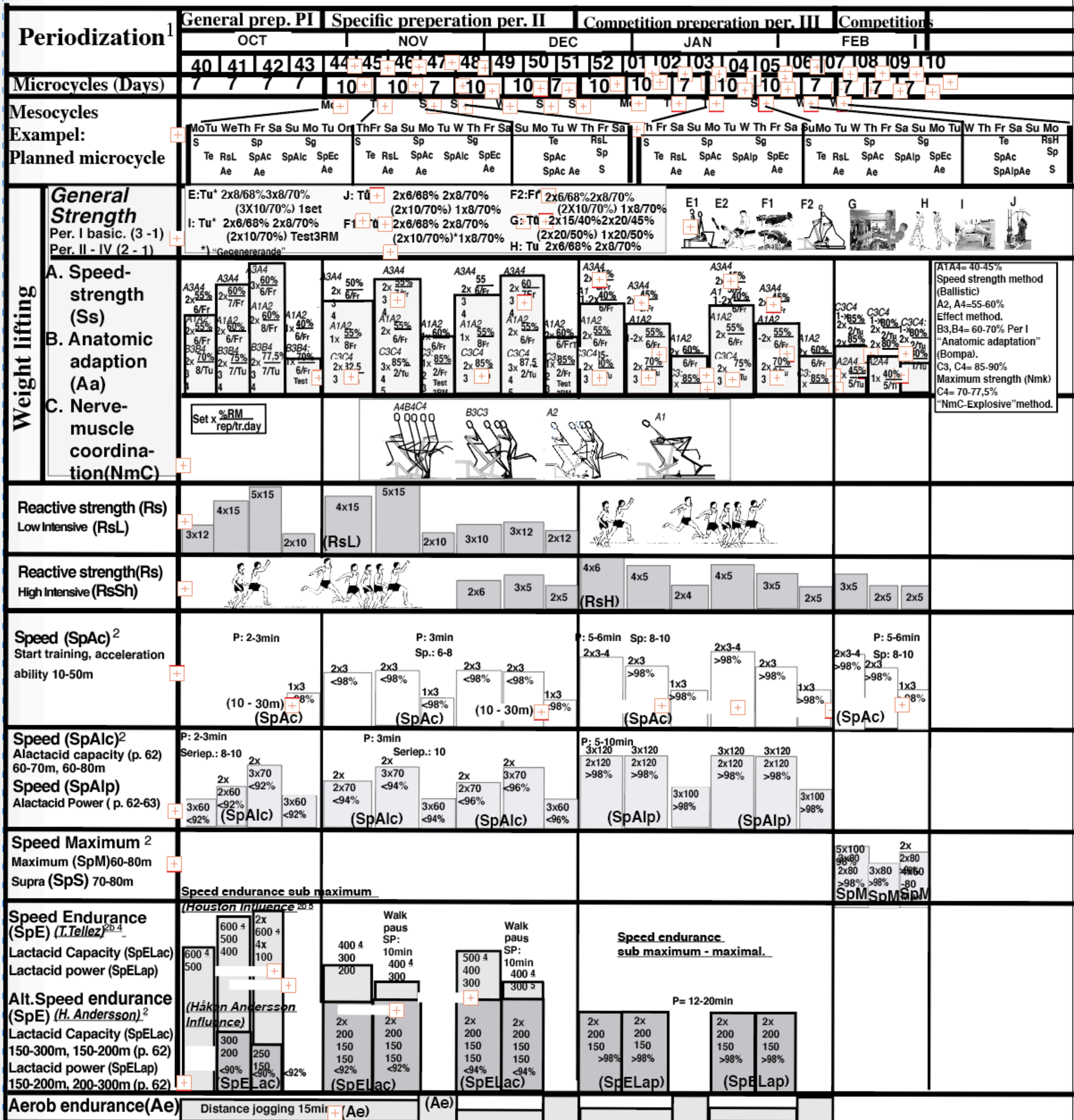
1) Processed Nick Newman, "the horizontaljumps" 2012
2) Processed from Håkan Anderssons sprint program
3) At high intensity och volyme recommended to use appendix 2a and 2b fully or alternatively only Annex 2b in the spring from week 11

Appendix 16



Gen. Per. I
Specifiv preperation Period II
Competition preperation Period III
Competitions Period IV
Competition preperation Period III
Competitions (Per IV)
Nerve-muscle coordination(NmC) Speed strength(Ss) Reactive strength(Rs) Technique(Te) Speed(Sp) Endurance(SnE)
NmC Ss Rs Te Sp SpE
Te Sp Ss Rs
Te Sp Rs Ss SpE
Te Sp Rs Ss NmC
Te Sp Rs Ss NmC SpE
APRIL
MAY
JUNE
JULY
AUG
SEPT
11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37
24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
Heavy
Medium
Light
Competiton week
Progressive training volume:
year 1-2: 1-2 serie /1day/week
3-4: 2-3 - " - /2 - " -
This schedule, for elite: 2-5 - " - /2-3- " -
Set x %RM rep/tr.day
3RM
Per 1: General.ex. (Tu): Method I: 2x15-25. Method II: 2-3x6-10
Per II-IV: (Tu) (Regenerating, maintain)
E1 E2 F1 F2 G H I J
(RsL)
(RsH)
Progressive training volume:
year 1-2: 1-2 serie
3-4: 2-3 - " -
This schedule for elite: 2-4 - " -
(SnAc)
Progressive sprint training volume:
year 1-2: s:a rep 2-3
3-4: - " - 2-4
This schedule, for elite: - " - 2-6
(SpAlc)
(SpAlp)
Progressive sprint training volume:
year 1-2: s:a rep 2-3
3-4: - " - 3-5
This schedule, for elite: - " - 3-6
SpM
SpS
Walk pause
(SpELac)
(SpELap)
(Ae)

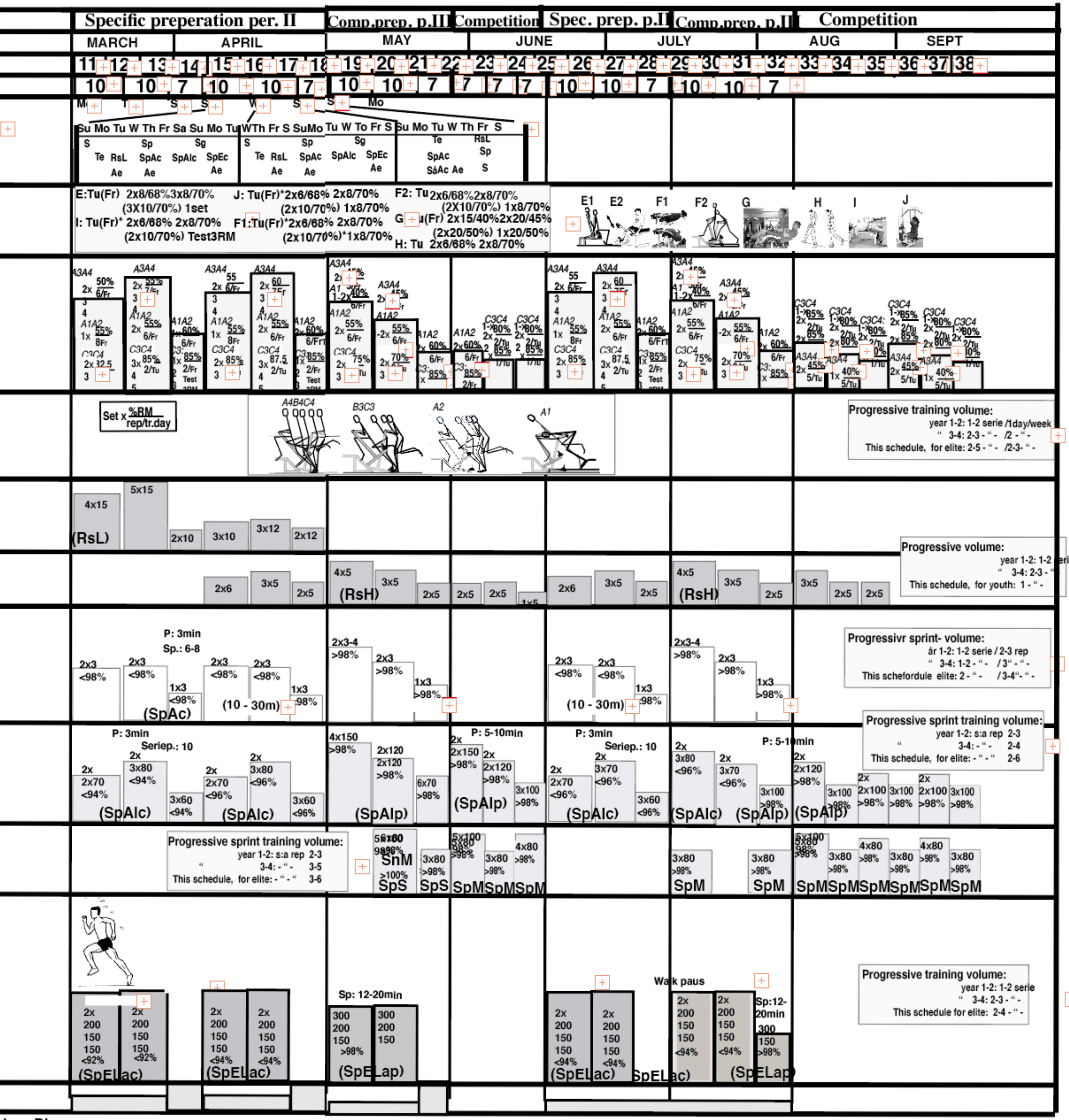
Appendix 17



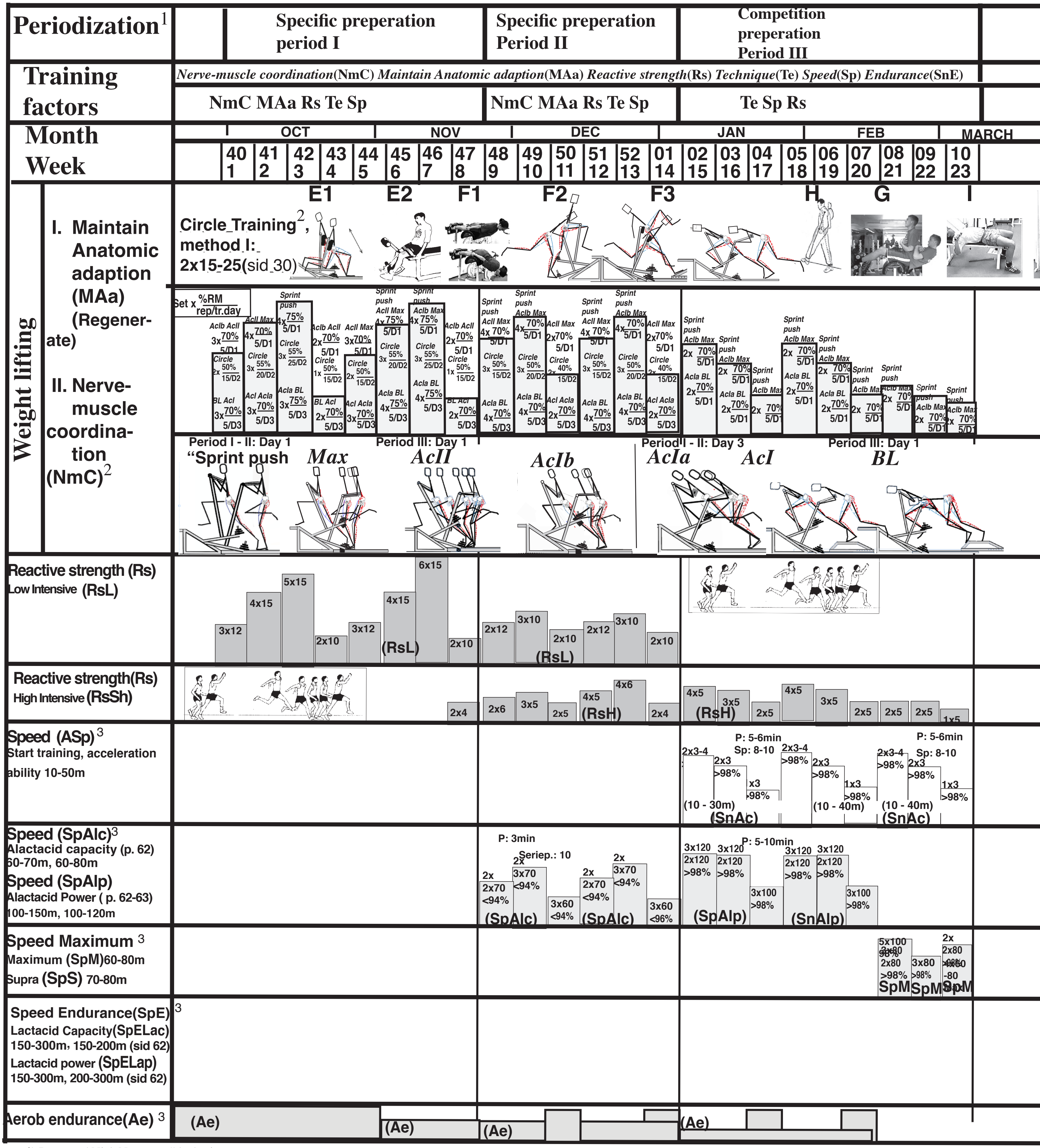
1) Processed Nick Newman, "the horizontal jumps" 2012 and Tudor Bompa "Periodization training for sports" 2015
2) Processed from Håkan Anderssons sprint program (high "Training quality" at a moderate training volume)
2b) Processed from Tom Tellez Houston
3) Optionally is used later years depending of volume increase acc. progressive plan.
4) These long races may be used first in the senior age and should always be done in parallel with some speed training.

*) Running tempos for elite sprin-
tance 100m Distance time
600 - 400 15 - 18 sek 90 - 108 (submax
500 - 300 13,5 - 15 68 - 75 - " -
400 - 200 12 - 13 48 - 52 - " -
300 - 100 max.tempo max.tempo

Appendix 18



nters:DIs-



1) Processed Nick Newman, "the horizontaljumps" 2012 (Proposel the Auther)

2) Processed from Swedish Coach Kenneth Riggberger researching on "Maximum "Explosive" speed and force with 70-75% RM (Nerve-muscle coordination training (NmC),(Inter/ Intra Musculary Coordination)) see page 31 (Proposel the Auther)

3) Processed from Swedish Coach Håkan Anderssons sprint running program (Proposel the Auther)

Appendix 20

	Per. I	Specific preperation Period II	Competition preperation Period III	Competition preperation Period IV	Competitions
	Nerve-muscle coordination(NmC) *Maintain Anatomic adaption*(MAa) *Reactive strength*(Rs) *Technique*(Te) *Speed*(Sp) *Endurance*(SnE)				
	Active rest	NmC MAa Rs Te Sp SpE	NmCTe Sp Rs	NmC Te Sp Rs	NmC Te Sp RsSpE

APRIL	MAY	JUNE	JULY	AUG	SEPT

11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49