PRACTICAL SPEED TRAINING

A SPECIAL REPORT FROM

PEAK PERFORMANCE

The research newsletter on stamina, strength and fitness

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A CIP catalogue record for this book is available from the British Library.

Printed by: Peach Print Limited
Impressions House, 3-7 Mowlem Street, London E2 9HE

Published by P2P Publishing Ltd

Registered office: 33-41 Dallington, London, EC1V 0BB
Tel: 0845 450 6402 Registered number: 06014651

ISBN: 978-1-905096-54-1

Publisher Jonathan A. Pye
Editor John Shepherd
Designer Lorraine Gourlay

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CONTRIBUTORS

John Shepherd is Peak Performance online editor. He is a former international athlete who still competes at masters level. He coaches international athletes and advises coaches and athletes from numerous sports.

Simon Thadani is football conditioning coach with Championship side Ipswich Town.

Phil Gardiner is a top level 4 track and field coach who also coaches rugby players.

LETTER FROM THE EDITOR

Speed is probably the most vital of all sports performance determinants. The player who gets to the ball first, the athlete who gets out of the blocks first and the tennis player whose serve is past their opponent before they can react all display just how important speed is to winning performance. These examples also display the varied nature of speed. Speed is not just about running at maximum velocity, it is integral to accelerating oneself or an object as fast as possible. It can refer in the latter case to the 'arm speed' required by a javelin thrower or baseball pitcher.

Speed requirements are varied and so too are the methods used to boost speed. Some are more likely to be effective than others. The enhancement of speed relies on training the sportsman and sportswoman's muscles, mind and their central nervous system. In this special report all these aspects are covered in a very practical way. As well as chapters explaining the science behind speed, there are numerous workouts with exercise descriptions and suggested routines. These can be adapted and used by sportsmen and sportswomen and their coaches.

I have attempted to provide content and programmes that cover numerous sporting speed applications, for example speed endurance, acceleration and out and out speed. The ideas presented in these chapters can be applied to numerous sports. Likewise the role of the central nervous system should be considered in training of sportsmen and sportswomen from all sports (see chapter 3). If it is not, then it is very likely that the performance will actually slow.

Speed can be trained and everyone can become quicker – you just need to learn how to do this and apply appropriate training methods and workouts. This *Peak Performance* special report will give you some very practical tools and information that will enable you to achieve this for yourself or in those you coach.

John Shepherd

What is speed?

In this chapter the various types of sports speed are identified. An athlete may apply speed in a straight line, over a turn or other rotational movement, through a punch, hit, kick, tackle, throw, jump, dive or reaction. It can involve the whole body, as in sprinting, or be unleashed ultimately through a single limb, as with the javelin throw, or tennis serve. Understanding the speed types will better consolidate the information, training routines and exercises provided in the subsequent chapters.

1. Optimum speed

Although it may seem surprising, on occasion too much speed can be detrimental to performance. If a long jumper, for example, builds up too much on the runway, he or she may be unable to take off into an effective jump. This is because he or she will have too little time on the take-off board to generate enough force to convert speed into height and distance (research indicates that most long jumpers, for example, take off at 'only' 96-98% of their actual maximum velocity).

Similar problems can occur in other sports. In rugby union, an elite place kicker, such as Jonny Wilkinson, knows his range when it comes to place kicks. He will have developed a rhythm with painstaking practice over many years. The England and Lions half-back could swing his boot faster at the ball in an attempt to gain additional metres, but would probably sacrifice accuracy as a result. It is therefore important for athletes to determine with their coaches an appropriate speed for their particular sports skills that does not compromise technical execution.

2. Out-and-out speed

There are obviously some activities that demand the full unbridled release of speed – sprinting being the most obvious example. But it is important to note that, whilst the sprinter needs to move his or her limbs as fast as possible during parts of the race, this must be carried out with a feeling of relaxation, since the effort involved in 'trying too hard' will tighten muscles and inevitably slow performance. Sprinters often comment that time seems to stands still when they are sprinting at their best. They feel that their body is producing maximal performance but almost without effort, and they are not fighting or straining to move flat out.

Out-and-out speed therefore calls for mastery of relevant technique, plus the ability to relax while the body is operating at maximum intensity. The central nervous system plays a key role in firing limbs at maximum speed (see chapter 3) and the learning of optimum muscle recruitment and discharge rates must be trained accordingly.

3. Acceleration

In order to achieve out-and-out or optimum skill/sports speed, a period of acceleration is usually needed. Sprinters leave their blocks from a stationary start, whilst a footballer may need to turn and sprint from a relatively static or off-balance position in order to get onto the end of a pass, and a tennis player must serve from a stationary base. Developing this accelerative ability calls for different training methods and practices from those used for out-and-out speed and other speed types.

4. Endurance speed

Speed training is often neglected by endurance athletes, such as marathon runners and triathletes, but is crucial to their success. The faster an endurance athlete is:

- the easier it will be for him or her to cruise at slower speeds during training and competition (they will have better 'running economy');
- the more power they will have, for example, for hill climbs;

- the better he or she will be at surging during a race to burn off the opposition;
- the more he or she will have in reserve for a killer sprint finish.

I define endurance speed for the purposes of this special report as the ability to sustain repeated powerful and fast muscular contractions over predominantly aerobic race and training conditions.

5. Reaction speed

In many sports a skill has to be performed in response to a cue. This cue could be aural, as with a sprinter reacting to the starting gun, or visual, as with a boxer avoiding a punch, a footballer responding to a change in the opposing team's formation, or a cricket batsman reacting to a delivery.

> **Tip:** it would not be productive for a marathon runner to train like a sprinter, as they would not develop the necessary heart and lung capacity to be successful. However, it would benefit all endurance athletes to 'borrow' some of the training elements that sprinters use in order to enhance their endurance speed, speed endurance, running economy and out-and-out speed.

6. Speed endurance

Speed endurance can be defined as the ability of the body to perform an activity at a very fast speed under conditions of anaerobic energy production. Examples include 200, 400 and 800m running and tennis match play involving long rallies. This speed differs from endurance speed in that the training methods used to condition it are usually briefer and focus on the anaerobic energy systems. Interval training is a key training method for speed endurance (see chapter 8).

Interval training divides periods of 'effort' up with periods of rest. Performing 6 x 40m sprints, with 3 minutes' recovery between efforts is an example of an interval training session, in this case one that would develop out-and-out speed.

7. Body part speed

For some sports a particular limb must move as fast as possible, for example, to throw an implement, as required by the discus throw. Although speed and power are needed throughout the thrower's body, their arm is the crucial link in the 'speed chain', as it ultimately advances the implement to optimum velocity at the point of release. If the arm is 'not fast enough', distance achieved will obviously be compromised.

8. Team speed

The need for team speed is obvious in the case of a sprint relay team, but is also crucial to the success of virtually all other team sports, where players must move quickly and in concert, for example, in order to score a try or defend as a unit in rugby. Developing this 'shared speed' should be a training requirement in such sports.

9. Rotational speed

Rotational speed is a vital quality in many sports. Footballers rotate their bodies to turn and chase down opponents or the ball, whilst tennis players have to 'wind' up to hit a serve, a baseline forehand or backhand pass. In track and field, discus throwers spin with almost balletic grace before releasing their implements and with the incredible force needed to achieve huge distances. Rotational speed can be vastly improved by the use of appropriate drills and training methods.

10. Agility speed

Agility is another key sports speed requirement, characterised by quick feet, body coordination and fast reactions. Its execution depends on a mixture of balance, out and out speed, acceleration speed, strength, flexibility, coordination and, crucially, sports-specific skill. Although a performer's agility relies heavily on the possession of optimum sports technique and 'match sense', it can be enhanced by specific agility speed conditioning. It should be considered that agility really is a form of power training and not necessarily, despite the

inclusion of it in this list of speed types, a separate entity. Additionally too much agility training can programme in motor engrams (patterned ways of moving and reacting, stored in the brain) that are actually not relevant to sports requirements.

11. Over-speed speed

This is the term used to describe training efforts that allow athletes to perform a speed skill to a level beyond that which would normally be achievable. It can involve the use of specialist equipment, such as elastic cords, which literally drag the athlete to higher velocities, and specialist speed training systems and protocols. Lower-tech options include downhill sprinting and throwing lighter implements or balls than those used in competition for throwing athletes.

Short to long speed training

When coaching speed it is crucial that neither coach nor athlete loses sight of the fact that speed should never be lost, only built on. In track and field, most speed athletes, such as sprinters, long jumpers and hurdlers would begin their training for the next season with periods of slow running and strength endurance work. In doing this they would in some way nullify the gains in speed that they have spent all the previous summer season developing. The short to long approach never loses sight of the prime concern of a speed training programme, ie the development of more speed – it is designed to build more speed on more speed and not significantly reduce an athlete's speed capability before attempting to make them faster. Endurance, if needed for example by a 400m runner, is then built onto speed – not the other way round, as is the case with the more traditional methods of speed training.

Coaches such as Charlie Francis (see box overleaf) have been at the forefront of such a shift in thinking and the development of the short to long approach to speed development. The method is seen to:

- maximise physical speed development;
- optimally stimulate the central nervous system (CNS) – see chapter 3;
- reduce injuries (athletes using the traditional method can pick up injuries when attempting to sprint after months of much slower work);
- allow for more speed peaks;
- minimise the negative effects of de-training speed and power producing fast twitch muscle fibre.

Charlie Francis – sprint guru or sprint devil?

In 1988 Charlie Francis coached the then fastest man in the world Ben Johnson to the world record and Olympic title in Seoul. Johnson, as we know, was subsequently stripped of this and other titles for a doping offence. However, it would be erroneous for us to assume that Francis' athletes only won because they were drug fuelled (although this helped). The 'Francis sprint training methods' did add that something extra to the performances of those he coached, and one of these was the 'short to long' approach. Among his many other coaching accomplishments was the fact that at the 1984 Olympics, of the 14 Canadian medals, 8 were won by Francis coached athletes. Not surprisingly, his techniques and thoughts are still in demand today. It should also be noted that his athletes were not the only ones using performance enhancing substances.

How much of an aerobic base does a sprint athlete need?

Aerobic fitness underpins the development of most other types of fitness. The more efficient an athlete's body is at processing oxygen, the quicker it will be able to recover between efforts. In the past it was reasoned that developing good aerobic condition in a sprint athlete would boost speed development. Thus it was not unknown for rugby and football players to go on 10-mile runs, or sprinters to run continuously for up to 30 minutes!

The logic of this approach, however, is questionable when you consider the actual aerobic/anaerobic content of these sports (see table 1, see p21). Most of the work done by field sport players and more obviously by the sprinters is anaerobic (table 2, see p22) and too much of an emphasis on aerobic work will blunt speed; this results from an unnecessary increase in the oxygen-processing capabilities of slow twitch endurance muscle fibre and a 'blunting' of the speed and power generation capabilities of fast twitch fibre.

Prolonged training with a specific emphasis (ie speed) can change fibre type. Sprint athletes obviously require a proliferation of fast twitch fibres – 70-80% of a top class sprinter's leg muscles will contain fast twitch fibres – and the

'short to long' approach never loses sight of this, as it maximises the opportunity for changing muscle fibres in the right way for speed enhancement.

So how much aerobic training is necessary in a speed/sprint training programme? Charlie Francis recommends that for training a 'mature' 100m, 200m or 400m runner, the development of base fitness with an aerobic element requires relatively little attention. He advocates only a 6-week period where this conditioning element is given any kind of ascendancy, at the beginning of the training year.

Training immature athletes (less than 5 years of consistent sprint training) will require a greater aerobic conditioning emphasis. Francis identifies an 8-12 week development phase at the beginning of the training year for them. Both these durations should allow sufficient time to plan a double or even a triple periodisation sprint programme using much more specific training (of which more later). Tempo running (runs at 70% effort over 300m in sets of 4-8, for example) is used as a much more appropriate specific base builder.

In the light of this it is interesting to consider the American approach to pre-season conditioning for field sports such as American football. Here, the emphasis is placed on developing speed and power and much less placed on general aerobic conditioning. The reasoning is that in pre-season (where the rigours of competition and travelling between fixtures are absent), proper attention can be given to developing the playing ingredients that will have the most direct effect on developing peak playing power. In-season, speed and power levels can be topped up. This, again, reflects the short to long approach to developing speed. Speed is built prior to the season and maintained throughout.

Maintaining speed in-season for speed athletes

Undulating periodisation (UP) is probably the sprint and field sports coach's most effective way to maximise the playing condition of his or her athletes. UP basically mixes and matches all the relevant training ingredients into one training mix.

Strength, power, agility, endurance, out and out speed, specific individual and collective playing skills and flexibility are all carefully overlapped and fused together to keep the athlete in peak playing condition.

This requires careful and consistent athlete appraisal on the part of the coach (something that Francis emphasises with his sprint training). It is also crucial that coaches realise that no two athletes will have exactly the same training needs and that individual training programmes will therefore have to be produced (although this may be more difficult for those involved in team games). It should also be noted that athletes from certain sports, such as football mid-fielders, will need greater levels of aerobic conditioning than others to allow them to cope with the energy pathway demands of their sport (see chapter 9 for a specific and practical consideration of football speed). However, even then, anaerobic training is the most important (see table 1).

Table 1: Selected track events and sports and their aerobic/ anaerobic energy pathway contributions

Analysis of these sprint performances can then identify which 'sprint areas' a player may need to work on. A poor 5m time (from standing) but a good overall 20m time, for example, would indicate that the player should work on reaction, the golden step and acceleration.

Event	Aerobic energy pathway contribution	Anaerobic energy pathway contribution
200m	5%	95%
800m	34%	66%
1500m	50%	50%
10 000m	80%	20%
Marathon	98%	2%
Baseball		100%
Basketball		100%
Football		
Goalkeeper	0%	100%
Mid-fielder	20%	80%
Field hockey	20%	80%

Table 2: Work performed by sprinters and energy pathway

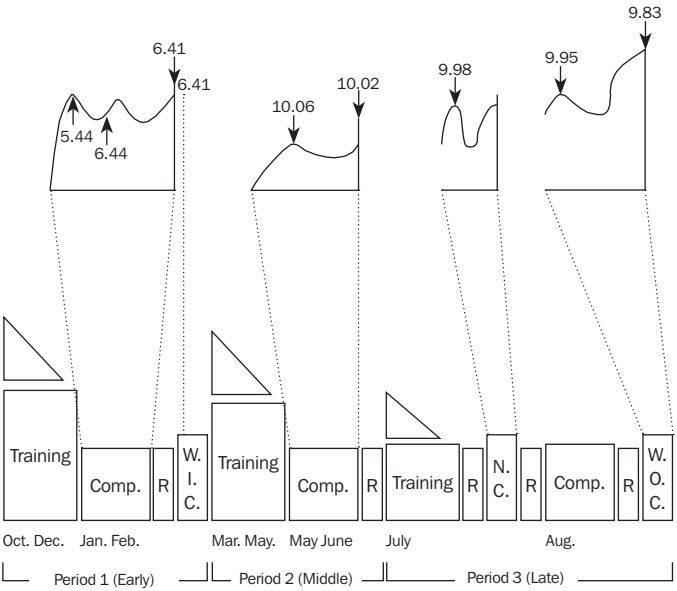
Energy pathway	Duration/comments	Sprint activity relevance – selected examples
Immediate anaerobic	6-8 seconds Type II b fibre* emphasis Targeted by sprint and plyometric (jumping) activities and very heavy load weight training * Type II b muscle fibres are the keys to generating increased speed and power. They need to be targeted specifically to develop speed	100/200m sprinters – very significant 400m sprinters – significant Football goalkeepers and strikers – significant Racquet sport players – significant
Short-term anaerobic	8-90 seconds Type II a* and II b fibre emphasis Targeted by weight training *Type II a fibres are also known as transitional fibres as they possess the capacity to take on a greater speed or endurance capability dependent on the training they are subject to	100-400m sprinters – very significant Field sport players – very significant Racquet sport players – significant
Aerobic	90 seconds onwards Type 1 fibre emphasis Targeted by steady paced running	Minimal

Intensity, not volume, is the key to improved sprint performance

Although nearly all athletes increase the volume of their training as they progress year to year, for sprint athletes it is training intensity that must have the ascendancy. Intensity should increase while volume often decreases. The coach needs to carefully monitor the volume of intense work being performed by the athlete and the recovery that is needed to allow progression and reduce injury. The short to long approach allows the athlete never to be too far away from absolute sprint conditon at any time in the training year (the role of the central nervous system is crucial in this respect – see chapter 3).

This is why for sprint athletes, double and even triple periodisation is advocated (see figure 1, overleaf). A triple-periodised training programme allows an elite sprint athlete to peak for the indoor season, mid-outdoor season and late outdoor season for Olympic or World Championships. For example, each peak should elicit a higher level of performance than the previous one, whereas the conventional long to short approach may fail to provide a real opportunity to achieve 3 optimum speed peaks, as too much time will be lost 'returning' to previous speed levels rather than building on them. An exacting sprint coach should attempt to blend all the ingredients of perfect sprint performance into the third peak (acceleration, absolute speed and speed endurance – see figure 1, overleaf).

Figure 1 –
Example of a triple peridiodisation programme for a sprint athlete (Ben Johnson)



	Speed Emphasis	**Speed Emphasis**	**Speed Emphasis**
Metres	**0-60m**	**30-120m**	**60-200m**
30	3.85	3.83	3.80
60	5.41-6.44	5.38	6.38
100		9.98	9.95
120		11.80	11.78
150			14.68
200			20.10
PROJECTED TRAINING TIME TO 100M TIME	3.85 (30m) = projected 9.95 100m	6.38 (60m) = projected 9.80-9.85 100m	6.38 (60m) = projected 9.80-9.85 100m
Training Goal	= Adequate Acceleration now in place	= Adequate Top Speed now in place	= Adequate Speed Endurance now in place

Keys: W.I.C. = World Indoor Championships
N.C = National Championships
W.O.C. = World Outdoor Championships
R. = Recovery Phase

Source: The Charlie Francis Training System P101

The importance of power

Power is obviously crucial for the sprinter, and the short to long method always keeps power on the boil. Francis ensures that complementary training takes place at all times, for instance by maximum strength work in the gym and during tempo running phases. He doesn't advocate combining flat-out sprint work with near maximum weight lifting, due to the contraindications of the two training methods and the 'strain' that this would place on the central nervous system. Interestingly neither does he recommend a weight training 'channelling' phase (this would use more sport-specific weights exercises, performed with increasing speed), rather he sees sprinting plus plyometrics exercises as the ultimate 'channeller'.

Sprint speeds as conditioning ingredients

In order to develop optimum speed, coach and athlete need to carefully blend sprint speeds. We have noted, for example, that aerobic conditioning becomes much less of a concern for nearly all speed and power athletes as they become more mature. In terms of absolute speed it is generally recommended that running intensities never fall below 70% of maximum speed. Speeds slower than this will not produce a sufficiently strong stimulatory effect on fast twitch muscle fibre.

Many coaches fail to divide up (in terms of their effects) the percentages of speed that can be generated between 70 and 105% of maximum speed (105% refers to the speed that can be generated through the use of over-speed techniques, such as downhill running and the use of bungees). Various terms have been applied to sprint running speeds, such as tempo runs, speed endurance, lactate endurance or maximum speed runs. Table 3 (overleaf) defines the key types.

Table 3: Sprint speeds as a percentage of maximum speed

Name of speed	Description and comments	Typical workout
Tempo runs	70-85% of max speed, run over 100-300m distances on the track (Francis recommends weekly distances of 2000-2400m)	6 x 200m at 75% effort (speed) concentrating on form. 5 minutes recovery between runs
Speed-endurance speed	Sprints over 60-120m designed to improve the sprinter's ability to maintain flat out speed. This type of training is very intense and should be used with caution, due to stress on the CNS. Regeneration of the athlete is paramount	2 x 120m 100% sprints – full recovery
95% effort speed	These runs are performed just below flat out. They will groove in flawless technique without over-stressing the athlete and, in particular, their CNS	3 x 120m with 7 minutes' recovery between runs
Out and out speed	These runs are performed at 100% effort, they are intense and will stress the CNS	2 sets of 4 x 40m sprints from block start – full recovery between runs
Over-speed	These runs are performed at 105% of top speed using downhill methods or bungees to achieve this. High level of CNS strain	4 x 30m downhill runs with full recovery

Speed-endurance training

Speed-endurance is crucial to a multitude of athletes and a lack will result in reduced sports capability. A rugby player short of speed-endurance may be intercepted and hauled to the ground after making a 60m break for the line, while a 200m runner may have built a seemingly commanding lead off the bend, only to be reeled in and passed in the last 5 metres of the race. In field sports, players make repeated short-lived but intense efforts; the athlete with a high level of speed-endurance will experience less 'fade' during a match or workout and will be able to maintain high power outputs. Speed endurance workouts are therefore crucial to their training (see chapter 8 for a detailed consideration of how to develop speed endurance and out and out speed for a 100 and 200m runners as the season approaches).

The short to long approach should be used when developing speed endurance as well as out and out speed. How much of an emphasis the coach places on this will be dependent on the training maturity of the athlete, the point in the season and the specific playing requirements of the athlete's sport. For example, a midfield football player will require greater speed-endurance capability obviously than a goalkeeper, who needs more 'immediate anaerobic pathway' conditioning.

George Dintiman is another of the world's leading speed training experts and he has devised an 8-week speed-endurance training programme designed to increase both immediate and short-term anaerobic fitness. Table 4 (overleaf) provides some sample workouts from this programme and shows how it is in keeping with the short to long theory of speed development. Note: numerous other professional field sports, such as football and rugby will use a version of this type of training in pre-

season.

Week	Workout	Routine and distance	Repetitions	Rest interval
1	1	Jog 15 yd, stride 15 yd, (75% speed), jog 15 yd, walk 15 yd.	5	No rest between reps; the 15yd. walk acts as the recovery phase
2	3	Jog 20 yd, stride 20 yd, (90% speed), jog 20 yd, walk 20 yd.	5	As above
3	9	Jog 25 yd, stride 25 yd, sprint 25 yd, walk 25 yd.	7	As above
4	11	Sprint 20 yd, jog 20 yd, sprint 20 yd, walk 20 yd.	7	As above
5	14	Sprint 20 yd, sprint 300 yd, run on the spot to exhaustion	10 1 2	Walk 10-30 sec., 3-4 min 1 min
6	15	Sprint 40 yd, sprint 300 yd, distance hop to exhaustion	8 2 1 each leg	Walk 10-30 sec., 2-3 min 1 min
7	19	Sprint 20 yd, jog 20 yd, sprint 20 yd, walk 20 yd, sprint 300 yd.	15 3	Walk is the recovery phase 2.5 min
8	21	Sprint 440 yd.	4	4-5 min

Adapted from Dintiman, Sports Speed (3rd edition) page 151/152

Table 4: 8-week speed-endurance programme

From reading the above you will begin to appreciate how important the right choice of training sessions, conditioning ingredients and, crucially, the underlying approach to speed training planning is when it comes to optimising speed. With training mature athletes in particular, the short to long approach offers the greatest potential for increased speed.

References

Dintiman G – *Sports Speed* (third edition) Human Kinetics 2002

Francis C – *The Charlie Francis Training System 1991* (e-book) available from CharlieFrancis.com

The role of the central nervous system (CNS)

When it comes to providing energy for sports performance, the aerobic and anaerobic energy systems would probably be at the top of most coaches' and athletes' lists. However, there is another source, perhaps less well known, but potentially more important – the central nervous system.

The CNS interprets and relays signals from around the body, via the spinal cord and brain. It is a complex system, a sort of control system for the body, one that is inextricably linked to athletic performance. Its behaviour has traditionally been thought of as being conscious, involving a degree of interpretation through the senses – however it is actually likely that much of its activity functions at a more unconscious level. If coach and athlete can understand its operation and relevance to athletic training and tap its full potential, then the result will be personal best performances, less chance of burn out and maximum training adaptation.

Why is the CNS important for speed development?

Research indicates that playing a sport for a long time influences the way the CNS 'controls' muscular recruitment. Here's some research:

Five different athlete groups from Finland were chosen as subjects for research – track and field jumpers, swimmers, footballers and poor and good vertical jumpers(1). The Finns wanted to find out how the sports performers recruited their muscles, and the role of the CNS.

Not surprisingly it was discovered that the track and field jumpers performed the most powerful vertical jumps, whilst

the swimmers were the poorest jumpers.

It was discovered that the CNS influenced the way in which the different sports performers recruited their muscles. For example, the swimmers were unable to create the stretch/reflex action in their leg muscles as powerfully as the jumpers, due to a different firing pattern – which resulted in poorer jump performance. The footballers' jumping movement, meanwhile, was more contrived, displaying a more staccato muscular firing rhythm, unlike the jumpers, whose muscles fired dynamically, rapidly and sequentially to produce jumping power.

The stretch/reflex action occurs in muscles when a concentric (shortening) muscular contraction immediately follows an eccentric (lengthening) muscular contraction, as occur when jumping, hopping and sprinting, for example.

The researchers attributed these differences to the specifics of the individuals' sports and years of relevant training, together with the effects these had on the CNS. They stated, 'The results suggest that prolonged training in a specific sport will cause the central nervous system to programme muscle coordination according to the demands of that sport.' He adds that '(the) learned skill-reflex… of the CNS seems to interfere hierarchically in the performance programme of another task.'

In slightly plainer English, the white-coated boffins were saying that it is good to train correctly for your sport/track and field event, maximising the CNS's potential to enhance performance. However, if you change sport/event and have to adopt new movement patterns that might be compromised by your prior sport/event, then less than optimum performance might result. Ever wondered why very few horizontal jumpers can be top class at the long and triple jump, despite the event's apparent similarities? Now we have an answer.

The CNS becomes 'used' to firing the muscles and reacting to the forces involved in a specific way for each event (remember it's not all about conscious effort). So the long jumper trying to triple could 'short circuit' the CNS loop if they switched to this event after years of training for another. Their conscious and, importantly, unconscious long jump take-off

actions will want to manifest themselves in the triple jump take-off, which requires different angles and forces (and therefore CNS function). For the coach of mature athletes thinking of advising a change of event, this is an important consideration – the CNS gets used to producing energy and movements through repetition, and taking these in a new direction can be very challenging.

Maximising the CNS's contribution to sport: a focus on track and field performance

If an athlete were to perform a 100% sprint to fatigue (forgetting all the physiological reactions that would occur in their muscles), the CNS would continually be relaying intense fatigue signals, which the athlete would have to combat to keep sprinting flat out. Producing this energy would severely tax the CNS. Now, this is a somewhat obvious scenario, but CNS fatigue is still an impairing factor under much less obviously fatiguing conditions.

Tudor Bompa is one of the world's foremost authorities on strength training. He has produced detailed plans based on research on how to construct and periodise (plan over time), for example, a weight training programme that will most effectively contribute to improved sports performance and crucially, in the light of this article, maintain the integrity of the CNS. As he writes, 'Increasing evidence suggests that the CNS limits performance to a much greater extent than once thought'[(2)]. He identifies two processes – 'excitation' and 'inhibition'– within the functioning of the CNS as it relates to sports performance. He sees there being 'neural energy' zapping backwards and forwards from muscle/muscles to brain and back again repeatedly at incredible speeds, not just in the 9 and a bit seconds it might take Usain Bolt to run the 100m, but in the 0.89 seconds or less that his foot is in contact with the track on each and every stride when he is flat out.

To move the body as fast as possible like this when sprinting requires the signal transference through the CNS to be virtually instantaneous. Consequently Bompa believes that exercises

should only be performed for as long as this and what he calls 'quickness' is possible, ie fatigue must be avoided. To ensure that this quickness is maintained he identifies the following symptoms of CNS fatigue that coaches must be on the look out for:

- increased ground contact times when sprinting, or performing plyometric (jumping) exercises;
- slower weight lifting speeds and reduced lifting capability;
- reduced ability to perform a sports skill;
- breakdown of optimum event technique.

As noted, Tudor Bompa is one of the world's foremost sports conditioning experts – the only coach to produce an Olympic champion in a power event, the javelin, and a world champion in an endurance event, rowing. Bompa's approach to CNS training is to create the best conditions for improved maximal muscular contractions. His training is designed to boost CNS capability which will increase its potential to contribute to better sports performance.

Bompa worked with Charlie Francis – coach to 'disgraced' sprinter Ben Johnson in the 1980s (see chapter 2). Although he refutes involvement with drugs, he advised Francis on how to get the most from the CNS. Francis designed a training programme where workouts were rotated around their effects on the CNS. Prescribed rest was crucial in this respect, as was an intuitive feel on the part of the coach as to when the athlete had had enough in a particular workout.

Sprinting

After a top-level performance in training and/or competition Francis would implement a 'recovery training phase'. This might be contrary to what the athlete felt they needed. Often after a pb, there is a tendency for the athlete to want to do more competitions or go for another training session pb. However, doing this could reduce the effectiveness of the CNS in supplying stimulation for further peak performances in the immediate and longer-term future. Francis' recovery phase would last 7-10 days and he would often ensure that his sprinters

ran no faster than 95% during track workouts. Indeed Francis would cut specific sessions to save CNS energy, ie if an athlete ran a pb in training, then the workout would be terminated. This strategy was designed to save CNS energy and also reduce injury potential.

Weight training

For weight training to improve explosive power, Bompa believes in low numbers of reps, but with very heavy loadings (in excess of 90% of 1RM) with long recoveries in excess of 5 minutes. Incidentally, these are also advocated because they reduce the effect on an athlete's muscle mass. If more 'body building' type weights workouts were used, these could reduce their power to weight ratio. Examples of such workouts include 4 x 8 repetitions with a load equivalent to 70-80% of the athlete's 1RM, with 1-2 minutes recovery between sets – these workouts produce more of the anabolic (natural) growth hormones.

For the athlete, tweaking the CNS could be the diagnostic that unleashes their ultimate potential.

The aim when training and maintaining the energy of the CNS should be to keep it sufficiently energised and fatigue-free to maintain high power outputs and create that vital high level of muscle excitation and neural energy. It's a bit like the fine-tuning that goes into an F1 car. It's not good enough for the machine just to run at 199mph – every ounce of performance needs to be squeezed out, so it can achieve 200mph (or whatever its maximum speed is). For the athlete, tweaking the CNS could be the diagnostic that unleashes their ultimate potential.

Potentiation

A further consideration when analysing the CNS's ability to generate increased athletic power is what's known as 'potentiation'. Performing sprints before a weights workout, or plyometrics, or vice-versa, has been shown to enhance the

performance of the subsequent activity. It is believed that this occurs because the CNS, the muscles, and their associated nerves boost neural excitation, recruit motor unit and muscle fibre and reduce inhibition under these circumstances. Basically, the horse-power of your muscles is temporarily boosted. Note: the potentiating activity must not unduly fatigue the CNS, otherwise the transference effect could be cancelled out.

The explanation for this is that muscles are made up of thousands of fibres that are switched on by neural energy coming from the brain through the spinal cord and through motor units and motorneurons. A sprinter has to want to run fast to run fast – to supply the required neural (mental) energy. If he or she is 'in the zone' then the supply of this neural energy to the muscles (and therefore a stream of fast and powerful contractions) can be almost continuous with the result of better performance. Potentiation seems to create a set of circumstances within the CNS that boosts the excitation of muscle fibres, allowing them to release additional power.

Training planning

It is very important to consider the placement of high intensity (CNS taxing) workouts and their proximity to one another in an athlete's training schedule. Table 1 (opposite) displays the types of activities that need to be moderated in an athlete's training programme with reference to CNS drain. Bompa advocates 48 hours' recovery between such workouts. He also recommends that on the same training day, more of the same training can be performed, due in part to potentiation and also to create a gap in the training programme where lower intensity and restorative training can take place. Thus a sprinter could perform a sprints workout and an equally intense plyometrics session on the same day. But on the subsequent training days their workouts would be selected so as not to challenge the CNS. Options here would include tempo runs (medium paced runs at 75% effort), or sprint drills performed at a similar intensity.

Table 1: High intensity training options that need to be 'controlled' to reduce potential CNS fatigue

Lifting weights above 80% of 1RM;
Performing compound weights lifts, such as cleans and snatches;
100% effort speed work with full recovery between reps;
Maximum effort plyometric work;
Maximum effort agility and deceleration work;
High effort anaerobic endurance work (ie timed max effort intervals);
Competitions.

Adapted from: www.thejump101.com/art/weight/highlowtraining.html

Conclusions

Coach and athlete will see that the role of the CNS in enhancing athletic performance needs special attention. It may hold the key to improved speed and power production, for example. One sprinter may do very much the same training as another, but their CNS may be being trained/affected differently. One may be getting the rest necessary to stimulate an enhanced CNS, and will therefore run faster, whilst the other is not and will not. On another level, one may be following a training plan that maximises the contribution of the CNS to high performance, whilst another is learning less than optimal muscle firing and movement patterns. The information provided in this article will enable coach and athlete to understand the role of the CNS and implement training strategies and competition plans that will maximise its contribution to sports performance.

References:

1 *Electromyogr Clin Neurophysiol*. 2003 Apr-May; 43(3):141-56

2 *Periodisation Training for Sports* Bompa T et al; Human Kinetics 2nd edition, 2005

Getting ready to go fast – warming up for speed

Speed training and competition is very intense; it's therefore crucial that the athlete warms up appropriately.

How to use the workout

The session should be performed twice a week. It's designed for a club standard (or above) sportsman or sportswoman who has been in regular (and relevant) sports specific training for more than 6 months. It involves specific dynamic preparatory exercises, such as leg swings, as opposed to static, held stretches that have little direct relevance to enhancing speed sport performance.

Who will the speed workouts benefit?

The workout will benefit sportsmen and sportswomen who need to warm up to specifically benefit their speed development.

The workout

If you have not trained regularly for speed and power then you will need to spend some time getting your body ready before you go flat out. This cautious approach will reduce injury risk and condition you to withstand the forces to which your body will be subject. Even if you are well conditioned for your sport you should always approach a new drill or skill with appropriate caution. Just because you are fast in a straight line, your body is not necessarily adept or conditioned to withstand fast changes of direction. Always underestimate what you think you can achieve and learn the technique of each drill first before performing them at 100%.

Kit

Wear kit that will keep you warm or cool and allow you to move freely. Running tights, perhaps offering compression qualities, are a good option. Compression clothing can assist speed activity training and support muscles.

Wear training shoes, as opposed to football boots or running spikes (where applicable), to perform the drills. Racing flats are a good option in that they provide a degree of cushioning, but are light and flexible and will allow you to more readily feel the contacts you are making with the ground.

Hydration and post workout recovery

Even a minor level of dehydration can significantly impair workout and competition performance.

As a guide, for workouts that last less than an hour, water should be sufficient.

For workouts that last greater than an hour, energy drinks (with their carb content) are best. If used, the hydration and energy replenishment process should start straightaway, ie by drinking every 20mins or so after commencing exercise. Note also that you should also be hydrated prior to your workout.

After the workout

A recovery/energy bar or drink, with its protein and carbohydrate content, will kick start your recovery process. Note that this information applies to all workouts.

Workout objective:

- To warm up safely and effectively, in particular for straight line speed, and heighten your neuromuscular system (this will get you mentally and physically ready to move as fast as you can);
- To take you to the point when you are ready to perform the main part of your speed/power session.

Estimated time to complete: 20-25 minutes.
Time in training year: all year round.

Part A – Raise body temperature by jogging for 3-5minutes

Part B – Dynamic mobility drills

These drills will take your muscles through the range of movement required for sprinting and other speed training. Note: they are sprint drills, designed to optimise sprint technique.

1) High knee lift walk, with clawing action of lower leg

Objective: to improve balance and sprint posture and specifically warm up the calf muscles and hamstrings.

How to perform: Stand tall and lift one thigh parallel to the ground and extend your lower leg forward. Then sweep it (and all your leg) down towards the ground, underneath and up behind your body, pulling your heel up towards your butt as you do so, whilst stepping forward with your other leg. Repeat this cycling movement. Basically you are performing the running action at walking pace.

Technique tips:

- Keep chest elevated;
- Make foot contacts on the balls of your feet;
- Coordinate your arms with your legs – that's opposite arm to leg.

Do: 3 x 20m.

2) Lunge walk

Objective: to warm up the hips and hamstrings.

How to perform: Stand tall and take a large step forward, placing your foot flat on the ground. Lift from your front leg and step into another lunge. As you pull your rear leg through to the front, take its heel up to your butt (this makes the drill even more running specific).

Technique tips:
- Keep your chest elevated;
- Coordinate your arms with your legs.

Do: 3 x 10 lunges.

3) Arm circles

Objective: to warm the shoulders up dynamically.
How to perform: Begin slowly jogging and cycle your arms around your head whilst keeping them long (not bending them at all).

Technique tips: Keep your chest elevated.
Do: single and double arm swings, circling your arms forwards and backwards.

4) Leg cycling

Objective: to specifically warm up the hamstrings for sprinting and other dynamic activity.

How to perform: Stand tall, side on to a wall or rail on tip-toes and place your inside hand on it for balance. Lift your inside thigh to a position parallel to the ground, extend its foot away from your body and then sweep it down, round and under your body, before pulling it through to the start position (this completes one leg cycle). Complete designated number of cycles and repeat on other leg.

Technique tips:
- Keep your chest elevated;
- Don't allow your body to hinge excessively as you cycle your legs beneath you. If this happens, then slow the movement down. This unwanted movement indicates a lack of relevant core stability – with practice and the implementation of other exercises, such as the plank and side plank this strength will develop.
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5) 'T' stretch

Objective: to warm up the back, legs and shoulders.

How to perform: Lie on your back with your arms outstretched in line with your shoulders. Keep your palms on the ground. Your legs should be straight out in front of you, with your heels shoulder-width apart. This forms the 'T' shape. Next, lift one leg straight up towards your head. At the sticking point (the point when you can't pull the leg back further) rotate your leg across your body in an attempt to touch your outstretched hand to the opposite side. If your shoulders lift from the floor, pause and bring your leg back to the centre, before slowly lowering it to the ground. Keep your other leg pressed into the ground throughout. Complete your designated number of reps and repeat to other side.

Technique tips:

- Keep the movement smooth;
- Hold the stretch for 5 seconds.

Do: 6 to the left and to the right.

6) Leg swings

Objective: to dynamically stretch the hip flexors (muscles at the top of the thighs) and hamstrings.

How to perform: Walk forwards, swinging one leg up in front of the body at a time from the hip with control. Try to touch the palm of your other hand with your toes – this hand should be held approximately parallel to the ground and coordinated with your leg actions. Pull the leg back to the ground to stand on it and then swing the other leg forward to repeat the drill. Complete the designated distance in this fashion.

Technique tips:

- Perform slowly and with control;
- Maintain a slight bend at the knee joint;
- Keep your chest elevated.

Do: 4 x 20m.

Part C – Neuromuscular enhancement drills

After you have performed part B you move onto further stimulating your neuromuscular system, so that you'll be in your best speed shape when it's time to sprint flat out in the main part of your workout.

These drills will engage body and mind and recruit your speed and power, producing fast twitch fibre – they'll 'hype' you up and stimulate your physiology for the quick reactions necessary for out-and-out speed expression.

1) Hand to knee drill

How to perform: Assume a medium lunge position. Hold the palm of one hand approximately parallel to the ground to the front of the leg that is behind your body (you will have to angle your arm down slightly).

When you are ready, drive your knee towards the palm of your extended hand as fast as possible to make contact with it. Take the leg back, pause and repeat. Complete your designated number of reps and repeat with the other leg.

Technique tips:

- Don't take your hand to your knee;
- Initiate the movement from your hip flexor (the muscle at the top of your thigh);
- Think 'sharp and snappy'.

Do: 5 reps on each leg.

2) Leg cycle from leg swing

How to perform: Assume the same start position as for the leg cycling drill. This time swing the leg backwards and forwards. Maintain a slight bend at the knee joint. Perform 2 swings like this and then when the leg reaches near to parallel to the ground in front of your body, sweep the leg down, back and round, underneath your body and back to the front as fast as you can. Perform another two swings and repeat.

Technique tips:

- Start slowly to build up relevant exercise confidence (and in particular hamstring strength), although ultimately the drill should be performed as fast as possible to fully derive the neuromuscular benefits;
- After performing these drills you will be ready to perform the main part of your session. However, prior to doing so, you should perform some fast strides over 40-60m with good recovery. Do 4-6 of these;
- Strides are smooth, controlled runs, where you focus on sprint technique. Build your speed up over a number of runs so that you are near/flat out on the last one.

Do: 5 cycles on each leg.

Running drills

Whatever your sport, you will be a faster runner if you have an efficient running technique. Athletes from numerous sports spend a great deal of their time performing sprint drills. These take a specific element or elements of the sprint action and allow the athlete to focus on them. Drills can form part of the warm up, as in chapter 4, but they can also form a session in their own right.

In this predominantly practical chapter, examples of various sprint drills are provided.

The drills

Ensure that you are properly warmed up before performing the drills – refer to chapter 4.

1) Foot strikes (straight leg bounds)

Objective: to improve foot-ground contact and leg power and make you a zippier runner.

How to perform: Begin by jogging forward, then, keeping your legs straight, lift each in turn (in a sort of goose stepping action), to strike the ground powerfully just in front of you as you pull your leg toward your body and the ground – strike the ground with your forefeet. Keep your toes up.

Technique tip: Coordinate your arms with your legs – that's opposite arm to leg – and keep your chest elevated.

Do: 4 x 20m.

2) Leg cycles – 'ankle over heel drill'

Objective: to increase your stride length by running with the most appropriate technique.

How to perform: Begin running at a slow to medium speed then start cycling each foot so that it passes over the ankle of your other leg. Make your movements fast and dynamic and coordinate your arms with your legs. You are not running fully, your strides are short and fast.

Technique tip: pull your foot back toward the ground in preparation for each foot-strike. Your contacts need to be light and dynamic.

Do: 4 x 20m.

3) '4' drill

Objective: to engage your hamstring muscles in the running action and improve what's known as the 'pick up' – that's when the foot leaves the running surface behind your body when running and follows a curvilinear path to the front of your body in preparation for the next stride.

How to perform: stand on tip-toes next to a railing (or suitable height object) and place one hand against it for balance. Lift your inside leg up, with its knee just in front of your other one. Keep your toes up – or 'foot cocked' as track coaches often describe. Concentrate and use your hamstrings to pull your heel up toward your butt, so that your heel is just above your standing leg's knee. Your thigh should be angled toward the ground.

Technique tip: keep the toes up throughout the drill and focus on the pick up movement.

Do: 3 x 10 on each leg and increase the speed as you gain confidence.

4) Marching leg drives

Objective: to improve knee lift and foot contact.

How to perform: March forwards, lifting one thigh at a time to a parallel to the ground position, then dynamically drive the leg back to the ground to strike powerfully, whilst stepping into the next stride at the same time. Coordinate your arms with your legs.

Technique tip: build up speed gradually and ensure that the ground contacts are dynamic.

Do: 4 x 15m.

5) Pull throughs

Objective: to improve leg speed and the recovery phase.

How to perform: This drill is similar to the leg cycles drill (drill 2), however, it is performed on just one side of the body and with greater speed. Basically, on every other stride you should quickly advance one leg from behind the body to a position in front of it, taking your foot over the ankle. A recovery stride is taken and then the drill is repeated (with the same leg). The non-cycling leg is pushed forward in order to accommodate the unilateral movement.

Technique tip: start slowly and gradually build up speed. When you have developed both exercise confidence and speed it may be possible to get two 'pull throughs' into each push of the other leg. This will enhance leg speed – do note that the basics of the pull through movement should not be overly compromised (ie range of movement should be maintained) and that each movement should be cyclical.

Do: 6 x 20 – 3 to the left and 3 to the right.

6) Speed bounds

Objective: to improve the drive phase of the sprint action and acceleration.

How to perform: Start from standing and step forward with one leg whilst driving the other leg backwards; hold the grounded foot against the ground for a split second on each stride to drive you forward and allow the leg to straighten. Then pull this leg through to the front, whilst driving the other one back forcefully against the ground to continue to drive yourself forwards. Continue in this fashion for the designated distance. The initial power for the exercise comes from the hip-flexor (the muscle to the front of your thigh at hip level).

Technique tip: coordinate your arms with your legs. Speed bounds can be described as straight leg running and this is a useful way to view them.

Do: 4 x 20m.

7) Dabs

Objective: to improve foot ground contacts and stimulate the neuro-muscular system for a heightened response.

How to perform: Start slowly jogging and then, taking very short strides with very low knee lift, move your legs as fast as possible over 2-3 metres. The movements should be short and staccato – the dabbing action. Jog a few metres and repeat.

Technique tip: drive your arms backwards and forwards as fast as possible. When sprinting the arms can increase leg speed and all good sprinters sprint with their arms.

Do: 6 x 30m – getting 3-4 dab phases in during the distance.

8) Sprint arm action

Objective: to enhance the sprint arm action.

How to perform: Assume a lunge position, then pump your arms backwards and forwards as if sprinting. Each arm should reach a position where the hand is in line with the eyes to the front of the body and the upper arm is parallel to the ground behind the body.

Technique tip: the chest should be elevated throughout the drill and the shoulders kept down. Although the aim is to move the arms as fast as possible, this should be done with relaxation. Tension will impair the generation of speed.

Do: 6 x 20 sec. alternating the leg forward in the lunge position.

Acceleration workout

Objective: to develop acceleration from a stationary position.
Time in training year: all year round.

Suitable for: sprinters, field and court players (although those involved in the latter sports will also need to work on improving their acceleration from moving positions). It can also be used by middle and long distance runners as a means to increase leg power, which will improve their top end speed and in-race acceleration.

As with the previous and subsequent workouts, spend time performing the drills at a low intensity before increasing their speed. Always underestimate what your feel you can achieve before completing all the sets and reps, especially if you are new to this type of training. Allow a full recovery between sets and reps in order to allow for technically correct drill performance – fatigue will impair technique and potentially lead to the learning of incorrect movement patterns.

Warm up – see chapter 4

The acceleration drills
1) Wall leg drives
Objective: to learn the leg action required for dynamic acceleration (pushing from the hip).

How to perform: Stand facing a wall. Place both palms flat against it around shoulder height. Angle your body so that there is approximately a 45-degree angle through your ankles, knees, hips and head. Lift one leg to a thigh parallel to the ground position and support your weight on the toes of your

other foot. Drive the elevated leg back towards the ground so that its toes contact the ground and then immediately pull the leg back to the start position. Complete the designated number of repetitions and swap legs.

Technique tip: the acceleration movement is initiated from the muscles at the top of your thigh – the hip flexor. Gradually increase your speed until you're performing the drill as fast as you can.

Do: 4 x 10 with each leg.

2) Alternate leg, wall drive combination

Objective: to further develop the pushing accelerative leg movement – this time working both legs.

How to perform: Assume the same starting position as for exercise 1. This time drive one leg down and as soon as it contacts the ground, pull the other up to a thigh parallel to the ground position and then drive it back down, whilst bringing your other leg to a thigh parallel to the ground position again. Basically you switch leg position.

Technique tip: maintain the integrity of your torso throughout – hold the 45-degree angle. The pumping, '1, 2, 3' action of the legs will transmit a large amount of force that will have to be controlled by your back and abs – you will need to be braced and ready. Gradually increase your speed until you can perform the exercise fluently and with optimum technique.

Do: 4 x 6 (1 rep = 'left, right, left'. Alternate this pattern with 'right, left, right' combinations).

3) Falling starts

Objective: to further learn acceleration leg action, this time with forwards movement, working on an inclined torso position throughout and a dynamic arm drive.

How to perform: Stand with your feet shoulder-width apart. To start, lean your entire body forwards and allow it to topple. When your body reaches an approximately 45-degree angle to the ground, 'snap' one leg forward and then dynamically drive it back against the ground (as per exercises 1 and 2). Your other leg should be pulled forward as you do this to power you into your first stride. This will control your fall and accelerate your body forward. Your arms should be vigorously driven backwards and forwards in unison with your legs to add drive to your acceleration. Continue to accelerate with legs and arms pumping – whilst maintaining the forward lean – for 15m.

Technique tip: spend time gaining the confidence needed to allow your body to fall to the approximate 45-degree angle before performing the drill flat out. It is crucial for maximum acceleration that the body is angled forwards throughout the accelerative phase, and not just the torso. The legs need to work behind the body to provide optimum propulsive force.

Do: 10 x 10m.

4) 'Sticky' strides

Objective: to learn the accelerative action with an emphasis on foot contact .

How to perform: Using a lean start, begin to accelerate. A lean start requires the athlete to lean forward from a short split stance (with one foot approximately 75cm in front of the other). Feet should be hip-width apart, with toes facing forward. The torso is then bent forward to about a 70-degree angle to the ground. As you move away from the start lean further forward to achieve a 45-degree or so body angle. This position will allow you to 'push' yourself forward by driving your legs backwards against the ground. You should emphasise each foot-contact as you accelerate. Pump your arms as per the previous drill.

Technique tip: 'feel' your foot strike the ground and the ankle and then leg extend to push you forward on each stride. Increase the speed of the drill as you begin to develop a feel for the foot contact and push off.

Do: 6 x 15m.

5) Prone position start and acceleration

Objective: to develop quick reactive acceleration.

How to perform: Assume a prone position with hands by hips, palms face down and chin on floor. Either to an external command or when ready, dynamically push your body up and accelerate away. Employ all the aspects of accelerative technique as described in the previous drills in so doing.

Technique tip: to react as quickly as possible, pull your stronger leg into your chest dynamically in the prone position and thrust it back against the ground to achieve a dynamic getaway, whilst pushing up equally explosively with your arms to lift your body.

Do: 4 x 20m (field and racquet sports players in particular should alternate the leg with which they push themselves up and away with from the start line). Doing this will develop more symmetrical strength and reflects game conditions where they will need to accelerate off either leg.

6) Acceleration from sitting, facing against running direction

Objective: to develop dynamic 'get up and go' acceleration. This is a great drill for field sports players who will fall to the ground and have to get up and back into play as quickly as possible as part of their games.

How to perform: Sit with your back to the direction of acceleration, having previously checked that there are no

obstacles behind you. Keep your legs straight and flat against the ground, your hands by your hips and head looking forward. Either to an external command or when ready, push yourself up, turn and accelerate away – using all the optimising acceleration techniques featured in the other drills.

Technique tip: pull one leg back underneath your body whilst pushing against the ground with your hands and rotate your body from your ankle to turn into the direction of acceleration, in order to get away from the sitting position dynamically. Do not stand straight up, as this will compromise your ability to use your legs, because they will be unable to optimally push and use their power. Move your arms backwards and forwards as dynamically as possible to drive yourself forward. Retain the forward lean of your trunk for much of the 20m acceleration distance.

Do: 4 x 20m.

Maximum speed sprinting workouts

Objective: to improve maximum out-and-out speed.

Suitable for: sprinters and all sportsmen and sportswomen whose sports require sustained out-and-out speed, for example hockey, football and rugby players. Other field, court and racquet sports players (whose sports rarely afford the opportunity to sprint flat out in a straight line, over a relatively long distance) may also benefit due to the power that these workouts will develop. Note: multi-directional speed needs to be specifically trained and should be viewed as a skill. The quickest players in a straight line will not necessarily be the quickest in multiple directions. In chapter 9 Simon Thadani provides examples of drills and practices that footballers can do to improve their speed.

Warm up: muscles, ligaments and tendons must be specifically prepared for sprinting. The key areas are the shoulders, hips, hamstrings, calf muscles and Achilles tendons. A dynamic warm up must be followed; this warm up must include exercises that work muscles over ranges of movement akin to sprinting and at speeds that replicate those to which the athlete will be subject – see chapter 4.

Training tip: an eccentric contraction occurs when a muscle lengthens as it contracts under load (a concentric muscle contraction occurs when a muscle shortens as it contracts under load – this is the most common of sporting muscular contractions). In sprinting the hamstrings are subject to great eccentric force when the legs are extended forward of the body

in the transition from one stride to the next. The hamstrings are stretching as they contract to arrest the forward travel of the lower leg and pull it back to the ground ready for foot-strike. It is during this eccentric contraction that the majority of sprint induced hamstring strains occur. Those who have not sprinted regularly (or who have sustained a previous hamstring injury) need to ensure that the risk of hamstring strain is minimised. They should progress carefully and build up relevant strength gradually. The number of sprints in a session should be low in number and over relatively short distances of 20-30m. Sprinting over longer distances will introduce a greater endurance requirement and muscles will become fatigued, which could lead to injury. Learning and adhering to the most effective sprint technique is also crucial.

How to develop the eccentric hamstring strength needed for sprinting

Leg cycling is a great eccentric hamstring muscle conditioner – see chapter 4. Leg curls which emphasise the lowering phase of the movement to a 4-5 count are also a good alternate exercise.

Maximum speed sprint workouts and the central nervous system

Sprinting is extremely taxing on the CNS, as indicated in chapter 4. If the CNS becomes fatigued during a workout and sprints are continued then the athlete runs the risk of patterning in movement and response patterns at sub-maximal intensities – this will occur at both the conscious and unconscious levels of CNS functioning. The CNS is a complex mechanism which responds consciously and unconsciously. An athlete can 'make themselves' run faster when sprinting, by being in the zone and supplying the neural and physical energy to do so.

However, if they are tired when sprinting, perhaps by doing one or two extra reps, they will unconsciously be training the CNS to function below its best. Coach and athlete must always be conscious of CNS fatigue and ensure that quality always takes precedence over quantity when performing sprint work.

Competition planning

For sprinters and other power athletes, sprint sessions and competitions should be carefully selected and implemented into the training plan. Failure to do so could result in the athlete becoming drained and performance suffering, with further strain placed on the CNS. Worse still, injury could result. It is therefore recommended that 24 to 48 hours' recovery be left between high intensity workouts and competitions. This maxim can also be applied to all sportsmen and sportswomen using high intensity training to develop their speed condition. Again, more information is provided in chapter 3.

Maximum speed workouts

These should be performed on a running track (or dry, flat grass), preferably in spikes. Note that if you are not used to spikes then you should spend some time getting accustomed to using them, as they will lead to greater forces being absorbed through your body and therefore potentially greater strain.

1) 'Rolling 30s'

How to perform: Using a 20m run on build up speed until you are at or near flat out at the start of the 30m phase, then sprint flat out for the 30m distance.

Technique tip: although you should drive hard to build up to speed before the 30m stretch, you should be relaxed and this should then transfer into the flat out phase. Relaxation at speed may be the single most important factor in maximising sprint speed. Tension impairs fluidity and can literally put the brakes on velocity.

Do: 2 x 4 – with 3 minutes' recovery between runs and 10 minutes between sets.

2) Bursts over 50m

How to perform: Accelerate into the 50m stretch and sporadically (but rhythmically) include bursts of 3-5 strides of

flat out running. You should 'take your foot off of the gas' and then 'burst' again.

Technique tip: once in the 50m zone you should be in an upright sprint posture. You should not lean forward to accelerate into each burst. Rather you should be on top of your running and should 'turn your legs over faster' to move briefly into top gear.

Do: 5, with 5 minutes' recovery between sprints.

3) 40 into 20

How to perform: You use the long acceleration period to build up to maximum speed, when you hit the 20m to go mark, you need to be at 98% effort. At this point you sprint flat out, emphasising leg speed in particular.

Technique tip: try to ensure that you keep your hips high and do not 'sit' when sprinting. You should not run high on your toes as this will invariably result in braking forces at the ankles as your ankles 'flex' to absorb the forces they are subject to. Rather, toes should be dorsi-flexed (held up) with the foot-strikes made on the forefeet. If you are a coach, a good coaching phrase is to tell the athlete to imagine that there is a hand in the small of their back, gently lifting them when they are sprinting flat out.

Do: 2 x 3, 4 minutes' recovery between runs and 10 minutes between sets.

4) 30/30/30 round and off of bend

How to perform: For the 200m sprinter, bend running is a specific skill. Speeds are generally slightly slower when running a bend compared to straights, mainly due to the need to lean into the bend to keep tight and the fact that the athlete is unable to generate all their force into a straight line. Note that the second 100m in the half-lap race is performed with no acceleration phase and it becomes a matter of speed endurance and of combating deceleration – see chapter 8.

Start 60m back from the exit of the bend. Cones should be placed at three 30m intervals. Sprint to the first cone and then relax to the second (running at 90% effort) then kick as you reach the second cone to sprint to the third as you enter the home straight.

Technique tip: relaxation is again key. You should lean into the bend and run tight to the line. This lean should be across the whole of your body. In time the left leg and side of the torso will develop the necessary bracing strength to perform this skill effectively. When exiting the bend, run tall (see workout 3, '40 into 20'). Running out of the bend offers a great way to feel and master the skill and sensation of running with high hips, fluently and relaxed whilst at speed.

Do: 3 x 3 runs – with 4 minutes' recovery between runs and 8 minutes between sets.

Speed endurance workout – preparing for 100m and 200m sprinting

Here's an 8-week programme suitable for use before tapering for a competition period.

Who would benefit from the programme?

This workout is particularly useful for the club standard and above 200m. A 100m specialist might drop session 1 in favour of a session similar to session 2 – see workouts below. A 400m specialist, meanwhile, could add an extra repetition to the speed endurance elements of session 1, but would still benefit greatly from including session 2 in their training programme. Note that the workouts would also be useful for field sports players in pre-season, if they have developed a relevant base of speed and condition.

Note: these are tough, high intensity workouts and should not be performed by the unconditioned or by those who have had a long lay-off from training. Ideally they should be performed after an appropriate preceding periodisation plan.

How to use the programme

The sessions should be performed once a week with a minimum of 48 hours' recovery (preferably 72 hours) between sessions 1 and 2. For example, session 1 performed on Monday and session 2 performed on Thursday. This will allow for plenty of recovery and the reduction of accumulated fatigue that can impair training performance and lead to injury. It'll also reduce CNS fatigue – see chapter 3.

Acceleration before speed endurance

I have included acceleration work before the speed endurance unit of each workout. This allows other elements to be trained during the remainder of the training week, for example, weights. This also allows for more recovery days when low intensity training can be performed.

I suggest that the acceleration work be commenced from a falling start (see exercise 3, chapter 6) and is then progressed to a three-point (tripod) start as the volume of runs decreases. The lower the starting position, the more demanding it is on the body. Progressing the start this way will allow a further progression into block starts towards the end of the 8-week training period.

Intensity levels

Acceleration runs to be performed at 98% effort (very close to maximum effort but with control). Intensity of speed endurance runs denoted in workouts.

Recovery guidelines

Maximal effort runs (includes the 98% acceleration ones) up to and including 30 metres, 1 minute for every 10m run:
Thus:
10m = 1min
20m = 2min
30m = 3min

However, with 30m starts from blocks it is wise to increase the recovery to 4-5min to cope with the additional demands created by the low starting position.

- Speed endurance runs – should be performed with either a 5m jog or standing start.
- Each repetition should be run at 95% effort, but must be performed with control and good technique.

Kit and environment

Make sure that you are wearing appropriate kit for the workout.

Obviously this will depend on climatic conditions but as the session is a tapering one it is most likely to be done in warmer weather for the UK outdoor season in the spring and early summer. The crucial factor will be keeping warm between runs and wearing clothing that will assist and not compromise the sprint action. Compression clothing could provide benefits for both these purposes.

Recovery between runs

The recoveries between runs are long – this is designed to allow the body enough time to recover and so reproduce the required speed on each subsequent run. With very long recoveries it is wise to have a cool down walk as soon as possible between each repetition, followed by a period of lying down (whilst ensuring the body is kept warm). Then prior to the next rep I advocate a short warm up period of active mobility and sprint drills to prepare the body for the effort to come.

No matter how painful the rep has been, it is not a good idea for the athlete to lie down on the track or sit still in the stands until some cooling down, ie walk or jog, has been carried out. Movement helps to disperse the waste products (lactic/lactate*) that are evident in the bloodstream during/following prolonged high intensity efforts.

* Lactate is a chemical present in the body at all times. With an increase in exercise intensity its levels increase in the working muscles. When this rise can no longer be contained it makes continuing further intense exercise very difficult and painful – lactic acid is formed at this stage. The burning sensations experienced in muscles as a result of speed endurance training are believed to be caused by lactic acid aggravating nerve endings. Regular speed endurance training will 'teach' the body to withstand the build up of lactate/lactic acid.

The speed endurance workouts

Session 1

Week	Acceleration	Speed end @ 95% effort	Recovery
1	4x15m	2x300m	10min
2	4x15m; 2x20m	300; 250m	12min
3	4x20; 2x30m	2x250m	15min
4	4x20m	2x250m	20min
5	4x10m; 4x30m	250; 200m	20min
6	4x15m; 4x30m	250; 200m	25min
7	4x30m from blocks	2x200m	20min
8	4x30m blocks	2x200m	25min

Session 2

Week	Acceleration	Speed end 98%	Recovery
1	4x15m	60; 80; 100m	8min 10min
2	4x15; 2x20m	60; 80; 100m	10 and 12 min
3	4x20; 2x30m	70; 90; 110m	12 and 14 min
4	4x15m	70; 90; 110m	12 and 14 min
5	4x15; 4x20m	80; 100; 120m	12 and 14 min
6	4x20; 4x30m	80; 100; 120m	12 and 16 min
7	4x20m from blocks	90; 110; 130m	12 and 18 min
8	4x20m from blocks	90; 110; 130m	14 and 20 min

Phil Gardiner is a level 4 UK athletics sprint coach working in the north east.

Football speed

There is no doubt that football is getting quicker. The evidence is conclusive in the pace of a Thierry Henry or Cristiano Ronaldo. It's not only that players are getting physically and mentally faster (the latter is an aspect that I will be focusing on in this article), but coaches are training players and teams to move the ball faster and encouraging players to counter-attack more than ever.
Also, the emphasis on scouting players with pace has become prominent.

Speed is the competitive edge

I believe that football is changing, and speed, in whatever form, is at the forefront. When managers and coaches discuss a player's physical attributes the two phrases I continually hear are 'The boy has got three lungs' (describing the player's CV potential) and 'How quick is he?' I must hear those remarks at least a dozen times a season! I was talking to a young up-and-coming coach in a top league and he told me how his club had spotted a young player during a pre-season game (he was playing for a non-league side) whose pace was frightening. After doing some research, they signed him and he has now gone on to score goals for his professional club. The player went on to represent his country at full international level, then moved to a new club for several hundred thousand pounds.

I have worked with players who may not be the most skilful, tactically aware or aerobically fit, but have the ability to accelerate, maintain, endure and change direction at high speed better than most other players on the pitch or training field. All these players have made a good living from the game and if they can read the game as well…well, they make a fantastic living. Play to these guys' strengths and your side will always have a chance.

'I have worked with players who may not be the most skilful, tactically aware or aerobically fit, but have the ability to accelerate, maintain, endure and change direction at high speed better than most other players on the pitch or training field'

Improve your football speed

Every player has the potential to improve their speed. Although speed is a natural component of a player's makeup (influenced by genetics and lifestyle, ie what sports the player played while young and indeed how they 'played'), you can improve a player's speed significantly as long as the training programme is well structured and the player works hard and has the right attitude.

'You can improve every player's speed whether they are naturally quick or not, but the greatest improvements will occur in those who want to get quicker'

Experience has shown that players who are sceptical tend to improve less than players with open minds. You can improve every player's speed whether they are naturally quicker or not, but the greatest improvements will occur in those who want to get quicker. By how much, however, is the difficult question and is much debated in football.

> Whatever standard of football you play at, players with pace, who are quicker than their opponents, will always stand out as long as they know their own strengths and your team plays to them.

Development of physical speed

For me the physical development of speed is split into two main areas:

1) Good base strength (foundation) – this can be developed during part of the close season and pre- and early-season training cycles (see chapter 1). This consists of exercises such as core stability, strength work, lunges, squats, specialist speed and agility training, step ups, bungees* (for over-speed work), plyometrics, medicine ball work and so on. What and how it is used will depend on your views and priorities as a conditioning expert.

*Bungees are elastic cables and harnesses which allow an athlete to sprint faster than would be possible under their own power – hence the term 'over-speed'.

2) Actual field work – this involves the use of speed drills and

techniques that look at components such as foot to ground contact and movement, agility and acceleration. Note: it is important to work to maximum during this phase. If this is not done then improvement will not follow, as the players' neuromuscular systems will not be enhanced.

Football is a multi-directional, multiple pace, explosive, but aerobically-based game; therefore drills should simulate what happens in a game. Players normally only have to sprint for 2–5 seconds and the maximum length of sprint is around 70 metres. When conditioning football speed you need always to focus on these match requirements and condition accordingly.

'Football is a multi-directional, multiple pace, explosive, but aerobically-based game; therefore drills should simulate what happens in a game.'

Basic theoretical knowledge

To develop speed you must have a basic theoretical knowledge of what makes a player quick. For me this rests on the following:

- **State of mind** – brightness, alertness, anticipation and reaction;
- **The nervous system**, which must switch on the muscles quickly and coordinate;
- **The muscles and tendons**, which must move rapidly with coordination and power.

Stages of a sprint

Football speed involves acceleration, a maximum speed phase and a deceleration phase (when you can no longer maintain your top speed and when stopping). However, I have observed that there are many other components to be aware of when improving football speed.

The physical and mental stages of an average sprint

I have learned that if you can improve two or more of these components, the player will get faster, whether physically or mentally.

1. Mental brightness and awareness – a player should never switch off during a game. They need to be alert, know their opponent's strengths and weaknesses, and watch his or her

body movements. The player needs to know their opponent – for example, is he right or left footed and which way does he prefer to turn?

2. Anticipation or/and reaction – speed in football is very much about anticipation, for example, 'Where is my team mate going to put the ball?' or 'The opposition is not going to get that ball, I can'. If a player can anticipate then they are already one step ahead. After that it's all about reacting first and 'getting that yard'.

'I have worked with several players who, when doing speed testing, have not had particularly good test results, but watching them play and train on numerous occasions they seem always to get to the ball first'

Components 1 and 2 summarise a phrase I have heard many times when talking about mental brightness, awareness, anticipation and reaction in football: 'You don't need to be fast to be quick' – although I must admit that it helps! I have worked with several players who, when doing speed testing, have not had particularly good test results, but watching them play and train on numerous occasions they seem always to get to the ball first, or intercept the ball or score when their marker or opponent is much faster than they are. The ability to be one step ahead of your opponent psychologically, have a 'footballing brain' or to react faster than others can make you quick and in possession of great football speed.

3. 'Golden step' – this is an American term, which basically describes the player's first step as being a positive and dynamic movement. It's the step that takes a striker away from his opponent and into a position to make a strike on goal.

4. Upper body awareness – this is often an underestimated part of speed work and involves not only the arms but the whole upper body. The arms drive the legs and a forward lean of the torso will aid acceleration, allowing the powerful muscles of the calves, hamstrings and butt to work in harmony to provide propulsion. Additionally, turning the hips and torso dynamically into the direction of the turn while driving the arms appropriately will make for a more powerful turn.

5. Initial steps (acceleration phase) – to develop the most effective acceleration, the legs must drive back against the ground (the movement is initiated from the hip-flexors – the muscles at the top of the thigh) and the arms should be pumped backwards and forwards vigorously. In this respect much can be learned from the starting technique of sprinters.

6. Technique and running mechanics – this means stride frequency, stride length, running economy. It is important to sow the seeds of good running technique into players at a young age. You will find it difficult to influence their running when they are in their twenties.

7. Deceleration phase – it is important that players learn how to stop quickly. This ability rests largely on appropriate skills training and on what is known as an eccentric muscular contraction. This occurs when a muscle lengthens as it contracts, as happens during the lowering phase of a biceps curl (a concentric muscular contraction occurs when a muscle shortens as it contracts during a the lifting phase of a biceps curl).

8. Speed endurance – this refers to the ability of a player to sustain maximum or near to maximum speed – training must be designed to promote this.

Steve Foley, 40 years' experience in football as a coach and player, on football speed:

'I have never seen a ball sweat! Quick accurate, positive passing will always beat any individual player in a race!
If you ever have a player with the speed of thought and natural speed in their legs, you will have a top class player to work with.'

The dos and don'ts of speed training

- Do train for speed early in a session (after warm up) – to allow for quality.
- Do use your imagination (use relays, rugby balls, etc).
- Do make the majority of sprints last between 2–5 seconds.
- Do train multidirectional speed.
- Do have plenty of recovery – 1:6 or 1:8 ratio effort to rest.
- Do speed work with and without a ball.
- Do make sprints competitive.
- Do ensure players' attitudes are right.
- Do try to have a theme for each speed session, ie anticipation, reaction, golden step, etc.
- Do use a variety of methods, for example, resistance work, over-speed work, hills and so on.
- Do a little and often – this is better than nothing.

Top players in the Premiership and the Championship can reach top speeds of 9.5 metres per second! Usain Bolt would be running at 11 metres plus a second at his fastest during a 100m – nevertheless this is good sprint speed for a footballer.

- Don't speed train without having first developed a sufficient strength base.
- Don't exceed more than 60–70m of sprint work on one run.
- Don't do speed work every day, 3–4 sessions a week, subject to games, will be sufficient.
- Don't do speed work when players are tired.
- Don't work at less than 100 per cent.
- Don't do speed work until players are properly warmed up.

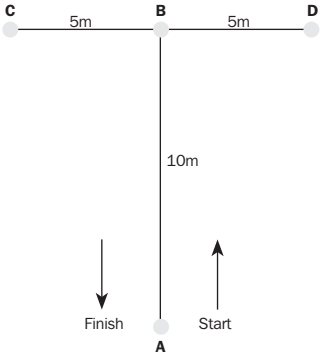
Football specific speed

A famous manager in the Premiership measures speed by timing how long it takes a player to control and pass the ball. He continuously measures this very short period of time with each player to promote fast, controlled, moving football within his teams.

Speed tests

We have briefly discussed the theory of speed and its basic components, so let's take a couple ways we can test it.

1) The T-agility test (adaptation)



Equipment: four traffic cones and stopwatch.

Start at A. You start the stopwatch as soon as you see the player's first limb movement. Sprint around B (90°) to C, then around it (180°) to D and around it (180°) to B, making a 90° turn to sprint past A.

Test scores

Any time:
Over 9.60 sec is poor
Under 9.30 sec. is average
Under 9.00 sec. is excellent

1/	Young centre forward	8.81
2/	Early 20s centre forward	8.90
3/	Early 20s centre forward	8.95
4/	Senior fullback	9.10
5/	Academy wide player	9.22
6/	Central midfielder 20s	9.35
7/	Senior midfielder	9.66
8/	Goalkeeper – young	10.15

Based on average of three runs. Test done early/mid season.

2) Sprint test

Measured by electronic gates.

- Players perform a flat-out sprint over 20m from stationary, with splits measured at 5m,10m and 20m;
- 20m with a 2m run-up – splits measured as above.

Examples of performances	Standing sprint			Rolling sprint		
	5m	10m	20m	5m	10m	20m
18-year-old centre forward	1.07	1.77	3.01	0.85	1.38	2.76
1st team centre forward	1.09	1.80	3.10	0.85	1.40	2.73
Senior centre back	1.11	1.83	3.29	0.91	1.43	3.02
1st team midfielder	1.09	1.77	3.29	0.85	1.38	2.91
17-year-old midfielder	1.34	2.09	3.42	0.87	1.56	2.87
Released academy midfielder	1.59	1.85	3.28	0.94	1.52	2.76
Released academy midfielder	1.16	1.92	3.33	0.92	1.66	3.04
Senior 1st team full back	1.01	1.67	3.28	0.87	1.30	2.86
1st team midfielder – wide	1.14	1.89	3.02	0.82	1.47	2.80
Released reserve midfielder	1.04	1.70	3.31	0.88	1.33	2.96
Academy goalkeeper	1.17	1.96	3.29	0.87	1.57	2.88
1st team forward	1.03	1.69	3.12	0.82	1.43	2.72
1st team fullback	1.10	1.72	3.20	0.84	1.44	2.84

Analysis of these sprint performances can then identify which 'sprint areas' a player may need to work on. A poor 5m time (from standing) but a good overall 20m time, would indicate that the player should work on reaction, the golden step and acceleration.

Simon Thadani is the football conditioning coach at Championship side Ipswich Town

Weight training for speed

One of the greatest conundrums for a coach is how to develop greater power in the weights room that will actually improve sports speed. Over the years I have seen many athletes from numerous sports spend their preparatory training phases getting stronger and developing a great physique only to become very dismayed when their performances are not an improvement on last season's – or worse still – disappointing when they compete. The more I research and speak to coaches, strength training experts and athletes from sports around the world, the more I see that increasing the power potential of an athlete seems to centre around enhancing the neuromuscular system in a way that enables it to exert more force, more quickly and engage as many speed and power producing fast twitch fibres as possible. This is primarily based on lifting very heavy weights (in excess of 80% 1RM) over a few reps (1-6) as fast, but as safely as possible. This is often called the 'maximum load method', of which more later.

Fast twitch muscle fibres were talked about in previous chapters, but to recap there are basically two types – type IIa and type IIb. The latter are the real power producers – offering the greatest speed and power potential and twitch rate (speed of contraction) capability. Now these fibres, or more specific their motor units (the nerves and bundles of muscle fibre that produce the action of a muscle), are recruited asynchronously. Basically this means that the greater the force that has to be overcome/produced, the more the larger motor units have to be recruited – they're not all switched on at the same time. To get these 'firing', a great amount of neural (mental) energy is required. If you are an athlete you will invariably be aware of

this when you attempt to lift a near maximum or maximum weight. If you are not in the right frame of mind or 'psyched' then the weight will stay on the racks. To move it you have to provide the neural energy to get your large fast twitch motor units engaged.

Maximum strength, power development, weight training and the thoughts of Tudor Bompa

Tudor Bompa, as noted in previous chapters, is one of the world's foremost strength and conditioning experts. He has a background in both research and practical coaching. The Romanian has devised numerous strength training protocols for what he calls the 'periodisation of strength' – the progressive development of strength through resistance training methods, notably weight training which is specifically relevant to improving sports performance (1). Limitations on space prevent a detailed analysis of his theories; however, a focus on what he calls 'the maximum load method' will provide much of the answer to how to use weight training to boost sports performance and particularly speed. Crucially, Bompa believes that the specific development of maximum strength is the key to improving speed, power and, interestingly, endurance. He identifies the following reasons:

- it increases motor unit activation, resulting in high recruitment of fast twitch fibre;
- it has a high neural (mental focus) requirement, which can translate to improved sports performance, by 'teaching' the body how to generate optimum force and speed;
- it is important in sports where increased power is required but without an increase in muscle mass – which could increase the athlete's weight and negatively effect their power to weight ratio;
- improved synchronisation of muscle groups under heavy loading; will result in improved sports performance. The 'smoother' and more skilled an athlete is at performing a powerful activity, whilst recruiting the maximum fast twitch muscle fibre (and numbers of motor units), the better they will be at performing dynamic sports skills.

Crucial to developing this maximum strength is the rate of muscle contraction. Bompa believes that despite the heavy load the weights should be moved as fast as possible. This will produce very high levels of neural excitation. Rest becomes a crucial training variable in the development of strength and power through the maximum load method.

This is put clearly into context by the requirement of these workouts to create as he puts it, 'the highest possible tension in a muscle' (2). Additionally, exercises must work the prime movers involved in the athlete's chosen sport – the calf muscles, hamstrings, quads, glutes and hip flexors of a sprinter, for example. And the reps must be low (1-4) to enable the athlete to achieve the highest possible muscle tensions. Furthermore, the rest period must be long enough to enable a 'full out attack' on each lift. Athletes will know that they only have a certain amount of 'energy' for these types of workouts. Bompa therefore argues that only 3-5 exercises should be included in a session. He argues that if there were more, the athlete would be unable to maintain the desired workout intensity from a neural and physical perspective.

Bompa advocates a recovery of 3-6 minutes between sets for the optimisation of performance. Six minutes may seem a long stretch of time between a set comprising of perhaps only 2 lifts, but remember the need for maximum effort to go into each lift. 'To stimulate the necessary physiological and morphological central nervous system changes, higher number of sets should always take precedence over a higher number of reps,' writes the strength expert. This is not just about maximum commitment on the part of the athlete, it is also about allowing the body's high energy body compound providers – creatine phosphate and adenosine tri-phosphate (ATP) – ample time to replenish between sets, therefore providing sufficient fuel.

Maximum strength development, athletic performance, recovery and hormonal response

As alluded to, short recoveries when combined with lifting medium to heavy weights fast will induce greater muscle hypertrophy (growth). This is a protocol used extensively in body-building with obvious success. Training in such a way will boost growth hormone and testosterone production and increase the potential for increased muscle size. As a larger muscle is often equated with greater power potential it is easy to see how this method of training can become the dominant one in the weights room for many athletes. However, in the world of athletics, where split seconds and millimetres count, weight gain could be detrimental to sports performance. The performer will have more weight that needs to be carried down the track and into the air. Obviously there are sports where increased size is valued, such as in rugby and for the athletic throws. The maximum strength approach rests on the fact that a muscle can be made a great deal more powerful without a significant increase in size. And in order to achieve this the rest period between sets and reps is very important, as are low reps. Here's some research that supports these considerations:

Shorter recoveries promote greater hormonal response
Brazilian researchers discovered that 30 seconds' recovery between sets for women who performed the same 4 exercises in a lower-body weights programme, produced superior growth hormone release, compared to 60 and 120 second rest periods [(3)]. Incidentally, no difference was found between the 60 and 120 second protocols. Other research has indicated that the more dynamic the exercise, the greater the hormonal response [(4)].

Greater recovery produces increased power
Researchers from Australia looked at the effects on strength gains of breaking down a 6-repetition maximum session (one that requires the athlete to lift a load that would induce failure on the 7th repetition if performed) into single, double and triple reps [(5)]. Three 'inter-repetition' groups were established:

1) Singles group – 6 x 1 repetition with 20 seconds between each repetition;
2) Doubles group – 3 x 2 repetitions with 50 seconds between each pair of repetitions;
3) Triples group – 2 x 3 repetitions with 100 seconds between each 3 repetitions.

Twenty-six elite junior male basketball and football players performed bench presses using their 6RM load. The power output for each repetition was recorded. The researchers discovered that significantly increased power outputs (from 25% to 49%) were achieved over the later repetitions (4-6) of the singles, doubles, and triples methods. Significantly greater total power output (increasing from 21.6% to 25.1%) was observed for all inter-repetition rest interventions when compared to traditional continuous 6RM total power output. Interestingly, no significant differences were found between the groups. This led the researchers to conclude that, '...utilising inter-repetition rest intervals enables greater repetition and (optimised) total power output in comparison to traditional loading parameters.' This would equate to greater power potential for the athlete to tap, which could enhance their speed performance – subject, of course, to a relevantly periodised conditioning programme.

It is beyond the scope of this article to go into specific detail about training programmes and training phases and the various types of maximum strength (and other) work that should be included when conditioning sportsmen and sportswomen to produce greater speed. Readers wanting to find out more and unlock the secrets would be well advised to look at Bompa's books. However, I hope that the information provided will better position athletes and coaches to understand how to get the most out of weight training in order to enhance speed.

References

1&2) *The Periodisation Training for Sports* (2nd edition), Bompa T, Human Kinetics 2005 (and 2) p174
3) *J Sci Med Sport*. 2007 Dec 17
4) *Indian J Physiol Pharmacol*. 2001 Apr;45(2):239-44
5) *J Strength Cond Res.* 2006 Feb;20(1):172-6