CROSS TRAINING:

why and how to cross train for maximum performance

A SPECIAL REPORT FROM

PEAK PERFORMANCE

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

Printed by: PLP Commercial Digital 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: 978-1-905096-49-7

Publisher Jonathan A. Pye
Editor Andrew Hamilton
Designer Charlie Thomas

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From the editor

For many sportsmen and women, the phrase 'cross training' merely conjures up images of triathletes performing their swim/bike/run training, or injured runners who are forced to cycle because they're unable to run. However, 'cross training' is much, much more than that. Done correctly, cross training will improve your performance whatever your sport, speed your recovery and even reduce your injury risk.

Cross training can be defined as performing any supplementary training activity that improves performance in your main sport; however, the supplementary activity you choose, how frequently you apply it and how you integrate it into your main training programme are all important. Get it right and you'll experience significant performance benefits in your main sport. Get it wrong and you'll gain nothing – indeed you could even end up blunting your performance.

In this special report, we look at some of the latest science behind cross training – what works and what doesn't, and how to apply a large range number of cross training modes to a number of different sports. Moreover, many of these cross training modes are applicable across the board, whatever kind of sportsman or woman you are.

They say that variety is the spice of life and if you take your sport seriously, some intelligent cross training could be just the ticket to spice up your performance and help you achieve that personal best!

Andrew Hamilton BSc Hons MRSC

An introduction to cross training

If you thought cross training was just about injury prevention and rehab for runners, think again. In this introductory article on cross training, **Andrew Hamilton** *explains why nearly all sportsmen and women can benefit from the intelligent application of cross training, whatever their sport….*

Once upon a time, 'cross training' was something runners did to stave off fitness losses during periods of injury. But with the growing popularity of cross training sports such as biathlon and triathlon came the realisation that cross training wasn't just about the rehabilitation and prevention of running injuries; used intelligently, it could actually enhance running performance. And in more recent years, coaches and athletes from a number of different sports have become aware of the potential benefits of cross training.

What is cross training?

Before we get into the nitty-gritty of cross training benefits, let's just define what cross training actually is. Cross training refers to any mixture of exercise types carried out on a regular basis in addition to a main sport or activity. So for example, cyclists who swim, rowers who run and runners who cycle are all examples of cross training.

However, cross training can include more than one extra activity – the classic example is triathlon, which combines running, cycling and swimming into one sport. Moreover, cross-training doesn't necessarily involve combining sports such as cycling and rowing; a cyclist who engages in yoga to keep flexible; a boxer who practices plyometric exercises to improve speed and power; a rugby player who does Pilates to improve core strength – these are all forms of cross-training.

The term cross training also implies some kind of goal. A swimmer who also uses their bike to commute to and from work is certainly mixing different activities on a regular basis. But unless there's some kind of intention to improve swimming performance by cycling, it wouldn't really be classed as cross training. Likewise, while performing post-running stretching is a different activity that can help running performance, it isn't normally considered as cross training because (for most runners) it's seen as an essential part of running.

These days, the term 'cross training' is generally used to describe mixtures of endurance and/or strength activities, whose combination is deliberately chosen in order to achieve a specific outcome; *eg* to reduce injury risk, to improve cardiovascular fitness or even to compete in a specific cross training event. Examples of specific cross training goals include runners who cycle to help prevent muscle imbalances in the legs, swimmers who do land training in order to maximise aerobic power and strength while keeping their body weight in check, mountain bikers who run in order to help them during very rough events where the bike has to be carried and of course triathletes whose event consists of swimming, biking and running.

'The term 'cross training' is generally used to describe mixtures of endurance and/or strength activities, whose combination is deliberately chosen in order to achieve a specific outcome'

How cross training can prevent injury?

The number of cross training permutations is almost unlimited, so for the sake of simplicity in this article, we'll examine cross training from the perspective of running, which of course includes a large number of sports such as football, rugby, hockey etc where running forms a large component of the activity. However, the principles discussed here such as improved muscle balance, enhanced recovery, improved strength *etc* are also applicable to most other cross training combinations.

As far as sports where running is a major component, regular cross training can make you stronger and faster, keep you motivated and make training more enjoyable. However it's probably fair to say that injury prevention (and rehabilitation) is probably the single greatest benefit of cross training. But why

Classic cross training events

Biathlon can mean a number of different things. Officially, a biathlon event consists of a mixture of running and shooting, and is thought to be symbolic of the enduring challenge faced by primitive man – to chase down and kill/capture prey. However, for recreational fitness trainers, a biathlon often refers to a kind of cut down triathlon, with the swimming excluded – *ie* consisting of running and cycling. Although not as 'all round' a cross training event as triathlon, this type of biathlon has become popular because it still provides cross training benefits, appeals to non-swimmers and is easier to stage (without the logistics and safety concerns that swimming involves).

Triathlon (swimming, cycling and running) is perhaps ***the*** classic cross training combination. The first documented triathlons were organised as offbeat training routines for runners back in 1974 by the San Diego Track Club, but the event really caught the public's imagination with the advent of the Hawaiian Ironman Triathlon 4 years later. Although it took a while for triathlon to develop into a mainstream sport, runners, swimmers and cyclists from all backgrounds began to realise that including small amounts of the other two disciplines could actually help their main sport by helping to overcome any muscle imbalances and also by enabling cardiovascular training to be continued, while resting the main muscles used in their own sport.

Modern pentathlon was established by the founder of the modem Olympic games, Baron Pierre de Coubertin, who persuaded the Olympic Committee to introduce Modem Pentathlon at the 5th Olympic Games of the modem era in Stockholm, Sweden in 1912. The choice of the five diverse and unrelated sports that make up the Modem Pentathlon arose out of a romantic vision of the wild adventures of a liaison officer whose horse is brought down in enemy territory, and who would need to defend himself with his pistol and sword, swim across raging rivers and finally deliver the message on foot. Thus the modern pentathlon's five disciplines - show-jumping, shooting, fencing, swimming and cross-country running - were chosen in the belief that this event, above all others, would test an athlete's moral qualities as much as physical resources and skills, and thereby produce the 'complete' athlete. Unlike pure endurance cross training, pentathlon also requires the development of agility, coordination and a variety of skills.

Decathlon/heptathlon The decathlon is a 2-day 10-discipline track and field event, which demands comprehensive all round athletic ability. Day 1 comprises of 100m, long jump, shot put, high jump and 400m, while day 2 entails a 110m hurdles, discus, pole vault, javelin and 1500m run. The women's equivalent is the 7-event heptathlon comprising of (day 1) 100m hurdles, high jump, shot, 200m run and (day 2) long jump, javelin and 800m run. Both events are a supreme test of athletic ability because they demand superb endurance, speed, strength and skill, all of which have to be developed without detriment to each other!

should this be the case? There are three main reasons for this:

● **Muscle imbalance prevention** – Running doesn't work all the muscles of the leg evenly. Over time, certain muscles become comparatively over-developed compared to others that remain comparatively weak, leading to muscle strength imbalances. When a muscle that helps control the movement of a joint becomes weakened compared to others, the resulting imbalance can adversely affect the movement around that joint, which in time can lead to a chronic overuse injury. A classic example occurs in the quadriceps muscles around the knee joint where the vastus lateralis of the outer thigh becomes relatively strong compared to vastus medialis muscle on the inside of the knee, leading to patellar tendonitis or runner's knee. Cross training can also help prevent muscle imbalances *between* different muscle groups. A classic example is cycling, which helps strengthen the quadriceps muscles of the frontal thigh and so counteract the tendency of the hamstring muscles of the rear thigh to become overdeveloped, which if left unchecked can destabilise the knee joint.

● **Enhancing joint mobility** – The impact associated with running places quite a lot of stress on the ankle, knee and hip joints. A combination of cumulative shock from each footfall and the fact that these joints also work through a rather limited range of movement, can lead to reduced joint mobility and increased stiffness, especially in high mileage runners. Cross training activities such as cycling, rowing and swimming help to mobilise the joints without impact and jarring and can also work them through a fuller range of movement. Most sportsmen and women who run regularly find that compared to doing nothing, 20-30 minutes of light cycling can be more effective at reducing stiffness in and around the hip joint caused by a long run.

● **Improving muscle flexibility** – Runners are particularly vulnerable to loss of hamstring (rear thigh) and calf muscle flexibility because the running action only works these muscles through a partial range of their movement. Although stretching can help offset this effect, regular cross training can reduce the

loss of flexibility in the first place. Swimming is great for increasing spinal, shoulder and back flexibility, while rowing is good for maintaining flexibility of the buttock and frontal thigh muscles. This is also where resistance training can also be invaluable; performed correctly, with full range movements, it can significantly increase muscular flexibility.

Injury rehabilitation

If you are unfortunate enough to pick up an injury, cross training can both help you recover more rapidly *and* help to prevent the loss of cardiovascular fitness that inevitably occurs when training stops[(1)]. Cross training exercise that mobilises an injured area without stressing it, will increase the flow of blood and nutrients to that area and aid in the transport of debris away from that area. The overall effect is to accelerate the healing process. Meanwhile the ability to keep training means that comparatively little aerobic fitness is lost, which in turn means a more rapid return to full fitness once running training is resumed.

Increased running performance

Cross training is much more than about simply preventing and recovering from running injury; it can actually help boost running performance in the following ways:

- **Increased strength** – Adding in cross training exercises like weight training, cycling and rowing can help build general leg strength, which in turn reduces the load on the 'running' muscle fibres when you run. This in turn can save energy and improve your running economy, and probably explains why weight training in particular has linked with improved biomechanical running efficiency performance[(2)].
- **Improved recovery** – During hard training, muscles accumulate metabolic by-products of exercise such as lactate and other breakdown products. Part of the rest and recovery process is to clear these products so the muscles can regain their full normal functioning – this is the 'freshness' you feel when you've had a day or two off. Cross training can accelerate

this clearance process by increasing blood flow through this area, but importantly *without* taxing those same running muscle fibres that need the rest. Studies have shown that gentle-moderate intensity cross training can actually produce better recovery and reduced soreness than complete rest[3]; this explain why it's sometimes referred to as 'active recovery'.

'Studies have shown that gentle-moderate intensity cross training can actually produce better recovery and reduced soreness than complete rest'

● **Reduced body fat** – Adding in cross training can help runners burn more calories per week. A typical runner for example could in theory lose nearly a kilo of fat every 12 weeks just by adding a weekly 60-minute cycling workout to his or her normal training schedule. Adding the same extra volume of running training would of course achieve the same (or perhaps even greater effect), but would carry with it a greater risk of injury. All other things being equal, losing a bit more body fat can make a big performance difference to runners; for example, a 70kg runner who loses a kilo of body fat (about 1.5%) would stand to lop off something approaching 2 minutes off his or her personal best time for a 10K run, purely as a result of this reduced weight.

● **Increased average intensity** – The trauma and impact of running means that most runners can manage no more than two or maybe three high-intensity workouts per week without the risk of injury. However, adding in a high intensity bike or rowing session does not produce 'running specific' trauma to the leg muscles and can often be well tolerated. This increase in average intensity can translate into improved running performances in two ways; by helping to develop maximum heart stroke volume and also by boosting blood volume – both of which increase the oxygen carrying capacity of the cardiovascular system.

● **Avoiding overtraining** – Athletes performing high training volumes are always at risk from overtraining, leading to tiredness, an increased risk of illness and infections, a general loss of enthusiasm, and 'tired' muscles that are more prone to injury. It's true that taking an extended break from running is a good way for runners to avoid the risk of overtraining, but this inevitably leads to a drop in aerobic fitness. However, by cutting

down on the volume of running and including some cross training in your routine, you can give your running muscles a regular break, which will help you avoid the overtraining trap4, yet still maintain most of your aerobic fitness.

● **Psychological benefits** – No matter how much you enjoy your sport, familiarity can still breed contempt! Most of us are stimulated by variety and turned off by monotony. Cross training introduces variety and can help you maintain your enthusiasm for your main sport, making it possible to train harder and more consistently and ultimately to perform better. So if you're a runner and doing more cross training and less running makes the training process more enjoyable, do it. If you just don't feel like running today, but you would be perfectly happy to get out on the bike instead, then cycle You'll still end up fitter and happier than a non-cross training runner who on 'off-days' only has the choice of running with a bad attitude or not at all!

Limitations and risks of cross training

Although cross training has a number of benefits, it's important to be aware of its risks and limitations:

● **Cross training risks** – Lateral, stop and go, bounding, and high impact activities such as tennis, squash, basketball, football, volleyball, rugby, down-hill skiing, and aerobic dance etc. can be very stressful for the soft connective tissue that surrounds the knee and ankle regions, especially in runners. Beware and use common sense when deciding whether to add certain sports to your fitness regimen. Make sure too that you schedule at least one day per week as a complete 'leg rest day'. While participating in your favourite cross training activities can be a helpful weight loss tool, don't overdo by skipping rest days, particularly for your legs; to do so will invite the risk of overtraining.

● **Training specificity** – One of the basic laws of exercise physiology is 'specificity of training'. Quite simply, if you want to excel at a particular activity, you need to train specifically for that activity in order to generate the required physiological adaptations. This is particularly true for sports that demand

high levels of skill. So for example, swimmers who want to excel at their sport should principally train by swimming[5]; likewise cyclists should cycle and runners should run. While *some* cross training can help you perform better and protect you from injury, if you start doing too much, you'll begin to excel as a cross trainer rather than as a runner, rower, footballer etc, and your running performance will actually decline. There's no exact agreement on how much cross training is optimum, but as a very rough guide, it's unlikely that spending up to a quarter of your time cross training would have any detrimental effects. Beyond that and you begin to enter the territory of cross training for its own sake.

'While some cross training can help you perform better, if you start doing too much, you'll begin to excel as a cross trainer rather than as a runner, rower, footballer etc'

Popular cross training activities for runners

There are numerous cross training activities that can be used for boosting performance, injury prevention, recovery or any combination of the aforementioned. The exact benefits offered, will of course, depend on what your main sport is. As an example, here are six popular cross training modes that can benefit sportsmen and women whose main sport is (or includes a lot of) running:

Walking

- **Muscles emphasised** – The calves, hamstrings of the rear thigh, quadriceps of frontal thigh and (if hilly) the buttocks.
- **Benefits for runners** – Although greatly underrated and fairly gentle, walking can provide great therapeutic benefits following a long or hard run by helping to mobilise stiff joints and muscles and promote active recovery. Long brisk walks can also help injured runners by helping to stave off the decline in aerobic fitness that would otherwise occur.

Swimming

- **Muscles emphasised** – Swimming works many of the major muscle groups in the body, though the exact emphasis depends on the stroke. Front crawl (probably the most popular stroke for non-swimmers who are cross training) emphasises the muscles of the back, chest, shoulders and buttocks.

● **Benefits for runners** – Swimming is a superb way of developing joint mobility and upper body flexibility and is extremely easy going on the joints. Runners in particular benefit from the mobilisation of the ankles and hips during crawl, and there's also good mobilisation for the shoulders and the muscles around the rib cage are stretched, which can improve breathing efficiency.

Rowing

● **Muscles emphasised** – Rowing works a large number of muscles in the body of the body, but especially the muscles of the back, the biceps of the upper arms, the gluteal muscles of the buttocks and the quadriceps muscles of the frontal thighs.
● **Benefits for runners** – Rowing is superb at building aerobic power, is impact free and is great at developing leg power and strength, both of which are vital for faster running and hill work. And because it works the quadriceps and the buttocks through a very full range of movement, rowing is also an excellent mobilisation activity for the knees and hips.

Cycling

● **Muscles emphasised** – Cycling is fairly concentrated work for the gluteal muscles of the buttocks and the quadriceps muscles of the frontal thighs. Using toe clips or clipless pedals also involves the hamstring and hip flexor muscles.
● **Benefits for runners** – Like rowing, cycling is an excellent way of developing aerobic power, is impact free and great at developing leg power and strength. The smooth spinning motion of pedalling makes it excellent mobilisation activity for the knees and hips and ankles, and the emphasis on the quadriceps can also help to redress the relative quadriceps weakness that many runners suffer. And because you work against gravity, outdoors cycling can be a good method of helping to keep lean and keeping weight gain at bay – useful for runners who find themselves unable to run for any reason.

Stair climbing/stepping

● **Muscles emphasised** – Like cycling, stepping/stair climbing

provides concentrated work for the gluteal muscles of the buttocks and the quadriceps muscles of the frontal thighs. When climbing stepmills or proper stairs, the calves are also involved.

● **Benefits For Runners** – Stair climbing is extremely good cardiovascular training, is impact-free and great at developing leg power and strength. The emphasis on the quadriceps can also help to redress the relative quadriceps weakness that many runners suffer. Stair climbing also generates high heart rates and because you work against gravity, it's excellent for burning up calories and shedding weight!

Elliptical training (gym machines)

● **Muscles emphasised** – The elliptical motion of elliptical trainers works virtually all of the leg muscles, and those with a variable incline (ramp) setting can also work the buttocks at higher incline settings.

● **Benefits for runners** – The total involvement of the leg muscles makes for a great cardiovascular workout and the smooth impact-free movement is perfect for injured runners or those seeking more mobility and a less traumatic alternative to the road. At higher inclines, more emphasis is placed on the quadriceps of the frontal thighs and the buttocks, which can help to redress the muscle imbalances generated by running.

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Can bike training improve the performance of non-cycling athletes?

At a Glance

- Cycling offers more than just 'cross-training benefits' – in particular it can be used as an 'active recovery' training tool, and it may also prolong running careers;
- The effects of bike training on leg speed, power and growth hormone release are discussed;
- Bike routines are suggested for non-cyclists who wish to improve these aspects of fitness.

Ask most physiologists and they'll tell you that sport specific training is the key to achieving the greatest performance gains. But, according to **John Shepherd***, there's plenty of evidence that cycling can benefit not just runners who wish to cross-train a little, but also speed and power athletes whose sport-specific movement patterns and skills are far removed from pedal pushing.*

Cycling to boost endurance for non-cyclists

It's seems pretty feasible that long distance cycling should benefit other endurance athletes such as rowers and distance runners. After all, these activities also place a heavy reliance on the aerobic energy system. And if you take a look at the research, there's evidence to back this up.

For example, a team from the University of Texas reviewed existing studies on the transfer of **cross-training** effects on VO_2max, between cycling, running and swimming [1]. VO_2max refers to the maximum amount of oxygen the body can process (measured either in litres per minute or in millilitres per minute

Jargonbuster

Cross-training Combining two or more training modes into a training programme to bring about a desired sport-specific outcome

Active recovery A recovery period characterised by activity, which is designed to help the recovery process by speeding up the removal of metabolites, keeping joints and muscles mobilised *etc*

Passive recovery Recovery period with no activity

per kilo of body weight). They discovered that there is indeed a transfer of training effects in terms of VO_2max from one training method to another, and that running had the greatest positive transference and swimming the least, with cycling ranked in the middle.

The greater VO_2max transference of running may be attributed to the fact that it places greater stress on the body than either of the two other exercise types, due to the impact forces involved and the larger amount of musculature recruited. Consequentially, it is more likely to improve measures of aerobic fitness more quickly than other endurance training options.

However, the group also discovered that the cross-training effects never exceed those induced by the sport-specific training mode, *ie* the best way to train for running is to run, swimming is to swim *etc*. But, while excessive cross-training can negatively affect performance (by effectively displacing the sport-specific training), there is evidence that for both endurance and (perhaps more surprisingly) for speed activities, cycling can if performed under certain conditions, contribute to improved or at least maintained non-cycling sports performance.

Cycling during the 'recovery' stage of training

Runners (and other athletes) usually take some form of rest at the end of the training season, before recommencing their build-up to the next. There has been considerable debate about how much fitness is lost during this period and whether the recovery should be **active** or **passive**. Researchers from California looked into the effectiveness of cycling cross-training between competitive seasons in female distance runners [(2)].

In particular, the researchers wanted to find out whether substituting 50% of running training volume with cycling would maintain 3,000m track race performance and VO_2max measurements during a five-week recuperative phase at the end of the cross-country season.

Eleven college runners were assigned to either:

- a run-only training group;

● a run-and-cycle training group, which performed the two different activities on different days.

Both groups trained at 75-80% of maximum heart rate. Training volumes were similar to the competitive season, except that cycling made up 50% of the volume for the run-and-cycle group.

At the end of the five-week period, the team discovered that 3,000m race times were on average slower by 1.4% (nine seconds) in the run-only training group, while the run-and-cycle group subjects were only slightly lagging behind (3.4% or 22 seconds slower). Equally important was the discovery that no significant change was found in VO_2max in either group.

The implications of this research go far beyond recommending the use of cycling for endurance athletes moving from one 'season' into another, as there is a real possibility that cycling has a role to play in all-year-round endurance training for non-cyclists. This is because:

● Cycling may enable the endurance athlete's body more time to recover from tough training/competitive training phases and improve future injury resilience (more about this later);

● From a mental perspective, the involvement of a different training method (cycling) may help to 'rejuvenate' the mental approach of endurance athletes, and ultimately boost performance.

On the face of the available evidence, using cycling as a means to improve/maintain the endurance of non-cyclists seems worth experimenting with. Introducing the activity in a way similar to that used in the 3,000m running study quoted above could be a useful starting point – *ie* at a transition in training (for example, at the beginning of a recovery period) and with a 1:1 ratio of cycling and running. Intensities (in terms of heart rate) should be kept to a level similar to a running-only programme. As a rough guide, cycle distances should be increased threefold in comparison to running distances in order to achieve a similar cardiovascular training effect.

Prolonging a running career by cycling

Running guru Tim Noakes believes that cycling can be of further benefit to endurance runners, particularly masters runners and those involved in the marathon and ultra-distance events[3]. This, he argues, is because of cycling's role in injury prevention, and in particular the ability of the legs to withstand prolonged eccentric muscular damage, resulting from years of distance running. Noakes believes that this damage will slow down even the most circumspect trainers with age.

An eccentric contraction occurs when a muscle lengthens as it contracts. This occurs in the quadriceps muscles every time they absorb the impact on each and every foot-strike when running. The quadriceps muscles are placed under even greater eccentric strain during downhill running (a condition likely to induce considerable muscle soreness when performed for the first time or after a prolonged break). Noakes believes that cycling can offer respite from eccentric muscular damage, potentially prolonging endurance and master athletes' running careers. This is because it will reduce the amount of eccentric impact damage and can maintain and even improve endurance performance.

Noakes cites triathlon as a case in point, where some of the very best triathletes in the world have achieved prodigious endurance running performances despite relatively modest running training. He provides the following explanations:

- Cycling can produce the same metabolic stress on the body without the same loading stresses on the muscles and the skeleton (particularly, eccentric muscle damage, as noted previously);
- Cycling may also help to 'programme' the brain to withstand the mental aspect of completing an activity*, such as an Ironman triathlon, that could last 10 hours or more. To bolster this belief he cites the case of one of the world's greatest triathletes, Mark Allen, who observed that he only gained Hawaiian Ironman success after he performed workouts that matched his winning race times.

** Noakes is a huge advocate of the role of the brain in optimising endurance performance; this is the premise of his Central Governor Theory, which argues that perceptions of fatigue and subsequent performance are regulated by the brain in an effort to conserve energy for emergencies. According to the theory, the brain will always terminate endurance activity at a level specific to the athlete's fitness; a level that can be adjusted positively with the 'right' training.*

Cycling to improve speed

Cycling would probably not be the first training option that springs to mind for those involved in sports that require out-

and-out speed, such as sprinting and field sports. However, a number of potential benefits have been identified.

To increase leg speed

George Dintiman[4] is one of the world's foremost speed training experts and he advocates the use of cycling to develop over-speed. Over-speed refers to a training condition that allows the athlete to perform his or her sport skill(s) above the speeds achievable under normal conditions. Examples of over-speed methods include, downhill sprinting and towing using elasticised harnesses.

Dintiman believes that high-speed cycling can potentially increase sprinting leg speed. He has devised an over-speed cycling protocol, which progresses the athlete through a 'high-quality' interval training programme. Quality in this case refers to the fact that the programme does not elicit a significant level of fatigue and **lactate** build-up.

The design allows the athlete to complete the given number of repetitions at very high speeds. Each repetition consists of incredibly short over-speed cycling efforts, which last no more than 2.5 seconds, sandwiched between two-minute recovery periods. After each flat-out effort, pedalling speed is gradually decreased over a period of 5-10 seconds, before the 25-30rpm two-minute recovery period is performed. At the end of the eight-week programme, nine such repetitions are completed.

It should be noted that the use of high-speed cycling in a speed athlete's training programme serves a supportive/peripheral role, and should not be seen in anyway as a 'cornerstone' workout to be used regularly in, for example, a sprinter's training programme. The reason is that the cycling motion has limited transference to the sprinting action – *ie* cycling, unlike sprinting, requires no speed-assisting arm action. Nevertheless, in terms of eliciting an enhanced **neuromuscular response**, which may transfer into out-and-out leg speed, high-speed cycling should not be discounted.

However, for out-and-out speed development, very intense cycling interval workouts, performed regularly over two- to four-minute intervals, with similar recoveries, should be

Jargonbuster

Lactate A metabolic product of vigorous exercise, which, when it accumulates (*ie* its rate of production exceeds its rate of clearance), hampers muscular activity and produces feelings of extreme fatigue

Neuromuscular response The ability of the body to send and respond to electrical impulses sent through the spinal cord to the muscles from the brain and vice-versa

Alactic/alactic anaerobic energy system An energy system used during very intense short bursts of anaerobic training and which doesn't rely on glycolysis and lactate production – often known as the 'phosphocreatine' or 'immediate' energy system

Cycling and growth hormone release

Cycling can have a significant effect on stimulating growth hormone (GH) release, particularly if workouts are performed intensely. GH is often described as the 'sport hormone' because it is involved in numerous anabolic (growth) functions, relating to cell proliferation and division throughout the body. Specifically, GH stimulates bone, cartilage and muscle growth, and can play a very significant role in lean muscle mass development and fat reduction. The key to increased GH response is exercise intensity; as a rule of thumb, the more intense the exercise, the greater the response[5].

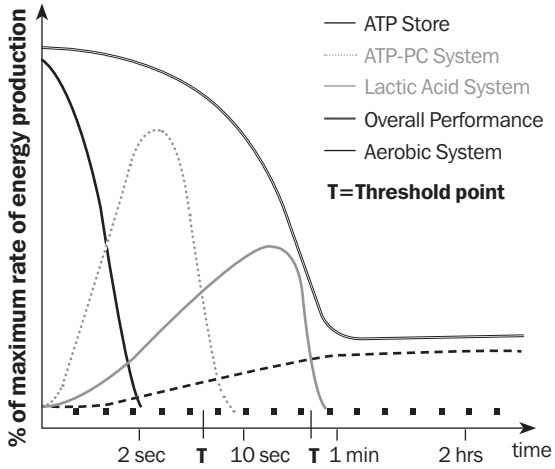
It should, however, be noted that if the duration of intervals is longer (30 seconds or more), higher intensity intervals do not necessarily lead to increased levels of GH release and may even blunt them. A team from Loughborough University in the UK studied the effect of maximal cycle sprinting on GH production [6]. Ten male cyclists completed two 30-second sprints separated by one hour's passive recovery on two occasions. The first effort was completed against a resistance equivalent to 7.5% of body mass and the second effort against a higher resistance equivalent to 10% of body mass. Blood samples were taken at rest, between the two sprints and one hour post-exercise. Although both sprints resulted in the same peak and mean power outputs, the measurements of GH levels showed that the first (lower intensity) effort elicited a significantly higher GH response than the second (higher intensity) effort.

For athletes who are injured and cannot perform their normal high intensity activities, cycling using quality interval training methods to promote GH stimulation may be of real value. To reiterate, cycling places little strain on the body yet can elicit high GH responses, which could significantly contribute to the maintenance of condition (and potentially speed up the healing process due to an increased 'assisting' hormonal response).

It is also possible to cycle with care using one leg only on a stationary bike and this is worthwhile considering (with relevant medical/expert approval) for an athlete who has injured one limb yet wants to maintain as much hormonal (and creatine phosphate/short-term anaerobic energy system) condition as possible. Although beyond the scope of this article, arm cycling using an arm crank machine, could also provide a further training option, dependent on injury.

avoided. That's because these longer intervals are primarily designed to improve a muscle's ability to produce and mop up lactate when producing energy. They are not designed to

Energy systems in the body



There are actually four main sources of energy in the body, which are integrated together to ensure energy is available both immediately and for more prolonged periods of time (see graph left):

ATP – muscular ATP supplies immediate energy for first one to four seconds, but is soon exhausted;

Phosphocreatine (ATP-PC) – helps bolster flagging ATP stores very rapidly by regenerating broken down ATP. Provides about 10 seconds' worth of energy;

Lactate system – helps to regenerate ATP fairly rapidly by the incomplete breakdown of carbohydrate; can supply about a minute's worth of ATP;

Aerobic system – uses fat, carbohydrate and even protein to produce ATP more slowly. Providing there's enough oxygen available, the aerobic system can provide energy for several hours.

develop leg speed and may well 'dull' the speed and power responsiveness of fast-twitch muscle fibres.

To improve high-speed short-duration explosive efforts

Speed and power athletes need to perform repeated high-powered efforts, for example, short sprints or high-loading weight lifts. Creatine phosphate is stored in muscles and is the key 'fuel' for these short-term **alactic** energy system activities (*see box on energy systems*).

Cycle interval training similar to that described for enhancing leg speed can improve the ability of muscles to produce and replenish creatine phosphate stores, although the exact mechanisms for this are not known. This could be useful for a speed athlete who has sustained a minor injury, that prevents them from completing their normal **alactic anaerobic energy system** training activities, or for the masters sprinter who has adopted a more circumspect approach to training and avoids performing too many potentially injury-inducing track sprinting workouts. A suggested workout is as follows:

- Warm-up;
- 20 seconds flat out effort on a medium/high resistance on a stationary bike;
- 2 minutes 'easy' pedalling recovery;
- Repeat six times;
- Warm-down.

In conclusion

Cycling can offer the endurance and speed athlete great potential, *ie* by contributing to injury reduction and rehabilitation. In terms of performance it can, at worst, contribute to maintaining existing levels of non-cycling athletes' endurance (given appropriate application). In terms of speed and power, cycling also throws up some very interesting potential benefits. However, whatever the type of activity being trained for, it is crucial that cycling is seen as an adjunct to the core, specific training completed by the athlete, and must never supplant it.

Practical implications

- Cycling can be used to help maintain aerobic fitness during an athlete's off-season period;
- High-speed, short-duration cycling sessions can also be used to help develop leg speed and power in sprinters and may even help build strength – however, athletes and coaches should ensure that any cycling training is relevant and appropriate for these goals.

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Strength training for cycling – does it really help?

At a Glance

- The effects of strength training in novice and club cyclists are discussed;
- A number of alternative exercise to complement cycle training are given;
- Research findings into high intensity and explosive leg training for advance cyclists is presented;
- Conclusions are drawn and recommendations given.

Most athletes and their coaches know that improved strength, power or muscular endurance is likely to lead to improved performance in competition. However, evidence suggests that, except for those at the very top of their sport, the same may not always be true for cyclists. **James Marshall** *explains...*

Top cyclists such as the Tour de France competitors have a full sports science programme helping them, including nutrition, physiology and psychology. However, apart from training on the bike, the average clubman or woman will probably limit him or herself to a bit of resistance training down at the gym, especially in the off-season. This article aims to answer the following two questions: Is strength cross training relevant for the beginner cyclist? How does strength training affect performance in elite sprint cycling and road racing?

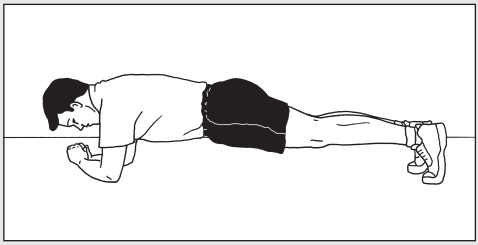
Strength training for the novice cyclist

The ability to produce a greater amount of force, to delay fatigue and to control the bicycle are all beneficial when looking

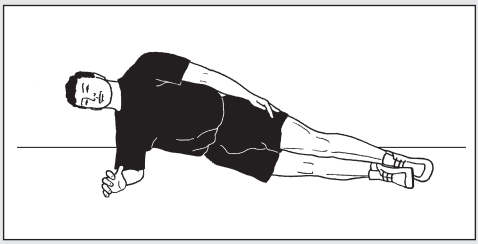
Postural exercises for cycling

Exercise	Repetitions	Progression
Press-ups	10-50	Kneeling to full
Plank	10-60 seconds	Kneeling to full
Side plank	10-60 seconds each	Kneeling to full
Single-leg squat thrusts	10-30 each leg	Increase speed of movement
Spotty dogs	10-30 each side	From lying to kneeling

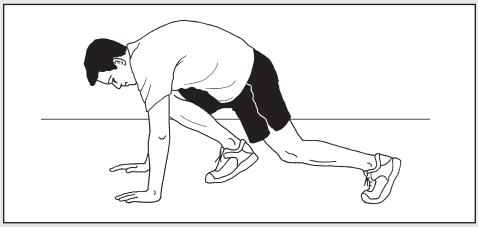
Plank From a lying position on the floor, lift your upper body off the floor to rest on your elbows, keeping your back in a straight line to your hips. Make the exercise harder by lifting your knees off the floor and keeping a straight line between your shoulders and your ankles. Try to stay perfectly still for the time given, but continue to breathe normally.



Side plank Similar to the plank, but performed sideways. Lie on your side, with one arm underneath you perpendicular to your body. Lift your upper body and hips off the floor, resting on your forearm, keeping your waist off the floor. Progress by lifting your knees off the floor, keeping a straight line between your shoulders and your ankles.

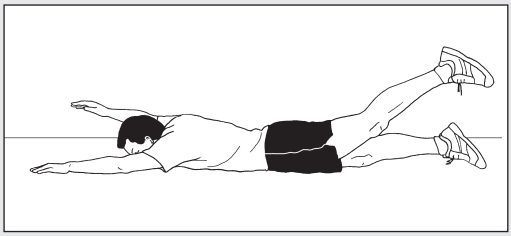


Single-leg squat thrusts Start in the press-up position, bring one knee level with your elbows, then return it to the start position, at the same time bringing your other knee level with your elbows. The feet move just above the floor. Progress by increasing the speed of your leg movements.



Postural exercises for cycling *(continued)*

Spotty dogs Lie face down on the floor, with your arms outstretched in front of you. Lift your right arm and left leg off the floor under control (meaning that you can pause at the end of the range of movement). Return to the floor, and then repeat with the left arm and right leg. Progress by doing this exercise from all fours.



to improve cycling performance, and strength training can help all three of these components.

Working with weights for the lower body – *eg* two days per week of four sets of **5 Repetition-Max (5RM)** squats – will help improve leg strength as tested in the squat. Repeated lifting of weights, with less recovery time – *eg* a circuit of squats, lunges, step- ups all at 15-20RM with 10 seconds of rest – will improve local muscular endurance. The use of weights and stability exercises in the upper body and torso will improve body strength and stability in these areas. But can this help the beginner cyclist improve their cycling performance? Strength training inevitably leads to increased strength, but that is only relevant if it helps improve cycling!

A study carried out in 1995 compared the effects of a) single-joint strength training b) multiple-joint strength training and c) a sprint cycling programme in beginner sprint cyclists [(1)]. The sprint cycling performance was measured by how much power they could produce in five seconds on a cycle ergometer.

All three groups followed their individual programmes for eight weeks, followed by a specific six-week programme of sprint cycling. The two strength-training groups improved their 10RM by 41-44%, with no significant difference between the two forms of training. However, all three groups improved their sprint performance by 4-7%, with no significant

Jargonbuster

5 Repetition-Max The most weight that can be lifted five times

Lactate By-product of intense exercise in the absence of sufficient oxygen, which causes muscular fatigue

difference between the three groups.

It appears, therefore, that for newcomers to a sporting activity, doing that activity may be enough stimulation to initiate a change and improve performance. In the study above, it may be that after only eight weeks of strength training the improvements in the 10RM test were mainly skill based, and the cyclists did not actually get stronger, but just better at doing the strength exercises. It would be interesting to see if after a further eight weeks of strength training whether they got stronger in the 10RM test, and then see if that improved their sprint cycling.

Strength training for club cyclists

If beginner cyclists are able to improve their cycling without doing strength cross training, how about club cyclists who are quite proficient at cycling but may need to be better conditioned? A recent study looked at introducing either a strength-based weights programme, or a muscular-endurance weights programme on club cyclists, three times a week for 10 weeks [2]. Testing was based on 1RM on four leg exercises, and **lactate** and VO_2 levels during a progressive cycle ergometer test.

Compared to a control group who did no strength training, the two strength-trained groups again showed improved 1RM scores on the strength tests. But neither group showed any improvement over the control group on the lactate and VO_2 levels during the cycle ergometer test. This led the authors to conclude that strength cross training did not improve the cycling performance of club level cyclists.

However, the cycling test of both of these studies was conducted on an indoor ergometer, in a fixed position. Cycling, especially downhill or mountain biking (DOMB) requires great stability in the upper body. That, and remaining in a position bent over the handlebars for long periods of time in endurance cycling mean that pressure is placed on the lower back.

Whilst strength training has not been conclusively proven to improve cycling performance, certain exercises may be

beneficial in allowing the new and intermediate cyclist to spend more time in the saddle, without incurring postural and overuse injuries in the upper body and lower back. Postural exercises *(see previous page)* performed twice a week for 15 minutes can help establish a base level of strength in the upper body and torso, helping the cyclist adapt to the added demands of their sport.

Go through the five exercises in order; start with one set and then progress to two sets with 30 seconds rest between exercises, and two minutes rest between sets. If you have any previous lower back pain consult your doctor or physiotherapist before commencing this routine.

Advanced level cyclists

If beginner and club level cyclists are best able to improve their cycling performance by simply doing more cycling, what about those at higher performance levels? Elite cyclists would probably find it hard to increase their volume of training and, indeed, excessive volumes of training are linked to overtraining in endurance athletes[3]. Are they better off looking at improving and making their current training regime of cycling more efficient, or can weight-training as a cross training activity offer real advantages?

'Are elite cyclists better off looking at improving and making their current training regime of cycling more efficient, or can weight-training as a cross training activity offer real advantages?'

One potential disadvantage of weight training may be the increase in muscle mass that results. An increase in size could hinder the cyclist by increasing the air resistance they face as they cycle at speed; the greater the speed, the greater the drag of wind resistance. Even where drafting is allowed, a larger 'frontal' cross-sectional area will make efficient drafting harder.

The other resistance faced by the cyclist is that of gravity; a greater mass means that there is gravitational force to overcome when there is any kind of incline. While this is not an issue for a track cyclist on a perfectly level track, it becomes a major factor for road cyclists, especially where the terrain is hilly.

Any strength-training routine must therefore result in an improvement in leg power or leg cadence greater than the increase in gravitational or air resistance produced as a result

High Intensity Training protocols used in peripheral adaptation study [5]

All the cyclists were timed to exhaustion (T) at their peak aerobic power (P). Their peak power output (PPO) was also measured.

- Group 1: 8 sets of 60%T at P, with 1:2 work:recovery ratio;
- Group 2: As 1, but recovery was judged when heart rate returned to 65% of maximum;
- Group 3: 12 sets of 30 seconds at 175% of PPO, 4.5 minutes recovery.

of increased size or mass. To date, no research has been published that analyses this cost/benefit ratio in elite cyclists.

For endurance cyclists, (indeed, for many endurance sports), increasing the legs' ability to resist fatigue is important. Whilst the majority of work will rely on aerobic metabolism to provide the energy for the race, about 13% of the energy required comes from anaerobic metabolism [4]. This energy source may be called upon at crucial times, such as the sprint to the finish line, or racing up a hill. The legs themselves may be working maximally, producing lactic acid, but because the rest of the body is working sub-maximally, it can redistribute this lactic acid to the liver, heart and upper body muscles, where it can subsequently be metabolised.

If the legs can become more proficient at dealing with an increase in lactic acid, by removing it quickly from the system, then more work can be done at a higher intensity, allowing a cyclist, rower, footballer etc to sprint for longer. This is the theory behind circuit-type training of the legs, but as yet, there are no studies in elite cyclists that specifically assess this type of training.

However, these peripheral adaptations have been shown to take place after High Intensity Training (HIT) in well-trained cyclists (average peak VO_2 = 64.5ml/kg/min) after only four weeks of training at two sessions per week [5]. Cyclists were split into three different training groups and a control group (*see box above*).

HIT with explosive leg exercises protocols[6]

1: 20 explosive single-leg jumps
2: 30 seconds maximal cycling effort, 30 seconds recovery – 5 times
3: 20 explosive single-leg jumps
4: 30 seconds maximal cycling effort, 30 seconds recovery – 5 times
5: 20 explosive single-leg jumps
6: 30 seconds maximal cycling effort, 30 seconds recovery – 5 times

All three training groups showed an improvement in their 40km time trial, **anaerobic capacity, peak VO_2** and **ventilatory thresholds**, but not their **total plasma volume (PV)**. The fact that the PV did not change but the performance measures all improved, indicates that the changes were in the legs, not in the central system. The fact also that three different high-intensity training routines all led to improvements shows that it was introducing the intensity that led to improvements in performance. Moreover, it may be that sequencing the different routines every four weeks would lead to further positive changes.

Explosive leg training

A study in New Zealand looked at combining HIT with explosive leg exercises, in an attempt at using specific power exercises to improve mechanical efficiency and anaerobic power[6]. This study took place within the cyclists' competitive season, with the exercise protocols replacing 20% of their normal existing road training (*see box above for protocol*).

The cyclists were tested for 1km and 4km power as well as peak power and oxygen cost. After five weeks of training (12 sessions lasting 30 minutes each), all the power indicators had increased, and the oxygen cost of cycling had decreased. Remember that these improvements occurred in the competitive season, when the cyclists were already well trained and supposed to be in peak form.

Jargonbuster

Anaerobic capacity
The ability to work at high intensity without the use of oxygen

Peak VO_2
The greatest rate at which oxygen can be delivered to the working muscles

Ventilatory threshold
The intensity of work at which the rate of breathing rapidly increases

Total plasma volume
Measure of total blood volume, which gives an indication of ability to deliver oxygen to working muscles

Not all the improvements can be due to an increase in central aerobic power; indeed, the 1km trial is mainly anaerobic in nature so an alternative explanation must be found. It is likely that the explosive leg exercises stimulated the neural system by rapidly activating the motor units within the muscles. This may have led to a quicker rate of peak force development when cycling, resulting in greater acceleration and sprint performance.

Summary

Strength training may improve cycling performance and other endurance sports performance through increased leg power, a greater ability to cope with local fatigue and improved upper body stability. However, this has yet to be proved in research. In beginners and club level cyclists, more cycling is probably the best way to improve performance. Taking time out from cycling to do strength training will probably lead to a decline in cycling efficiency and skill level. The exceptions are abdominal and lower back exercises that can help prevent lower back pain.

Once skill and aerobic fitness levels have improved through normal cycling training, performance can be improved through introducing high intensity training even during the competitive season. This is a very specific way of inducing load onto the legs that forces local adaptations to take place. Just doing ever-larger volumes of cycling may well lead to overtraining.

For elite level cyclists, introducing explosive strength and body weight exercises is likely to improve sprint and short hill climbing performance. Traditional strength exercises, however, may be detrimental in that they increase muscle mass and size, adding to the air and gravitational resistances that cyclists need to overcome.

The important thing to remember is that new stimuli force the body to adapt and improvements in performance are made. New training methods should not be used in addition to existing training. Instead, try to keep one or two sessions a week aside for variety. These may include strength training, HIT or core work.

Practical implications

- Beginners and intermediate level cyclists should emphasise increased cycling volume to develop sports specific skill and efficiency;
- At higher levels, the evidence suggests that explosive and high-intensity weight training can benefit sprint performance;
- The recommendations above would also be applicable to other endurance sports such as rowing and shorter distance running.

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Short and sweet – why all sportsmen and women should consider 40m sprinting!

At a Glance

- The relevance and potential benefits of 40m sprinting are discussed;
- Recent research on improving 40m sprint times is presented;
- Tips for testing 40m sprint times are given;
- A sample 40m sprint training programme is outlined.

Many team sports athletes will go through a battery of fitness tests throughout their career. One of the most widely used is the 40m sprint (the 40-yard dash in the USA), which is used to test speed. **James Marshall** *explains how you can benefit from 40m sprint training*

While it's true that there are other speed tests that are relatively easy to administer and which provide immediate feedback to coaches and athletes, the 40m test is so prevalent in sporting circles that athletes may benefit from training plans that improve their 40m sprinting, as well as their linear speed, to assist their sporting performance. Indeed, in the USA, whole training programmes, websites and camps are devoted to 'improving your 40'.

This data is relevant to sports such as field hockey, football and rugby, where players are not only required to run bursts of similar distances during the game, but also need to have high top speeds and good acceleration, *eg* being first to a ball or

racing back to get into defensive position; 40m sprinting can also be relevant in sports such as ice hockey (which has no running in it) as a measure of power and leg speed[1]. One study showed a high correlation between ice hockey players' 40yd times and their shooting performance within matches[2].

Running, jumping or squatting?

In order to improve running speed over 40m shouldn't you just practise running 40m? Inevitably, practising any skill that is going to be tested will result in improvements in untrained subjects as a learning effect takes place. However, developing strength through weight training exercises such as the squat, or power through exercises such as plyometrics or jump squats has

The NFL Combine

The National Football League holds a scouting combine in Indianapolis each year in which the top 300 college players are invited to perform a battery of physical and skill related tests. This six-day event is an opportunity for the 32 professional teams to assess the capabilities of players at each position. The college draft takes place two months later in which teams select players by rounds. The earlier a player is selected, the more money he will make. The 40yd dash (36.9m) is one of the physical tests, alongside vertical jump, how many times a player can bench press 100kg and others.

Players across all positions have to perform the same tests, so 159kg offensive linemen and 81kg defensive backs all do the 40yd dash, but are compared by position. The results of all these tests provide a high correlation with draft position only for running backs, wide receivers and defensive backs – strangely enough, exactly the positions that frequently have to cover 40yds in the game at top speed[11]!

The 40yd dash times receive immense coverage in the US media, mainly because it is an easy to understand figure; every fan wants to know what their favourite player can 'do the 40 in'. The fastest time at this year's combine was by 79.5kg Yamon Figurs who ran the 40yds in 4.30 seconds. Figurs was drafted by the Baltimore Ravens in the third round and was the 74th player taken overall, coming from a small college, with limited prospects. His position was definitely augmented by his 40yd time.

also been advocated as an alternative to just running.

As usual, research is not 100% clear on the answer, mainly due to the design of the studies and the use of 'recreationally trained' or 'untrained' subjects (such as university students) who are usually male, instead of well trained athletes. The training effect demonstrated in these studies may therefore not be especially relevant for those who are better trained or are female.

What is clear, however, is that running the 40m requires acceleration over the first 15m, which is improved by forward body lean and short but quick strides with minimal ground contact time and with a large force[3]. From 15m to 40m, stride length increases, with the fully extended rear leg pushing off the track with the toes and the leg driving forward with a high knee action. Squatting and jumping exercises that reproduce either a quick ground contact time or allow the triple extension of the hip, knee and ankle are most commonly used. These include jump squats, cleans and bounding drills.

Decreasing the ground contact time without enhancing the ability to increase force proportionately will result in slower linear speed because the acceleration produced will be less. Developing power with resistance training is usually achieved by either using heavy weights (70-90% 1RM) and low velocity or lighter weights (30-50% 1RM) and high-velocity movements. Both have been found to be effective when using squat, hip extension and hip flexion movements in improving 20m acceleration time[4].

Improving maximal leg strength may prove to be crucial in improving speed in untrained subjects, but less so in experienced athletes. This is due to the fact that a large increase is needed in leg strength before a corresponding increase in speed is seen. A large strength increase is easier to achieve in untrained subjects than those who have been training for 10 or more years.

In trained subjects, squatting immediately before sprinting may produce an acute effect over 40m due to **postactivation potentiation** (PAP)[5]. One set of three heavy squats at 90% 1RM

Jargonbuster

Postactivation potentiation An increase in the contractile property of muscle after a series of previous contractions due to a combination of chemical, neuromuscular and mechanical changes in the muscle[13]

were effective in reducing 40m sprint time in college American football players compared with three squat jumps with a 30% 1RM load. A four-minute rest period was enforced between the exercise and the sprint. However, this is not recommended for untrained subjects as the squats would have an unduly fatiguing effect and reduce the ability to produce power.

Testing 'the 40'

While testing the 40 is theoretically quick and easy to administer, experience shows that it can't always be done. One major problem is the weather. Indoor facilities that have a 50m space in a straight line (you have to allow at least 10m for safe deceleration at the end) are rare. Outdoors, the surface has to be dry to allow foot purchase and should be consistent between tests to establish reliability. Athletic tracks that have surface water on them become very slippery and injuries could occur.

Wind is also a factor, with tail, head or cross winds all affecting the times. If you are just conducting one test to establish who is quickest on your team, then wind is not a problem because the conditions are the same for everyone. But, if you are using the data to monitor progress over time or comparing with players from other parts of the country, then conditions become important.

Equipment used could be handheld stopwatches or electronic light gates. If using handheld times, then up to three testers should be used and an average between the three scores recorded[12]. If using electronic gates, make sure you have spare batteries, as they can become depleted quite quickly. Mark out the distance with an accurate tape measure and ensure you get metres and yards correct – I have seen the two confused and some very fast scores recorded!

Allow athletes sufficient time to warm up, providing a general and then specific warm up with speed drills. Then allow each athlete three attempts to run their quickest score, with rest time between each attempt. The starting position is important, from a two-point or three-point stationary start; on the line or 75cm behind the first electronic gate. The times recorded will be different for each protocol, but the consistency between tests is crucial – everyone must follow the same protocol. There's no evidence that athletes competing against each other over 40yds run faster than when running against the clock (or vice versa), so whichever method is easier for you to administer should be used[12].

The recovery phase

Most studies have looked at training the drive phase of the sprint action; however, training the recovery phase could be just as important. One study using untrained subjects improved 40yd times over eight weeks by using elastic bands to improve hip flexor strength for the recovery phase[6]. The subjects tied the elastic band around their ankles and then reproduced the high knee lift against the resistance of the band. The subjects improved hip flexor strength by 12% and decreased their 40yd time by 9%.

The idea of reproducing this action under load is sound, but it is unlikely to work in trained subjects due to the limitations of using elastic bands. Unlike using free weights or cables, which require a large initial force to overcome inertia, bands have little inertia at the beginning of the movement, but resistance increases towards the end of range. This results in early deceleration, which is counterproductive in most athletic movements.

Jargonbuster

Phosphocreatine energy system Generates ATP for immediate efforts of activity from two to seven seconds in duration

Sprint training protocols

As the 40m is a very specific running test, and most training time is limited, the running drills need to be very effective. Running a series of 40m sprints, with 'walk back recovery,' which is common in team environments, may not produce the best results. Instead, carefully managed rest times that allow recovery of the **phosphocreatine energy system** should be used. This will then help the athlete run at their top speed for each sprint in the training session. Rather than run the same set of drills in each session, it may be best to include some over-speed and uphill sessions as well as normal sessions.

Incline or running with resistance is designed to increase ground contact time and reduce stride length, which may be useful in the initial 15m of acceleration. Downhill running or overspeed training is designed to increase stride length and reduce ground contact time, important in the 15-40m phase of the sprint. When using inclines, declines, resisted or overspeed training methods, it is important to observe running mechanics. Too much incline or resistance will result in severely altered running styles and poor posture, which then has a detrimental

Sample 40m sprint training programme for football (also applicable to other field sports)

Concentrating on four areas: technique, strength, sprinting, plyometric training (energy system conditioning is assumed to be done as part of the team training sessions through the use of small-sided games).

A – Off-season

Technical drills to be done for 10 minutes as part of football team training warm-ups.

Strength (two sessions per week)

Squats 4 sets of 3 reps @ 90% 1RM 2 mins rest between sets
Jump squats 4 sets of 5 reps @ 30% 1RM 2 mins rest between sets
Cable leg drive 4 sets of 5 reps @ 30% 1RM 2 mins rest between sets

Plyometrics (two sessions per week)

Double-leg bounds 10m; progress to 20m
Tuck jumps continuous 2 sets of 10 reps
Single-leg bounds for distance 10m; progress to 20m
Single-leg bounds for speed 10m; progress to 20m

Sprints (two sessions per week)

Session 1

Alternate each week between resisted sprints towing a 10kg weight or an uphill run of 40m at 3 degrees. 4 resisted/uphill sprints, 3 mins rest between reps. 4 flat 40m sprints at full speed, 5 mins rest between reps.

Session 2

4 downhill sprints for 40m at 3-degree decline, 3 mins rest between reps. 4 flat 40m sprints at full speed, 5 mins rest between reps.

Sample week for a player who does two team sessions in the off season; player does two sprint sessions, two plyometric sessions and two strength sessions each week

	Sun	**Mon**	**Tues**	**Wed**	**Thurs**	**Friday**	**Sat**
Session1	Rest	Sprint1	Plyo1	Rest	Plyo2	Rest	Strength2
Session2	Rest	Rest	Team	Strength1	Team	Sprint2	Rest

B – In-season

Sample week for in-season training; only one strength, plyometric and sprint session per week in order to avoid fatigue (because of the high number of matches being played)

	Sun	**Mon**	**Tues**	**Wed**	**Thurs**	**Friday**	**Sat**
Session1	Rest	Sprint	Rest	Match	Rest	Plyo	Match
Session2		Strength	Team		Team	Rest	

effect when the resistance is removed. The same is true for decline or overspeed training (being towed).

Two studies had different views on this. The first used a protocol of towing (over-speed sprints), pushing (resisted sprints) and normal sprints and compared the three groups over 22m[7]. The subjects were untrained college students and the sprint sessions were conducted three times a week for six weeks and consisted of sprinting 22m five times.

All three groups improved their times at their own protocol (*ie* the resisted group got better at running against resistance) but the transference to flat speed was greatest in the normal sprint group and then by the overspeed group. The short-term nature of this study indicates that the adaptations to the training were neuromuscular in nature; the subjects became more efficient at their drills. This may not have transference to sport specificity, but if you are trying to get good at a one-off 40m test, then training at that speed for six weeks may help. However, in the longer term, you are unlikely to get better results by just doing that.

'If you are trying to get good at a one-off 40m test, then training at that speed for six weeks may help. However, in the longer term, you are unlikely to get better results by just doing that'

The second study combined uphill, flat and downhill running into the same session to provide resisted, tempo and overspeed stimulation to the subjects and compared that to just uphill, flat or downhill sessions (without resistance or towing)[8].

The researchers designed and built a wooden platform that had a 20m flat portion, a 20m incline at 3 degrees, a 10m flat portion at the top, a 20m decline at 3 degrees and then a flat 10m at the end. The combined uphill/downhill group ran this 80m total six times with 10 minutes' rest between sprints, three times a week for six weeks. The other groups ran the same total distance, but in shorter bursts using the same platform, so they ran 12 sets of 40m combining the flat and either the down or the up portion of the platform.

At the end of the six weeks training, the subjects were tested over 35m and the combined uphill/ downhill group showed a 3.4% increase in top speed with the downhill group showing a smaller 1.1% increase. The flat and uphill training groups made no significant changes to running speed after six weeks of training.

The key factor distinguishing between the downhill only group and the combined uphill/downhill group is that the latter had their neuromuscular system overloaded, then unloaded and then assisted. This loading and unloading in the same session could be the difference and is worth trying in training.

Other benefits of practising 'the 40'

Regular sprint training can lead to better sprint times, but could it also be used as a training tool in itself leading to other physiological improvements. Plyometrics are often used as an effective training method to help reduce ground contact time for sprinters and jumpers. A Croatian study compared a sprint training protocol with a plyometric protocol over 10 weeks and looked at the effects on drop jumps, countermovement jumps, squat jumps and squat strength as well as 20m sprint time and 20yd shuttle runs[9].

Both groups improved their jumps but the sprint group also improved their isometric squat strength and their speed and agility scores. This study showed that sprinting could be used as a training tool that has similar or better effects than plyometrics. The same researchers also analysed anthropometric characteristics of the two groups and found that the only significant change was a 6.1% reduction in body fat in the sprint group[10].

Summary

Assumptions may be have to be made in designing training protocols for well trained athletes due to the paucity of research using trained subjects. However, it does appear that once a well developed strength base is in place with sound sprint mechanics, the use of different sprint speeds and drills followed by normal mechanics at top speed is more effective than running just flat speed drills.

In untrained subjects the most effective way to improve 40m speed over the short term (circa six weeks) is to practise the test and coach the running style well. This will be effective once, but for those athletes who are tested regularly, a solid strength base needs to be developed in combination with power exercises either in the gym or using plyometrics.

It's worth commenting on the use of time spent on sprint drills. Most coaches who have limited access to their players will not allow players to spend even 10 minutes doing nothing in their training session; taking up a whole evening doing six maximal sprints over 40m with 10 minutes' recovery will not therefore go down well. Try doing that on a rainy night in January and your players won't like it much either! Doing 20 sets of 40m sprints with 'walk back recovery' may look busier and the players will be tired, but it won't help their 40m speed either!

Working on lower body strength and power in the gym, however, will have the two-fold effect of improving both sprint speed and overall conditioning, which will help in contact and collision sports.

Practical implications

- Increasing 40m sprint speed can benefit all sportsmen and women whose sports involve short bursts of high intensity activity;
- Athletes wishing to increase 40m speed should work on lower body strength and power using weights and plyometrics rather than just perform endless sprint drills.

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Punching above your weight – can boxing training help non-boxers?

At a Glance

- Amateur boxer and professional trainer Ian Burbedge provides an insight into the world of boxing training and its relevance for other sports;
- Practical examples of beneficial 'boxing type' cross training routines are given for nonboxing athletes.

Boxing is one of the toughest sports around and boxers are renowned as being among the fittest athletes, requiring a combination of agility, speed, power, strength and, of course, mental toughness. Former amateur boxer and professional boxing trainer **Ian Burbedge** *talks to* **John Shepherd** *about boxing training methods and their relevance to other sports*

Ian Burbedge trains professional boxer Lenny Daws twice a day, 5 days a week. Lenny is a professional light welterweight boxer (10 stones) who at the time of publication had won 18 fights, drawn 1 and lost 1. Lenny is a former British number one and in 2008 was ranked 5th (he fights at the same weight as Ricky Hatton).

In general terms, the preparation for a fight depends on the number of rounds. Ian explains that the minimum preparation phase would be six weeks for a 6-round fight, but that if the fight were longer (for example 10-12 rounds) then another 3-4 weeks would be added.

Ian believes that the amount of running that boxers typically do is exaggerated, with run durations often reflecting the length of

Jargonbuster

Fartlek
Method of training that alternates high and low intensity running but where the athlete decides what speeds to run at and what recoveries to take while running

Jargonbuster

Aerobic
Energy system where energy is provided by oxygen metabolism and which is developed by steady state cardio work at low intensities

Anaerobic
Name given to the two energy systems that rely on high energy body compounds stored in the body, such as creatine phosphate and stored carbohydrate rather than oxygen metabolism

Lactate
A naturally produced by-product of metabolism, which accumulates during intense exercise – specifically where energy is derived from carbohydrate in the absence of oxygen

the fight – for example, a 36-minute run for a 12 x 3 minute round contest. In particular, Ian believes that there is no real need to run more than three miles, as boxing is an explosive sport rather than a slow steady one.

Lenny often performs his runs in **fartlek** style, upping the intensity with sprints and faster paced running. The idea is that this more closely reflects that true nature of boxing, where there are flurries of activity, rather than a single steady effort. Ian advises Lenny to run every training day (five per week) when preparing for a fight, with the run being the first of the two or three workouts he does each training day.

Circuits

Circuit training provides the foundation for Lenny's conditioning. When preparing for a fight, it forms the mainstay of the second workout of the day, with the more technical components of boxing such as pad work forming the third. Four to six weeks before a fight, the format is reversed; specific boxing preparation work takes precedence and the circuit training follows.

Typically there are eight exercises in a circuit and these are performed in 5-minute bursts. All boxing-specific training would involve 3 minutes of effort with 1 minute of recovery, to reflect fight conditions. In terms of actual exercises a typical circuit includes chin-ups, diamond, normal and plyometric press-ups, crunches, the plank (core exercise) and squat thrusts. Weight exercises are also included, *eg* dumbbell flyes and lateral raises, but loadings are kept relatively light. These workouts are designed to increase Lenny's ability to handle his own weight, develop power and resilience under conditions of fatigue yet not build muscle (which could slow him down). An additional concern for Lenny is that as a light welterweight, a significant increase in muscle mass from weight training could take him over the 10-stone (63kg) limit.

Three or four weeks out from the fight, Lenny still runs but the work done in the gym becomes much more specific as the fight closes in. Typically he does a couple of rounds of shadow boxing and maybe bag work and then goes straight into sparring.

Boxing speed

The 'greatest', Muhammad Ali, claimed that he was so fast that he could be in bed before it went dark after he flicked the light switch! Speed of hand and speed of foot are vital attributes for a boxer.

Speed of hand – Ian believes that the best way to develop hand speed is through pad work. This requires the trainer to be in the ring holding pads and moving the fighter around as he throws various punches to the pads. He explains: 'It's very difficult to do this when sparring because you're constantly looking for openings and you're not thinking directly about improving hand speed. Also, with a punch bag, it's amazing the amount of times you will throw the same combination of punches – you get into a habit. However, because you're working with someone on the pads, the dynamics are very different and you don't fall into that trap.'

Speed of foot – Skipping is still used by many boxers and other athletes as a way to develop foot speed and agility, but Ian explains that more modern practices may be more beneficial and he adapts agility and quickness drills used by other sports and employs them in Lenny's training. These are introduced about three weeks before the fight, when the boxer's legs are strong. This out and out speed work is done with fuller recoveries. Specifically, he uses a very short speed ladder of only four rungs aimed at developing 'change of direction' speed. 'When he boxed conventionally [*ie* 'orthodox' with a left leg lead] he was perfect at anything going to the left. But if he had to go to the other side, he wasn't comfortable at all.' Lenny is now able to take the fight to his opponent with equal speed in either direction largely due to Ian's use of contemporary agility and quickness training. Ian also recommends this mode of training for other sports where agility and quick leg speed are required."

In terms of numbers of rounds, Lenny will start with three x 3 minutes and then build up to six x 3 minutes to reflect the fight's specific requirements.

For amateurs Ian recommends following the same planning format, gradually building up from two x 2 minutes to four x 2 minutes of sparring over time. After the boxing-specific work, Lenny still performs a circuit but as Ian explains, he will constantly be assessing Lenny's condition and adapting and progressing training accordingly to develop ring readiness and avoid overtraining, for example by reducing the circuit's intensity.

Table 1: VO_2max data for amateur boxers of various nationalities for 3 x 3-minute contests

Boxer's nationality	VO_2max in ml/kg/min
Greek	55.8
Hungarian	56.6
French	64.7
Indian elite juniors	54.6
Indian elite seniors	61.7

Adapted from http://www.media.usm.my/~ssy/ARTICLES/article_2.htm

'Boxing workouts are more anaerobic and require greater all-body power than treadmill running'

Taking punishment

Ian explains that learning to trade and take blows comes from sparring. *'It sounds quite odd but the body becomes conditioned to be hit. You find that over the first couple of days of sparring that you tend to get a few lumps and bumps, especially if you get caught but after a while your body hardens up.'*

So what's it actually like being in the ring? Ian explains that as the fight approaches, nerves increase but once the bell goes you become focused on your job. Ian claims that anyone who says that they aren't nervous beforehand is lying! He continues: *'I've been knocked out. I can remember doing my boots up back in the changing room and asking my coach, 'what time am I on?' As I continued doing my boots up, my coach said, 'you've been hit', and I said, 'Shut up'!! Occasionally a shot will hurt but more often than not you won't feel it because you're thinking about your own plan. The only thing I can liken it to is if you don't head a football right, you get that black feeling come over you and there is a bit of a wobble, but it goes quickly and you get on with it.'*

Ian explains that it is only after the fight, as the adrenaline decreases and the pain starts, that you really realise how much you have been hit.

The physiological requirements of boxing

Compared to other sports, the volume of scientific research on boxing is severely limited (likely due in part to the controversial

Box 1: Boxing lactate levels – how do other sports compare?

Blood lactate levels are a powerful indicator of the anaerobic contribution to a sport or activity; all other things being equal (fitness of participants etc), the more intense the exercise, the higher the levels of lactate. As the results below show, boxing ranks right at the top as a test of the short-term anaerobic energy system.

- **Wrestling –** Research examples of post-contest lactate levels – US collegiate wrestlers – 19.0mmol/litre [2] and (at 1998 World Wrestling Championships) 14.8mmol/litre [3], with recorded VO_2max of 52.63ml/kg/min.
- **Rowing (a sport traditionally associated with high lactate levels) –** Research examples: 13.4 mmol/litre – collegiate rowers performing a flat-out 6-minute ergo test [4]. NB – in rowing there is a surge in lactate during the last 500m as the finish line nears. Olympic rowing is about 60-70% aerobic and 30-40% anaerobic in terms of energy system spread. Boxing with 2-minute rounds primarily taxes the short-term anaerobic system with a reduction in the aerobic content. The demands of four x 2-minute round boxing would be far more anaerobic (nearer to 60-70% anaerobic and 30-40% aerobic).
- **Tennis (like boxing also played using an alternating work/rest format) –** 20 Austrian ranked tennis players showed only an average lactate build-up of 2.1mmol/litre during games [5]. Tennis rallies are very short, normally lasting a matter of seconds, and, relatively speaking, there's plenty of rest (although matches can last for hours). This lower overall intensity results in lower lactate levels.
- **Football –** Danish division 4 players – first half 6.0mmol/litre; second half 5.0mmol/litre [6].

nature and risks – perceived or otherwise – of the sport) but there are a number of studies that have looked at the demands it makes on energy.

Boxing and boxing training requires energy from both **aerobic** and **anaerobic** energy systems. The demands on these energy systems vary in regard to the duration of bouts just as they would with different length track races. For example, a heavyweight who goes toe to toe for 15 rounds relies on a different spread of energy system usage to an amateur who fights for four x 2-minute rounds.

Amateur boxing has switched from three x 3 to four x 2-minute rounds and research indicates that this has made the sport even more anaerobic [1]. Indian scientists discovered that

Box 2: Example of an effective boxing based fitness circuit

1. Bench press x 10
2. Fast chest press using resistance bands x 15
3. Squat, jump and medicine ball throw x 15
4. Cycling action sit-ups x 25
5. Chin-ups x 10
6. Upright row using resistance bands x 20
7. Side plank with rotation x 10 each side
8. Lateral raise and shoulder raise combination x 10
9. Squat thrusts x 15
10. Diamond press-up and biceps curl combination x 10 each

The circuit would be completed with no rest between exercises and a minute's recovery would then be taken before going again. The number of circuits completed would depend on the athlete's fitness and the time in the training year.

lactate levels peak at 14-15mmol/litre and averaged 13.6mmol/litre for four x 2 min rounds compared to 8.3mmol/litre for three x 3 min rounds. Average heart rate was also seen to increase to 192 beats per minute (bpm) from 176bpm.

The higher high heart rate levels indicate a higher percentage of **VO_2max** being utilised, a higher anaerobic energy system contribution and greater fight intensity (although the intensity is maintained for less time during the shorter rounds).

Table 1 shows the recorded VO_2max data from amateur boxers of various nationalities gathered under the (previous) three x 3-minute round format. Meanwhile, box 1 (*overleaf*) shows how lactate (and therefore intensity) levels in boxing typically compare with those from other sports.

Boxing fitness

Many of you reading this may have done boxing-based workouts as part of a cross training/fitness routine, or might be thinking of doing so. So how physiologically effective are they and can they provide sport-specific benefits to other sportsmen and women, for example footballers and rugby players?

Boxing circuits generally take 45-60 minutes and involve

skipping, circuit exercises for the whole body (such as press-ups and crunches) and occasionally (for more advanced trainers) bag or pad work and shadow boxing. Recoveries are kept to a minimum and the workouts can be very tough.

Researchers have compared boxing-based workouts to treadmill running to determine energy expenditure [7]. Eight adult males with boxing-based class workout experience took part in the study, which consisted of three conditions:
1) An hour's boxing-based workout in a laboratory;
2) An hour's boxing-based workout in a gym;
3) An incremental run on a treadmill.

In the lab and gym, the men burned 671 and 599 calories respectively. Interestingly, these calorie-burn figures compared with the energy expenditure of the hour's treadmill run (running is a very effective way of burning calories and the runners covered about 9km in this time).

The energy expenditure figures are high for all the test protocols. More significantly they demonstrate the significant calorie expenditure that boxing-based workouts can produce. Moreover, these boxing workouts are more anaerobic and require greater all body power than the treadmill running, confirming that they are an effective way of developing general fitness, power and local muscular endurance under conditions of anaerobic fatigue.

Boxing training for general sport fitness

Ian believes that boxing training offers considerable benefits to sportsmen and women and he works with rugby and football players to introduce boxing training into the players' conditioning. As he explains: *'If you are looking at developing **fast-twitch muscle**, boxing training is all good work and I think it's got a place in a lot of sports. Rugby players probably take to it better than footballers because they are used to doing a lot of work with their hands.'*

Ian provides the analogy of the rugby hand-off as being like a punching movement, and as a specific area where boxing training can offer a real performance benefit to the player. However, apart from heading the ball, footballers only tend to use their

Jargonbuster

VO_2max
Measure of the oxygen processing capacity of the body

Short term anaerobic
The shorter acting of the two anaerobic systems and the one most tested by boxing; it can only supply energy around 90 seconds before becoming exhausted

Fast twitch muscle fibre
The type of muscle fibres that are the primary generators of muscle speed and power

upper bodies for balance and do not carry as much muscle. By contrast, he finds that players of the 11-a-side game have better endurance when performing boxing workouts compared to their 15-a-side counterparts, partly he believes because of their lower muscle mass and the greater running demands of their sport. Box 2 gives an example of the kind of conditioning circuit that Ian would recommend for footballers and rugby players.

Conclusion

Boxing is a very demanding sport and training for it needs to reflect this. Changes in the amateur sport in terms of length and numbers of rounds and in the professional sport in terms of the number of rounds scheduled should be taken into account when conditioning the fighter. The high anaerobic content of the sport should be the primary conditioning requirement. Boxing cross training for athletes, particularly those involved in stop/start dynamic anaerobic sports, can act as a useful conditioner. It's also useful for fitness enthusiasts, contributing significantly to calorie burning and all body strength and tone.

Practical implications

- Boxing is primarily a high-intensity anaerobic sport and coaches and boxers must ensure that training reflects this by developing speed, power and strength.
- A number of other sportsmen and women can benefit from boxing based workouts in their routine, especially those whose sports contains bursts of high-intensity work.

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Trunk strength cross training for powerful throwing and striking

At a Glance

- The basic biomechanics and the role of the trunk in throwing/striking are outlined;
- Cross training strengthening exercises to develop appropriate trunk strength are described;
- The importance of skill practice to develop throwing coordination is explained and training suggestions given.

Throwing and striking balls with an object all involve the use of the shoulder and the trunk. As **James Marshall** *explains, a cross training routine that strengthens these areas can not only increase the speed and power of a throw or strike, but also reduce the likelihood of injury*

Coaches often look at a problem somewhere in the body and then concentrate on strengthening that area specifically – for example, the shoulder when hitting or striking. However, sportsmen and women use their whole body in order to generate power at the end of their action and if other parts of the body are not strong enough or have limited range of movement, then injury may manifest itself in the shoulder as they try to overcompensate.

Basic biomechanics

Before knowing what to strengthen and how, it is important to understand the basic biomechanics behind throwing actions.

Figure 1

Throwing with the opposite arm and leg going forward allows pelvis and trunk rotation, increasing throwing speed

Throwing or striking is usually a whole-body action. It's true that there may be times when you have to throw or strike from a more awkward position, such as kneeling, sitting or lying down, but in this article we will look only at optimal delivery.

Competition is hardly an ideal time for the 'perfect delivery', but the Green Bay Packers quarterback Brett Favre was a prime example of this: he was able to provide excellent deliveries while throwing off-balance or across his body.

A study on throwing biomechanics by scientists at Bowling Green University in 2006 looked at 49 children ranging from three to 15 years old, and how well they threw a tennis ball at speed under various constraints. In particular, they looked at different variables in the throwing action and compared them with the skill level of the thrower [1,2].

These variables included:

- stride length;
- time from foot contact to ball release;
- linear and rotational speeds of the trunk;
- the degree of incline of the pelvis;
- the position of the humerus and forearm at time of foot contact.

The study first looked at the trunk and lower limb, then at the forearm and humerus, in 11 different combinations, to assess how the ball was thrown farther and to establish an idea of progression for teaching the throw. A number of findings emerged from the study. For example, the progression of throwing technique gradually incorporated more body parts, each one leading to an increase in throwing velocity and distance. Trunk rotation, speed and linear speed of the pelvis and trunk were also key elements in increasing ball velocity, so it was important to optimise this.

Jargonbuster

Internal rotators of humerus – muscles responsible for turning the upper arm inwards. These include the latissimus dorsi, teres major, subscapularis, and pectoralis major

Eccentric contraction – when a muscle contracts but lengthens under load

It turns out that the throwing action can be performed with just the arm, the same side leg and arm going forward (described as ipsilateral); or with the opposite arm and leg (contralateral). Taking the example of boxing, a jab is ipsilateral and a right cross, contralateral.

The stepping action of either leg results in an increased linear speed of the trunk and pelvis; and the faster the step action, the faster is the linear velocity. Throwing with the same side arm and leg forward helps to increase the linear velocity of the trunk, but reduces the ability of the trunk to rotate. By contrast, having the opposite leg going forward enables the trunk and pelvis to rotate (*see figure 1, left*). A longer-than-normal stride also helps with this rotation.

Figure 2

A longer step results in an increase in forward lean of the trunk, which contributes to the forward velocity of the throwing action

Jargonbuster

Concentric contraction – when a muscle contracts and shortens under load

In the contralateral throw, using the opposite arm and leg forward allows pelvis and trunk rotation, increasing throwing speed.

Tilting the pelvis forward is also important: this helps to increase movement of the upper torso forward after an initial trunk hyperextension caused by the step (*see figure 2, right*). This delay causes the rectus abdominus and oblique muscles to be contracted **eccentrically** during the trunk hyperextension and then rapidly **concentrically** as the trunk moves forward. A delay between the trunk rotating and the upper torso rotating tends to occur in better throwers – this can be seen in the wind-up of major league baseball pitchers[3].

This effect is due to the fact that the initial leg, pelvis and rotational trunk speeds are greater, creating a lag effect. The humerus then has to catch up with the trunk and does so at speed, resulting in an increase in ball velocity. Less able throwers do not generate such fast rotational and linear lower body speed and there is not the same lag effect. This lag is effectively an 'upper body plyometric movement'. The **internal rotator** muscles of the upper arm are first stretched (because the lower trunk has

accelerated away) and then rapidly contract to catch up with the trunk.

You can see this effect for yourself with an elastic band. Cut it in half and hold one end in your left hand. Just using your left hand, flick the band against a wall. Now try the movement again: but this time hold the other end with your right hand, then flick your left hand and, as the band stretches, let go with your right – you will see how much quicker the band moves.

A longer step results in an increase in forward lean of the trunk, contributing to the forward velocity of the throwing action; and the more joints moving at speed that are used in any action, the greater the overall speed of delivery. Increasing an individual joint speed helps the overall action, but just as important is the ability to coordinate all these actions smoothly and efficiently. The more skilled the thrower, the quicker is the chain of movements from initial footstep to release of the ball. Trying to falsely create a lag effect will result in less overall velocity, so there is no point having strength if you do not have the coordination to apply it. A long, quick step with forward pelvis tilt and quick trunk rotation will create a lag effect that causes the shoulder and arm to accelerate quickly before releasing the ball or striking the object.

'The more joints moving at speed that are used in any action, the greater the overall speed of delivery'

Training exercises

Once you understand the basic biomechanics and what muscle groups are responsible for what actions, then you can start performing some cross training to enhance your throwing and striking performance. The connection between different parts of the body has been known for some time; in their classic text *Anatomic Kinesiology*, Logan and McKinney describe the effect of the core musculature as being like that of a Mexican serape[4]. A serape is a Mexican garment that wraps around the body in a criss-cross fashion. The abdominal muscles work together in the same way, and move and support the trunk in coordination with each other, not in isolation.

It therefore makes sense to cross train the trunk as a whole, before looking at individual parts that need specific attention.

Trying to isolate individual core muscles would not only take a lot of time (there are more than 20 different muscles attached to the pelvic girdle); it also doesn't replicate how the body actually works.

Two good examples of whole-body strengthening exercises that work the trunk are the deadlift and the squat. The deadlift is an exercise that requires the athlete to pick up a weight from the floor; the squat requires the athlete to perform a sitting motion with weight on their shoulders. Sitting down and picking things up from the floor are both basic movement patterns that occur in everyday life, and the squat and deadlift are just more strenuous variations on this.

Jargonbuster

1 Repetition Maximum (1RM) – the maximum weight that you can lift once

Ditch the stability ball

Trunk muscle activation in these two exercises is greater than, or equal to, that when performing stability ball 'core' exercises [5]. The researchers in this study looked at muscle activation of the rectus abdominus, external oblique, longissimus and multifidus when performing deadlifts and squats at 50, 70, 90 and 100% of **1RM**, and when doing three different stability ball exercises.

Even at loads of 50% of 1RM, the deadlift and squat had the same muscle activation as that of the stability ball exercises. When the loads increased, there was no difference in rectus abdominus and external oblique activation, but there was in the longissimus and multifidus, both of which are back extensors. The limitation of these exercises is that they are performed in a single plane of movement. Some resisted rotational work would be recommended to work in that plane of movement. For healthy athletes, there seems little point in performing stability ball exercises, when that time could be spent cross training with whole-body exercises that are just as effective, if not more so, and which also work the major muscle groups of the legs.

'For healthy athletes, there seems little point in performing stability ball exercises, when that time could be spent cross training with whole-body exercises that are just as effective, if not more so'

Kneeling down on a stability ball to practise your passing or throwing can actually disrupt your skill or potentially cause injury, because you are inhibiting the ability of the pelvis to rotate and tilt. Trying to throw or strike in this position as powerfully as when standing may increase the shear forces on your upper

Medicine ball programme

The following medicine ball exercises (used in the study described in this article) can be used to develop throwing strength, power and speed:

Hitter's throw – Stand in a normal hitting stance, holding the medicine ball in both hands, level with your back shoulder; then throw it forward with maximal effort, in line with a normal swing.

Standing figure 8 – Stand back-to-back with a partner and exchange the medicine ball behind your back at waist level, as quickly as possible, receiving on one side and returning on the other side.

Speed rotations – Similar to the figure 8s, but this time throwing and catching the ball with arms fully extended, instead of handing.

Standing side throw – Stand in a batting stance, this time with the ball in two hands, at hip height, then throw forward maximally, with hip and torso rotation.

Granny throw – Start by holding the medicine ball in both hands, above your head; lower it quickly between your legs and then, with your backside in a parallel squat position, use your legs and shoulders to throw the ball directly above your head.

Standing backwards throw – Same as the granny throw, but throw the ball up and behind your head.

Squat and throw – Same as the granny throw, but this time start with the ball held at chin height, with your arms extended and the elbows pointing outwards.

NB. All of the rotational throws were performed on both sides of the body to limit the potential of imbalances. For the first four weeks, the athletes performed two sets of six reps with a 5kg ball; during weeks five to eight they did two sets of eight reps with a 4kg ball and for the last three weeks they did two sets of 10 reps with a 3kg ball. The progression was from heavier weights and slower movements to lighter weights and faster movements so that the movements became more similar to the baseball swing.

limbs, due to compensation for the lack of lower-limb involvement. The exception may be the likes of water-polo players, who are more susceptible to shoulder injuries than other throwing sports, due to the lack of ground reaction forces when throwing. In this case, training in positions without the use of the lower limbs would be more appropriate.

Training velocity

Jargonbuster

External rotators of humerus – posterior deltoid, infraspinatus, teres minor

Some fundamental strengthening work needs to be done at slower speeds; but, unless you train at game-related speeds also, your muscles will not be placed under the correct degree of stress necessary for specific development. The velocities created at all the joints are high – perhaps as high as 7,000 degrees of rotation per second in elite throwers [6] – so your training should reflect this. In the deceleration phase of the throw, the force on the humerus can exceed 500N (about 135kg) [7].

Traditionally, shoulder-strengthening exercises have been performed concentrically as part of injury rehabilitation programmes. However, when throwing, the **external rotators** of the humerus and the rotator cuff muscles contract eccentrically during the deceleration phase of the arm, and an imbalance between concentric strength of the internal rotators and eccentric strength of the external rotators can lead to injury [8].

Two studies with female college tennis players and the baseball throw in male college players used eccentric rotator cuff and shoulder training protocols to address this imbalance [9,10]. The female tennis players used elastic bands to create eccentric contractions from the external rotators of the humerus.

The limitation of the study in practical terms was that it did not assess the tennis serve itself before and after the interventions. Instead, the ratio of concentric to eccentric strength was assessed and an assumption made that this would increase shoulder stability and therefore help prevent injury when serving. The eccentric strength work took place only around one joint and in one plane of movement, so an assumption that this transfers to the multi-joint, multi-plane tennis serve needs to be made.

The study with the baseball players also used elastic bands for some of the exercises, but it also used a 2lb medicine ball to provide mass to throw forwards and backwards around a single-joint axis in standing and kneeling positions. Compared with a control group that used only traditional concentric contraction strength work of the shoulders, the plyometric

group improved the velocity of their pitching from 83.15mph to 85.15mph after eight weeks of training. The key point here is that the isolation work on a single joint (with the potential to produce imbalances that could lead to injury) was augmented with strengthening exercises (using a medicine ball) to augment the overall throw.

Full-body exercises

The combination of full-body cross training strength exercises and multi-joint, multi-planar ballistic throwing actions seems to be an effective way of developing the speed and power of throws, swings and strikes. For example, a programme in which high-school baseball players used medicine balls was found to increase their rotational torso strength and angular velocities of the hip and shoulder more than just full-body resistance exercises alone [11,12].

'The combination of full-body cross training strength exercises and multi-joint, multi-planar ballistic throwing actions seems to be an effective way of developing the speed and power of throws, swings and strikes'

The control group just swung a baseball bat 100 times a day, three days a week, for 12 weeks. The full-body trial group used squats, stiff-legged deadlifts, bench and shoulder presses, dumbbell rows, triceps extensions and biceps curls, as well as the baseball bat swings. The medicine ball group protocol consisted of three days a week of doing the resistance exercises, followed by medicine ball exercises. The full-body medicine ball throws were performed on the middle day, when no leg weights were used, so as to avoid fatigue.

Most importantly, the combined medicine ball/strength group improved their bat swing velocity by 6.4%, compared to 3.6% in the strength-only group, compared to no change in the control group.

So why not just do medicine ball throws and technical work? Because there are also other beneficial side-effects of an overall strength training programme, such as reducing the likelihood of injury, or improving performance when running bases, and jumping or diving to catch the ball.

Summary

The problem with research is that it usually concentrates on

just one aspect of the body, when we have seen that the whole body is used in an everyday action such as the throw. Working with one joint, such as the shoulder, enables specific measurements to be taken before and after a very specific exercise protocol is introduced. However, doing so may interfere with the overall movement mechanics. Also, the speed of the joint action during these specific exercises nowhere near matches that of the actual movement, because there is only one joint involved. The sequential effect of using multiple joints is what leads to the massive speed of the shoulder, elbow and wrist during the throw or strike.

Any cross training to develop strength should therefore work on strengthening the overall body with multi-joint lifts; isolating the muscles that are likely to get injured; working with the correct form of contractions in several planes of movement; and using ballistic actions involving the whole body, with the aid of implements such as medicine balls. This must be coupled with skill practice, so that the underlying correct movement pattern is constantly reinforced. If the movement requires the athlete to not be in contact with the ground during the action (*eg* water polo, a volleyball spike, a tennis serve for some players) then the strengthening and throwing actions with medicine balls should not use the lower limbs.

Practical implications

- Sportsmen and women whose sports involve throwing or hitting should be aware that power results from a whole trunk movement - not just shoulder and arm movement;
- Cross training exercises that emphasise full body movement and trunk strength/speed of movement are recommended for developing maximum throwing and hitting power.

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Triathlon – why swim, bike and run cross training is not enough

At a Glance

- The rationale of strength training for triathletes is explained and common concerns addressed;
- The importance of flexibility and stability in a strength programme is outlined;
- Key strength training exercises are presented.

Triathlon may be considered the ultimate cross training sport but according to **Nick Grantham**, *triathletes wishing to fulfil their true potential need to also cross train for musculoskeletal strength and flexibility*

Triathlon is an endurance sport consisting of swimming, cycling and running over various distances. In most modern triathlons, these events are placed back-to-back in immediate sequence, and a competitor's official time includes the time required to 'transition' between the individual legs of the race, including any time necessary for changing clothes and shoes.

While there are various race distances the three most common are Sprint, Olympic and Ironman. Take a look at the breakdown (*see table 1 overleaf*) for each stage of the event and you can see that when it comes to the Ironman competitors, these are no normal athletes!

Shifting paradigms

For most triathletes, the benefits of strength training are

outweighed by the fear of gaining too much bulk, loss of flexibility and diminished 'feel' of their sport. Unfortunately this thinking keeps many triathletes from participating in a properly designed strength and conditioning cross training programme.

'By and large the triathlon community has overemphasised the benefits of endurance-based training and underestimated the benefits of strength training'

Many triathletes tend to have a traditional 'endurance training'-based paradigm, centred on volume of training and time spent training for the actual event itself. It's all about wearing a badge of honour for the number of hours spent running, cycling or swimming. Unfortunately this is a pretty flawed approach, not least because there is a mass of research showing that volume of training is one of the main culprits of overtraining and injury incidence[1,2]

By and large the triathlon community has overemphasised the benefits of endurance-based training and underestimated the benefits of strength training. Triathletes will spend hours completing endurance sessions in the hope that they can squeeze a little bit of extra performance from their cardiovascular system, but are reluctant to spend just a couple of hours a week in the gym.

One heart, two lungs, lots of muscles!

Part of the reason for the above is that many triathletes have forgotten about the huge potential that the musculoskeletal system has to offer to performance and pay scant regard to its training benefits. Let's not forget that the only reason your cardiovascular system is involved in the first place is because of the demand from your muscular system; your muscles don't move because of cardiovascular demand – the demand on the cardiovascular system is elevated because of muscular demand.

If the musculoskeletal system cannot handle the stress of

Table 1: Discipline breakdown for common triathlon events

Event	Swim	Bike	Run
Sprint	750m	20km	5km
Olympic	1.5km	40km	10km
Ironman	3.8km	180km	42.2km

thousands of repetitions (which is what happens when you are training for a triathlon) then you need to condition the musculoskeletal system first. In other words, you should programme your body based on the movements it's going to perform – not based on the cardiovascular system, which is an upside down method of programming!

Strength training in the gym can make a real performance difference via a direct **'transfer of training'** effect into the event. Typically the triathletes that I've worked with have had so little structural integrity that a resistance training programme to target their muscular weaknesses and imbalances had to be our first approach.

The fact is that for many triathletes, moving the body is the biggest problem – not their ability to transport oxygen! I've worked with a number of triathletes who have seen the light and are now benefiting from a structured strength training programme. For years they've been focusing purely on improving their cardiovascular system but more often than not, they've broken down at some point during their season through illness or injury. Using a motoring analogy, they were trying to trying to put a new engine in a beaten up old car with worn out chassis and suspension. A better approach is to set to work on improving the chassis and bodywork first and tinker with the engine later.

Jargonbuster

Transfer of training
A principle that places more importance on doing the training that gives the best result as measured by performance, than on conforming to specificity for the sake of specificity[4]. It is not necessarily about trying to mimic sports movements in the weights room

Setting the programme and shifting the mindset

Triathletes typically cite three main areas of concern when considering cross training for strength:

1. Increased mass – fear of weight gain and subsequent drop in performance is a real worry. However, this is not a problem; a correctly balanced training programme will develop relative strength and power (*ie* improved power and strength to weight ratio) without significant increases in weight;

2. Lack of time – many triathletes are convinced they won't have any extra time to fit strength cross training into their already busy schedule. This is flawed thinking! Many triathletes have lots of time to swim, cycle and run but won't consider adding just a small proportion of strength training into their

Box 1: Benefits of flexibility in cycling discipline

Quadriceps Miles of cycling in the bent-over cycling position can create tightness in the quadriceps and the psoas (hip flexors). Tight quads and hip flexors can pull, creating an anterior tilt of the pelvis, setting in motion a cascade of muscle imbalance. This includes increased arching of the lower back which overloads the muscles of the lumbar spine while at the same time lengthening and weakening the abdominals.

Shoulders and mid-back It's that bent-over cycling position that leads to a rounded upper back causing the shoulder blades to elevate and protract. As a result, the muscles in the chest and upper trapezius become tight leaving the shoulders hiked up and pulled forward. Tight pectoralis major and upper trapezius weaken the mid-back and scapula stabilisers. Weak scapula stabilizers can place undue stress in the shoulder joint during overhead movements, while tight upper traps are a major contributor to neck tension and pain.

Head and neck Cycling posture pulls the head forward. As the head is pulled forward the distribution of its weight shifts and more force is placed on the vertebrae at the base of the neck. A forward head also leads to tightness of the neck flexors and weakening of the neck extensors. This places undue stress on the muscles in the back of the neck and commonly results in neck pain and tension headaches.

training schedule. The key is to make sure that your programme is time efficient – 30-45 minutes duration (maximum);

3. Increased risk of overtraining – triathletes are often (rightly) concerned about overtraining, so there is a very real concern that extra strength work may tip them over the edge. However, the key is to ensure that the strength training sessions are quality focused and don't have too much volume in them. That said, the risk of overtraining is much more likely to arise from hours and hours in the pool or on the road than a couple of 40-minute gym workouts!

Having convinced the triathlete that we can help them, the key is to develop a programme that will have a positive impact on performance. I like to tackle programme design using the following continuum:

Flexibility ⟶ Stability ⟶ Strength

Flexibility

Flexibility, corrective stretching and dynamic movement preparation should play a major role in every triathlete's programme. This is not to say that you need to adopt a 'stretch everything' mentality but you do need to recognise that the nature of the sport means you undoubtedly have to address some flexibility issues before you even think about working on developing strength.

Box 1 (*left*) uses the example of the cycling portion of the event to demonstrate why you may want to prioritise the development of flexibility before moving on to strength.

Putting it together

When we train triathletes, they soon learn that tennis ball and foam rollers are their new best friends. At the start of each session they spend four minutes (two per foot) rolling a tennis ball over the arch of their foot. They place a good amount of weight through the tennis ball, making sure they hit all areas from the inside to the outside and from the front to the back. Why? Connective tissue (fascia) can be a source of tightness and by performing this simple technique we can get a systemic release through the fascial system, priming it for the session that will follow.

They then move on to the foam roll and complete a 'poor man's massage' focusing on the areas that are prone to problems – calves, quadriceps, hip flexors. Once they have completed the foam rolling session, they stretch out any tight postural muscles and other problem areas before moving on to the other exercises.

'Flexibility, corrective stretching and dynamic movement preparation should play a major role in every triathlete's programme'

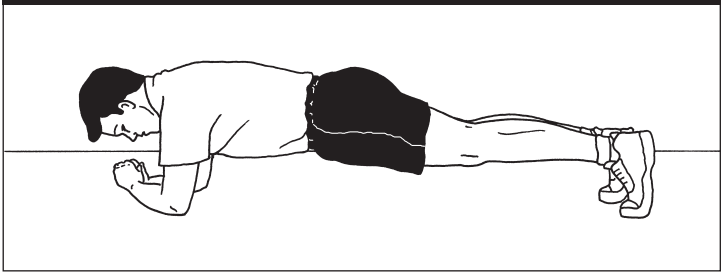
Stabilty training

If I had to choose just two core exercises that produce the biggest bang for the buck, it would be the plank and side holds. Research has shown that these two stabilisation exercises result in far more recruitment of the core musculature than more traditional exercises such as sit-ups *etc*.

- **The plank** is a static exercise for strengthening the abdominals, back and shoulders:

'If I had to choose just two core exercises that produce the biggest bang for the buck, it would be the plank and side holds'

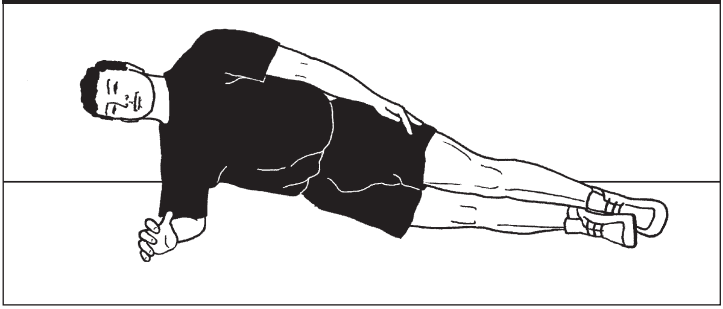
The plank



1. Position yourself on your elbows and toes (elbows under your shoulders);
2. Keep your ankle, hips and shoulders in line;
3. Maintain your back, head and body in a neutral position – think about squeezing your glutes together, tightening your abdominal muscles and pushing your chest away from the floor);
4. This is a static position – so don't move!
5. Hold for 30-60 seconds.

● **Side holds**:
1. Start by lying on your side, legs straight, feet stacked on top of each other;
2. Support yourself on your elbow, keeping it in line below the shoulder, and place free hand on your hip;
3. Balance on sides of feet (feet are stacked) – squeeze your glutes and tighten up through your stomach;

Side hold



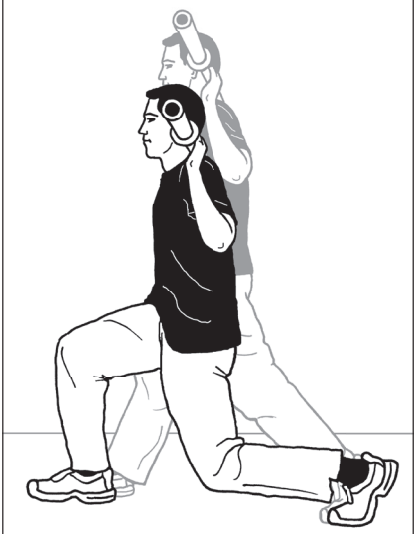
4. Don't allow your hips to drop toward the ground;
5. Again, this is a static position – so don't move!
6. Hold for 30-60 seconds.

Strength training

Here we focus on what the Americans like to call 'big bang for your buck exercises'! These exercises are multi-joint, multiple-muscle group and sometimes multi-planar exercises that recruit considerably more muscle mass than a single joint or machine variation. The box below provides explanations of some of the best cross training strength exercises for triathletes:

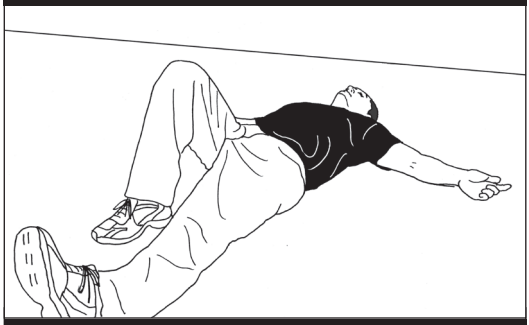
● **Split squat** (you can perform this exercise with bodyweight or external loading such as dumbbells or a barbell):
1. Place barbell on your back or dumbbells in your hand, and take a long step out (the shin of the lead leg will determine the horizontal length of this step during the lowering – keep it fairly vertical);
2. Aim to keep the trunk vertical throughout the movement;
3. The bottom position should be one where the knee of the rear leg is almost touching the ground. The top position should be just short of the end of range;
4. This can be progressed into dynamic and walking lunges once the appropriate level of control, stability and general strength has been achieved.

Split squat

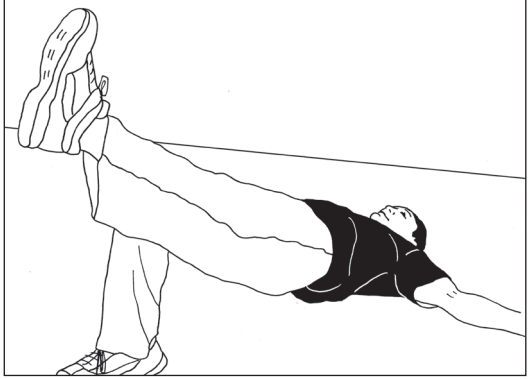


● **Single-leg hip extension** (a great exercise to activate the gluteal muscles; most triathletes have problems activating their glutes as a result of spending so much time in the saddle):
1. Lying supine on the floor, bend your left leg to 90 degrees and straighten your right leg (make sure your toes are pulled up to your shin on both legs);

Single-leg hip extension (start)



Single-leg hip extension (movement)



2. Your arms should be face up at 45 degrees from your body;
3. Now lift your entire body up one inch by pushing off your left foot. This is the start position;
4. Continue to lift your body ensuring you maintain a straight line and your thighs are parallel to each other (the only other parts of your body that are in contact with the floor are your arm, upper back and left foot);
5. Lower to one inch off the floor, pause and repeat for the desired repetition – be sure to keep your hips in a straight line.

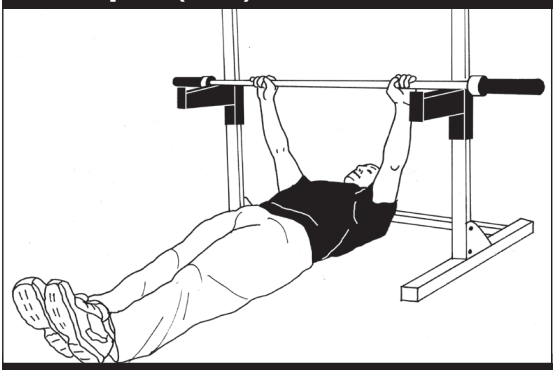
● **Press-ups**

A simple but extremely effective exercise for triathletes, press-ups are not just a great upper-body exercise, but a great exercise for the core (female triathletes note; if you struggle to complete a

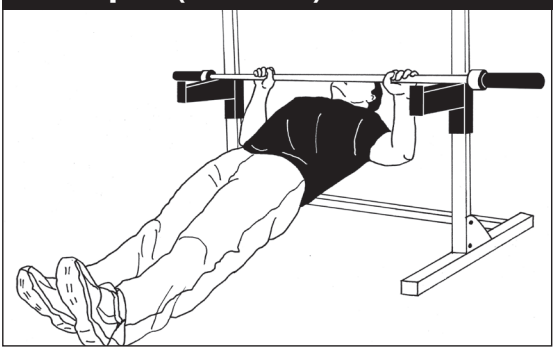
press-up it may have very little to do with upper-body strength and more to do with your core strength – make sure you build planks and side holds into your training). I'm not going to explain how to do a press-up here – you should all know how by now!

1. If you can't do full press-ups, you can start on an incline;
2. If they are too easy simply slow the tempo (see PP 256 *for an explanation of tempo), or try decline, medicine ball or weighted vest variations.*

Inverse pulls (start)



Inverse pulls (movement)



'Second only to press-ups, the inverse pull is possibly the most feared exercise in our training facility'

● **Inverse pulls**

Second only to press-ups, this is possibly the most feared exercise in our training facility. Again this is a horizontal pulling movement that is a total body exercise and which really works the core.

1. Lie on your back under an Olympic bar that is placed in a squat

rack just slightly beyond arm's length;
2. Grip the bar with an overhand grip and pull the upper body to the bar so that the chest touches the bar;
3. Keep the body completely flat throughout the entire movement;
4. Once the exercise becomes easy (this will take some time!) you can increase the difficulty by raising the feet. If it is too hard to start with the legs bent.

Summary

Training the cardiovascular system alone and neglecting the musculoskeletal system and its contribution to performance is a big mistake that will inevitably lead to reduced performance. This article has hopefully provided an insight into how a strength and conditioning cross training programme can help improve a triathlete's performance by addressing not just the strength, but the flexibility and stability requirements too.

Practical implications

- Triathletes should be aware that cross training for endurance alone while neglecting strength a flexible will not allow the development of full triathlon potential;
- Strength training should emphasise basic compound movements of the type described here and be supplemented by flexibility work.

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Inspiratory muscle training – the cross training technique you can't neglect!

At a Glance

- The story of the science behind the development of IMT is recounted;
- The latest thinking on how inspiratory muscle cross training works to enhance performance is presented;
- The practical implications are discussed and examples of inspiratory exercise given.

Since the first reports of an ergogenic effect of specific inspiratory muscle training (IMT) in the mid-1990s, researchers have not only demonstrated its efficacy beyond reasonable doubt, but are also beginning to understand how it works. **Alison McConnell** *takes a look at the latest thinking on IMT as a cross training technique and why serious athletes neglect it at their peril*

Background

For those readers who are unfamiliar with IMT, we should perhaps take a small step back in time to set the stage for the following discussion. In the early days of research in this area, those of us with an interest in ventilatory limitations to exercise performance were viewed with what might politely be called scepticism.

The received wisdom has always been that there is no respiratory limitation to exercise performance; after all, maximal oxygen uptake is not limited by the transfer of oxygen across the lung, but by the ability to transport and utilise it. This being the case, what possible advantage could there be to

Jargonbuster

Maximal oxygen uptake
the highest rate at which oxygen can be transported and utilised by the exercising muscles

Lactate threshold
the exercise intensity above which there is a gradual increase in the concentration of blood lactate (physiologically identical to the MLSS, but measured using a less time-consuming methodology)

Maximum lactate steady state (MLSS)
the highest blood lactate concentration and intensity of exercise that can be sustained over time without continual lactate accumulation[10]

increasing the ability of the respiratory pump muscles to ventilate the lungs? Furthermore, the respiratory muscles were thought to be 'super human', and immune to fatigue, by virtue of their continuous activity throughout life.

The first questions about these assumptions began to surface in the early-1990s, when compelling evidence emerged that the inspiratory muscles (specifically the diaphragm) exhibit fatigue in the same way that other skeletal muscles do[1]. This was followed by evidence that the work and associated metabolic demands of the inspiratory muscles during intense exercise were far greater than anyone had anticipated[2]. Not only that, but the inspiratory muscle would 'steal' blood (and oxygen) from the exercising limbs in order to meet their own metabolic demands[2].

Any coach who was confronted with such evidence would instantly conclude that the respiratory pump muscles were a dangerous weak link and warranted specific training. However, the sport scientists were so bogged down by their preconceptions about there being no respiratory limitation to maximal oxygen uptake that it took a further five years, as well as overwhelming direct evidence, to persuade them that IMT is genuinely ergogenic[3].

How IMT works

What is now emerging from the published literature is a clearer picture of just how IMT exerts its ergogenic effect. Well-conducted studies of IMT had demonstrated consistent changes (or lack of them) in a few key physiological outcomes after four to six weeks of IMT[3]. These included no change in **maximal oxygen uptake**, but reductions in the intensity of breathing and whole-body effort sensations, as well as a lower blood lactate concentration and heart rate at equivalent intensities of exercise. These observations provided some vital clues about how IMT actually works and sparked a series of experiments to test the resulting hypotheses.

Changes in blood lactate concentration are reminiscent of the response to whole-body training, and lead to questions about an increase in the **lactate threshold**. We examined this question

Summary of physiological changes after four to six weeks of inspiratory muscle cross training:

- Improved exercise performance in time trials and fixed-intensity exercise to the limit of tolerance;
- Lower intensity of effort sensations (breathing and whole-body);
- Lower blood lactate concentration at equivalent intensities of exercise;
- Lower heart rate at equivalent intensities of exercise.

specifically in a carefully conducted study that used the most accurate and meaningful index of lactate turnover as the main outcome variable – the **maximum lactate steady state** (MLSS)[4]. If lactate concentration is lower after IMT because the exercise intensity corresponding to MLSS (or the lactate threshold) increases after IMT then we would expect to see a measurable change in exercise intensity at which MLSS is achieved. In short, despite a significant reduction in the lactate concentration at the cycling power output that corresponded to MLSS, we did not observe any change in MLSS power. Our study was capable of detecting changes in MLSS power of as little as 2.5% (6 Watts). Thus, we concluded that IMT cannot operate via a mechanism linked to improvements in the lactate threshold.

Jargonbuster

Vasoconstriction constriction of blood vessels leading to a decrease in their internal cross-section, and an increase in their resistance to blood flow

Changes in heart rate and effort sensations hint that the cardiovascular strain of exercise may be reduced following IMT, but this is not because the oxygen cost of exercise is measurably lower, because this does not appear to change[5]. However, the evidence that inspiratory muscles can 'steal' blood from locomotor muscles led some researchers to examine the interaction between inspiratory muscle work and cardiovascular control during exercise.

In an elegant series of experiments, researchers at the University of Wisconsin identified that when the inspiratory muscles are subjected to fatiguing bouts of work (breathing against an added external load), they provoke a reflex change in vasoconstrictor output to the limbs[6].

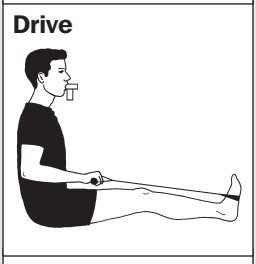
In other words, in the face of fatigue, the inspiratory muscles

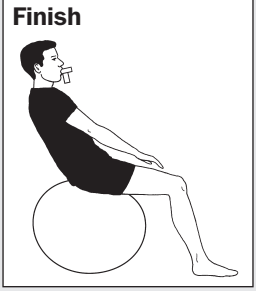
Sport/posture-specific IMT example – rowing

In the case of rowing, I have recommend three exercises that are designed with posture specificity in mind, but they should only be attempted after a four-week period of traditional, upright training to provide an IMT foundation:

Catch – For this exercise, the abdomen needs to be compressed by bending forward from a standing position and grasping the ankles. The knees should be slightly bent and pushing against your abdomen. The required number of inspiratory repetitions (breaths) are then undertaken in this posture using an IMT device. This exercise is very tough and may require a step down in the training load setting on the IMT device when getting started. Emphasis must be given to maximising the volume of each breath, inhaling the breath as quickly as possible, and focusing on using the diaphragm to get maximum benefit.

Drive – Although breathing in during the drive is not to be recommended, ensuring that the inspiratory muscles are capable of rising to this challenge may be advantageous. A high-resistance rubber cord with handles is required for this exercise. The exercise is undertaken in a seated position with the feet together and legs extended. The cord should be wrapped around the feet and pulled (as if rowing); simultaneously, an inhalation is made through the IMT device for the required number of repetitions. A more advanced version of this exercise would be to use a seated row machine weight in the gym to simulate the arm pull of the drive. An upright row with barbell or dumbbells is a further modification of this exercise. In all cases, the inspiratory effort should be made through the IMT device at the same time as you lift/pull the weight/resistance.





Finish – A core stability accessory such as a Swiss ball, or balance ball, is needed for this exercise. The body should be positioned so that the upper body muscles are engaged in postural stabilisation activity, such as sitting on the ball, slightly extended at the hip, with the shoulders leaning back behind your centre of gravity. Next, the required number of repetitions are executed. A more advanced version would be to sit on the ball without the feet in contact with the floor.

signal the cardiovascular control centres to divert blood away from the working limbs. This has a two-fold benefit from the viewpoint of the inspiratory muscles; firstly, it ensures that they get more blood and oxygen (protecting their vital function); secondly, by restricting blood flow to the working limbs, the supply of oxygen and removal of metabolic by-products is impaired, which leads to an enforced decrease in exercise intensity, or even cessation (reducing the ventilatory demand).

The most recent study from this group went on to show that if the work of breathing is manipulated during very intense cycling exercise that the severity of leg fatigue is also changed – if inspiratory muscle work is increased, then leg fatigue is increased, and if respiratory work is reduced (by allowing a ventilator to 'breathe' for the subjects) leg fatigue is reduced[7]. This is entirely consistent with the inspiratory muscles maintaining a high position in the 'pecking order' for the supply of blood flow.

What we believe occurs after IMT is that the enhanced strength, power and fatigue resistance of the inspiratory muscles leads to an abolition or delay in the triggering of the reflex **vasoconstriction**. This mechanism is consistent with all of the physiological changes that arise after IMT.

Practical implications

The first question that most coaches ask me is, 'How long does IMT take?' There are two answers to this: 1) the training itself requires about three minutes twice per day; 2) performance improvements are measurable within four weeks[8].

Until we fully understand the mechanisms (the explanation given above is our best guess at this moment in time) it will not be possible to offer specific guidance on training regimens for different sports. However, what has been identified in the laboratory is a regimen that works for time trials of between six and 60 minutes duration, in rowing[8], cycling[5] and running[9] – *ie* 30-repetition maximum load executed with maximal effort. The latter is important because it ensures that the muscle recruitment is maximal – *ie* as many muscle fibres as possible

are forced to contract against the load.

Aside from the laboratory based research, my dealings with athletes in a range of sports have also led me to identify a number of postural challenges that appear to benefit from 'posture-specific' IMT. For example, the sport I have worked most extensively with is rowing, which is probably one of the toughest sports for the respiratory system.

'From a pragmatic point of view, the obvious thing to do is to train the inspiratory muscles under the conditions where they experience the greatest challenge'

Rowers normally inhale at two points in the stroke (just before the catch and just after the finish), with the largest breath being just after the finish. Both of these points in the stroke impose restrictions on breathing. At the finish, the hips are extended and the shoulders are behind the hips. This means that the muscles of the torso (including the inspiratory muscles) must work against gravity to prevent the rower from falling backwards. At the same time, the rower needs to take a large, fast breath, which means that the inspiratory muscles are subjected to competing demands for postural stability and breathing.

Once the rower reaches the catch, he or she must take another breath, but in this position the movement of the diaphragm is impeded by the crouched body position. At the catch, the thighs push the liver, stomach and gut upwards against the diaphragm, compressing the abdomen. This compression makes it harder for the diaphragm to contract, flatten and move downwards, as it must do in order to inflate the lungs.

Once again, looking at this from a pragmatic point of view, the obvious thing to do is to train the inspiratory muscles under the conditions where they experience the greatest challenge.

Summary

A very successful and knowledgeable coach friend of mine describes the inclusion of inspiratory muscle cross training in his athletes' training as a 'no-brainer'. In his view, there's nothing else that he can add to their training that requires so little time and provides such a large guaranteed benefit to their performance. He coaches indoor rowers, and has taken some of them to World Championship medals, so his opinion should count for something.

Scientists have seen IMT move from being the preserve of heretics (myself included), to a credible and intensely intriguing phenomenon that is now undergoing equally intense scrutiny. The next few years should see IMT really come of age, and as more coaches and athletes gain experience of manipulating the training to suit the demands of their own sports, the greater the benefits should be for sport as whole.

Finally, for the 20% or so of athletes who have asthma, it is worth mentioning that IMT is also becoming a well-established, drug-free method of managing asthma symptoms. Indeed, one IMT device has recently been made available on prescription (POWERbreathe®), thanks to its proven efficacy in clinical trials[11]. So, for athletes with asthma, or those with borderline symptoms that don't qualify for medication in competition, IMT could provide an even greater benefit.

Practical implications

- Two to three minutes per day of inspiratory muscle cross training carried out for 4-6 weeks can produce real gains in performance and should be considered by any endurance athlete;
- For maximum effect, training should be designed to closely replicate the postural demands of your sport.

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Plyometric cross training: footballer's friend or foe?

At a Glance

- The energy expenditure and movement demands of football are considered;
- The potential benefits of plyometric cross training for football training are discussed;
- Recent research on the relative merits of weight training and plyometric training is presented and recommendations made.

Plyometric type training exercises for power and speed are used with great effect in a number of sports. But how useful are they as a cross training technique for footballers? **John Shepherd** *looks at the latest research and comes up with some surprising conclusions…*

Football is a high-intensity intermittent sport. Although players can cover up to 11km in a game, most of this is done in short, sharp bursts lasting seconds, and this performance therefore relies on anaerobic energy, speed and power. Plyometric (jumping) exercises to develop power are used by sportsmen and sportswomen from myriad sports with success. But can they be applied to football and combined with traditional approaches?

A plyometric exercise involves the combination of two muscle contractions coming together to enhance muscular power outputs and therefore speed and power (*see box 1*). Footballers need to posses agility, speed and strength (*see box 2*) and plyometrics are a great way to condition these outcomes. Firstly, let's take a look at some research that has examined the inclusion of these types of exercises into football training.

Swiss researchers examined the effect of surface type (grass

Box 1: Understanding plyometrics

A plyometric exercise is used to develop power and speed and involves the combination of two muscle contractions Specifically this occurs when a **concentric** muscle contraction immediately follows an **eccentric** one. It's a bit like stretching a spring to its fullest extent (the eccentric contraction) and then letting it go. Large levels of energy are released in the split second the spring contracts (the concentric contraction) and this specific muscular sequence is also known as the 'stretch shortening cycle'. There are numerous exercises that can be used to develop a player's plyometric power, such as hops and bounds, **drop jumps** and agility practices.

Jargonbuster

Anaerobic
Energy system for high intensity exercise that doesn't require oxygen

Concentric muscle contraction
When muscles shorten under load – eg the lifting phase of a biceps curl

Eccentric muscle contraction
When muscles lengthen under load – eg when stopping from running and landing from a jump or the lowering phase of a biceps curl

or sand) on residual muscle soreness, vertical jump and sprint performance in 37 footballers [2]. Why residual muscle soreness? Well, if a player suffers from soreness or gets injured and has to be rehabbed back to full fitness, the knowledge of the best surfaces on which to train will be of great benefit to football conditioners, physiotherapists and managers.

Eighteen players followed a four-week plyometric training programme on grass, while 19 followed the same programme on sand. Pre and post-intervention programme, the players were tested on 10m and 20m sprint performance, squat jump and **counter movement jump** ability. Muscle soreness was tested using a questionnaire. The results showed that both interventions improved sprint speed and squat jump performance similarly. However, it was discovered that the footballers performing plyometrics on sand improved their counter movement jump more than those who jumped from the sand. It was additionally discovered that the players who performed their jumps from grass reported less muscle soreness.

In the world of sports conditioning, specificity is seen as key in terms of conditioning drills and practice, and maybe, therefore, jumping from sand could be seen as less relevant than jumping from grass. However, it's not always that simple. To perform a squat jump requires the generation of force from a stationary position, primarily using a concentric muscle contraction in the ankles, thighs and hip muscles. But the

counter movement jump utilises the eccentric/concentric stretch shortening cycle interaction and jumping from the softer surface will slow this down. Basically the sand will 'damp' the explosive capability of the muscles, which explains the reduced adaptation to this training method of the players in that group.

However jumping from sand requires greater strength and this probably explains why the players who performed their plyometrics from this surface improved this jump more significantly. It was as if they were performing their jumps with added resistance, which overloaded their muscles to a greater extent than the grass, producing a resultant increase in strength.

What are the lessons here for football conditioners? Varying the surface from which players perform their plyometrics training could yield physiological and performance benefits, and reduce residual muscular soreness, allowing a player to complete more high-intensity training. However, everything else being equal, it's probably still better that players train on hard dry grass, running tracks or sprung sports hall floors when performing plyometrics. This is because the harder surfaces will help develop a 'quick fire stretch shortening cycle', which will translate into improved on-pitch performance.

Jargonbuster

Drop jump Jump performed immediately on landing after stepping from a box or platform (recommended box height 30-75cms)

Counter movement jump Jump performed with eccentric to concentric movement (knee bend and jump)

Weight training

For comprehensive football conditioning, weight training and plyometrics can be combined. But what kind of weight training protocol works best for footballers? Researchers from Norway examined weight training protocols used by professional football teams [3]. Specifically they wanted to find out whether there was a strong relationship between maximal strength, sprint and vertical jump performance among elite players.

Seventeen international players, with an average age of 25, participated in the survey. They were tested for maximum half-squat, vertical jump and sprint performance over 30m and using a 10m-shuttle run. It was discovered that half squat performance was a key determinant of all test performances and it was also noted that this did not compromise anaerobic endurance as measured by the shuttle run. The researchers

Box 2: The demands of football

In 2003 researchers from Britain looked at the specific movement and energy expenditure patterns of Premiership players[(1)]. In all, 55 players from 12 teams – all internationals with an average of 36 caps for their respective countries – were observed around the pitch using a player cam. It was discovered that the players spent about 40% of their time on the pitch performing 'purposeful movements' – that's time spent running at various speeds and performing football specific movements and skills.

When this purposeful movement was further analysed it was discovered that strikers, midfielders and defenders spent 48.7% of their time moving directly forward, 20.6% not moving in any direction at all and 30.7% performing football specific movements and skills. Table 1 breaks this information down further into movement types:

Position-specific movements of Premiership players (% of time)			
Movement	**Striker**	**Mid-fielder**	**Defender**
Standing	5.3	2.1	6.3
Walking	14.1	12.8	15.8
Jogging	24.7	28.3	31.5
Running	11.1	14.6	7.6
Sprinting	5.5	6.4	2.5
Skipping	8.3	9.1	12.3
Shuffling	9.5	7.9	10.5
Other	21.5	18.8	13.6

The researchers then went even further and looked at the specifics of the 'other' movements, such as turns and even the degrees through which the players rotated, including how many were made to the left and to the right. In all it was determined that 726 turns were made by all player groups across a match with 69% of these being between 0 and 90 degrees. All outfield players made an average of 111 on-ball movements.

As you'll see from the table it was discovered, for example, that strikers made more 'other' movements than mid-fielders or defenders. And more of their turns were between 270 and 360 degrees, reflecting the spins and turns they need to make to shake off defenders and free up space up front.

By contrast, defenders made more backward runs and feet forward dives.

Strikers not surprisingly (because of the feet first antics of the defenders!) had to absorb the most physical punishment. They also performed the highest intensity activity, for example, stopping and swerving. Midfielders did the most running with around 11km per match compared to the 10km of strikers and defenders, and also made the most forward runs and passes.

These results (and similar research) indicate specific training demands. For example, a striker needs to be physically strong and powerful and the training should reflect this. More specifically, they will also need to maximise their turning ability. Plyometric training would therefore appear to be a key training ingredient both for strikers and other players.

concluded that '*elite soccer players should focus on maximal strength training, with emphasis on maximal mobilisation of concentric movements*' *(see box 3, overleaf*).

Power combination cross training

Power combination training combines plyometric and weight training exercises into the same workout. The exercises are usually paired and must work the same muscle groups. Typical examples include the squat jump and half squat, and the split jump and the single leg press. Loadings on the weights exercises must be in excess of 70% of one repetition maximum (1RM). This is to ensure that the exercise targets large numbers of fast twitch fibres (a lighter weight would tend to emphasise slow twitch fibres – which have an endurance role and are consequentially much less likely to contribute to power, speed and strength development).

Power combination workouts have been shown to enhance the power outputs of fast twitch muscle fibres within the workout and over a training period. This is believed to occur as a result of 'potentiation', which is essentially heightened neuromuscular activity in the relevant muscles. The net effect is that an athlete is able to recruit larger numbers of fast twitch muscle fibres without conscious effort, thus boosting their power output.

However, there is some research which argues that this

Box 3: Maximum strength training

The inclusion of heavy load, low-repetition weight training is increasingly recommended for sportsmen and women in power sports. In many ways this recommendation comes from the work of Tudor Bompa – one of the world's foremost conditioning experts [4]. Bompa believes that optimum performance is not possible unless an athlete follows what he calls an 'MxS' of maximum strength training phase. He argues that this phase enables the athlete to recruit larger numbers of their fast twitch (speed and power) producing muscle fibres.

This type of training should be performed as dynamically as possible given the heavy load, but with adherence to strict exercise form. Long recoveries (3-6 minutes) should be taken between sets of 1-4 repetitions to enable the athlete to apply maximum effort to each lift. It should be noted that the intensity of this training is very high; footballers (and all other athletes) should progress systematically to being able to handle such loads over time using a properly constructed training programme, which allows gradual progression to these high intensities.

'Heavy strength training leads to significant gains in strength and power-related measurements in professional soccer players'

method of training may be less beneficial for football players. Norwegian researchers looked at power combination training methods and their effects on professional players [5]. Six players were assigned to a heavy weight training group, who also completed 6-8 specific football sessions a week, whilst 8 players performed plyometrics as well as the heavy strength work and the football sessions. A control group just performed the 6-8 weekly soccer sessions.

The pre- and post-intervention tests used by the researchers included maximum half squat, counter-movement jumps and peak power in half squat with 20kg, 35kg, and 50kg loads (basically the players' speeds of movement were measured during the half squat with these weights and their power outputs measured). In terms of sprint speed, acceleration, flat out speed and 40m times were tested.

The result showed that there were no significant differences between the footballers who had performed the power combination training or the heavy squats only. As a result of these findings, the researchers decided to create just one intervention group with players performing heavy weights and

plyometrics. Again, a control group just performed a comparable number of weekly football sessions. The power combination training footballers showed improvements across all tests, except the counter movement jump. These improvements were deemed to be significant for the half squat 1RM and sergeant jump for example. However, non-significant differences were seen on the half squat power tests with 20kg and 35kg loads and all of the sprint tests.

'The power combination training footballers showed improvements across all tests, except the counter movement jump'

This led the researchers to conclude that, *'there are no significant performance-enhancing effects of combining strength and plyometric training in professional soccer players concurrently performing 6-8 soccer sessions a week compared to strength training alone. However, heavy strength training leads to significant gains in strength and power-related measurements in professional soccer players'*.

How can these findings be reconciled with the fact that much other research indicates that power combination cross training works? Simon Thadani is the conditioning coach at Ipswich Town FC, and believes that football conditioners must be conscious of the training that players are doing with the football coaches and that this must all be assessed and added to the overall training load on the players.

He provides the following real life scenario: '*One of the football coaches took away several of the defenders for half an hour to concentrate on heading. I watched the session and observed that each player ended up doing 150 plus headers. I therefore decided that the players had done enough and did not need to do the afternoon session, nor plyometrics the next day*.'

Basically, what Simon is noting is that the football sessions were conditioning the jump performance of the players without them having to do a specific jumping workout. This might explain the findings of the Norwegian researchers above; a crucial consideration for football conditioners (indeed conditioners of all high intensity intermittent sports) is that the physiological demands of the sport itself (both through training and competition) cannot be overlooked as a contributor to the overall training and conditioning load.

Conclusion

Developing the maximum power capabilities of footballers is crucial for maximum playing performance. Although plyometric exercises tick all the right boxes in this respect, it would appear that heavy weight exercises, notably the half squat, are perhaps even more effective as part of a properly constructed training programme.

Plyometric exercises, as a cross training technique, may be more beneficial in pre-season and from an injury prevention perspective (in terms of mastering improved technique and strengthening relevant muscles) in a controlled environment. And, finally, when plyometrics are used, conditioning coaches should also be mindful of the surface on which they are performed, in terms of training response and potential muscle soreness.

Practical implications

- Although plyometric exercises tick all the right boxes for speed and power development in football, conventional heavy weight training appears to be more effective and should thus be considered the first choice of ancillary training for footballers;
- Controlled plyometric work should be considered as a useful off-season mode of training, particularly for developing improved technique and building injury resistance;
- Coaches and athletes should be aware that the surface on which plyometric exercises are performed will have an impact on the conditioning outcome.

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Grounded! Land-based cross training for explosive swimming performance

At a Glance

- The importance of the 'transfer of training' effect is discussed for swimming conditioning programmes;
- Four basic exercises for developing explosive strength and power in swimmers are described;
- The principles of combining strength exercises into a coherent programme are outlined.

In the quest for performance, swimmers typically cover thousands of metres in the pool with nothing more interesting to do than look at the ceiling or bottom of the pool. But according to **Nick Grantham**, *a properly designed land-based cross training strength and conditioning programme is essential too, and simple circuits on the poolside are not enough*

Land work for swimmers is becoming increasingly popular, although it is by no means a new concept. Researchers and swim coaches have been expounding the virtues of 'land-based' training since the late 1970s[1-6] However, many 'land-based' cross training programmes that I come across simply don't hit the mark when it comes producing a really positive impact on performance.

Most coaches pay lip service to strength training by simply 'bolting on' a circuit session at the end of one of their pool sessions. Although well intentioned, they try and cover everything from injury prevention and rehab through to power development in one 30-minute training session a week. This is better than nothing and can be a good starting point. However, the purpose

Jargonbuster

Bilateral
Exercises that involve both sides of the body (usually both arms or both legs working at the same time, *ie* squats)

Track start
For the track start, the swimmer places one foot forward with toes over block edge while the other leg/foot is behind

Posterior chain
A group of muscles in the lower body that are important in force development for explosive movements like jumping and sprinting (hamstrings, calves, glutes and lower back)

Relative strength
A term used to denote an athlete's strength per unit of bodyweight

of this article is to provide you with an overview of some of the key strength and power development strategies that coaches and swimmers can implement to get maximum bang for their buck.

Sport-specific vs transfer of training effect

Before we discuss the areas that can have the largest impact on swim performance, we need to clear a couple of points up. Sport-specific work is the best way to get better at that sport; if you want to be a better swimmer, then swim! But how can you make additional gains when you have maximised your swim time? One way is to add 'land-based' training. However, the big problem is that coaches often fall into the trap of being too 'sport specific' when designing their strength training programmes.

The main problem with developing exercises that are really sport specific is that you may be in danger of harming the one thing that you want to improve – swimming technique and performance. For example, an ambitious young coach that I once worked with had developed some sport-specific drills replicating the swim strokes in the gym – so much so that he even set a metronome to the exact stroke rate used by the swimmer in the pool to perform each repetition of the strength exercise!

But by getting so close to the actual movement pattern in the gym, you may actually start to interfere with the neural patterns being laid down during swim training and actually make the swim stroke worse. If you want swim-specific strength therefore, do it in the pool. Research supports the use of resistance devices in the pool such as the use of a tether, or rope with a sponge attached, *etc*[7]. But just lying on a bench in a gym trying to replicate your freestyle stroke to the sound of a metronome is wasting time and effort. What you should actually be thinking about is the 'transfer of training effect' – *ie* what cross training can I do that will have transfer over to improved performance in the pool?

Where can the strength coach make a difference in the pool?

Research shows that decreases in swimming speed throughout a race are the result of decreases in the power-producing

capacity of the swimmer (fatigue) and swim performance[8]. However, while this is an important area to consider when developing a swimming strength training programme, my experience working with elite swimmers indicates that there are two main areas that strength and conditioning coaches should focus on – starts and turns.

'My experience working with elite swimmers indicates that there are two main areas that strength and conditioning coaches should focus on – starts and turns'

The training methodology here will not only improve your swimmers' explosive power so that they can get off the blocks at the start of the race and explode off the wall at every turn, it will also have a positive impact on power production during the actual stroke, as well as injury prevention and rehabilitation. Research carried out in the former Soviet bloc confirms that explosive strength is vital for the swimmers seeking a fast starting take-off, and strong push-offs with the legs on the turns[9].

How do we improve strength and explosive power?

Almost all muscles are used in swimming, from the top of your head to the tip of your toes. This is exactly how you need to develop the strength and power required to get off the blocks and out of the turns as quickly as possible. Isolation exercises are a waste of time, because this is not how the body works. Box 1 (*overleaf*) provides just four exercises that all help develop explosive starts and turns.

You will note that all of these lifts are **bilateral**. I've assumed that you will have already developed appropriate levels of unilateral strength before embarking on these more advanced techniques. If you adopt the increasingly fashionable **track start** for getting off the block then you will want to include several unilateral versions of the lifts described in this section to increase the transfer of training effect.

Olympic lifts

We can't talk about explosive power development for swimming without discussing Olympic lifts. A lot has been said about the efficacy of Olympic lifts (clean, jerk and snatch), and whether or not they have a role to play in the development of sport-specific power.

Box 1: Core lifts

Squat (front or back)

While there are many variations, the basic squat is the foundation for nearly every functional movement involved in developing the all-important 'triple extension' required for fast starts and quick turns. Not only do you get all of the benefits of the more traditional back squat but you also start to train the recovery phase of the power clean (another core lift for developing explosive power):

1. With the barbell resting in a squat rack, grasp the bar with an overhand grip and step under the bar, placing it on your collarbones and shoulders;
2. Maintain a full grip on the barbell – do not rest it on your fingertips;
3. Continue to perform the squat pattern as you would a normal back squat;
4. The position of the bar allows you to maintain a better back position, develops the recovery phase of the power clean and focuses development on the quadriceps.

Deadlift

Another great exercise for developing the strength needed to go from a 'dead' start, as well as being the start point for the key Olympic lifts such as the power clean. Deadlifts are a simple exercise really, made difficult by over-trying and over-thinking:

1. Stand before the weight in a solid, shoulder-width stance (may be up to six inches wider), shin to the bar;
2. Bend at the waist and knees equally, and at the same time;
3. Grasp the bar fully and securely in an over-grip or an alternate under/over grip about waist width (may be up to six inches wider for comfort);
4. Looking straight ahead, your spine in a powerful flat position (not stooped over or rounded), steadily pull the bar and stand up;
5. Keep the bar close to the body throughout the lift;
6. Pause for a second of contraction and slowly bend your knees and lower back as you return to the starting position.

Jump squats

The jump squat is a great exercise in its own right, but can also be used with a conventional squat as part of a squat 'complex' or 'superset' (*ie* perform a set of squats and then, with minimal rest, perform a set of jumps squats). Using

complexes allows you to develop the strength qualities of the lower body using the squat and then exploit the explosive properties of the lower limb using the explosive squat. You can use bodyweight or external loads (barbell/dumbbells), just make sure you don't compromise technique for load:

1. Stand with your feet shoulder-width apart;
2. Sit back into a squat;
3. Jump up so that both feet leave the ground;
4. Land with your knees bent to absorb the impact;
5. Pause, reset your body and repeat.

Stiff-leg deadlift

This is an advanced lift and requires great hip/hamstring flexibility and the ability to maintain normal spinal curvature. It's an excellent choice for developing the swimmer's **posterior chain**.

1. To perform the lift, deadlift the barbell from the floor;
2. After standing, slightly flex your knees, lock your spine, and slowly bend forward at your waist by flexing your hip as far as you can without losing your normal spinal curvature;
3. Once you have lowered the bar as far as you can, reverse the direction and raise the barbell by hip extension back to the start position.

I like to use these lifts with swimmers, but they are advanced lifts. If you are not confident in the coaching of these advanced lifts you will still be able to develop power using the four lifts outlined in box 1. Olympic lifts are important for developing triple extension but it is important to realise that they are not the be all and end all.

Programming

Simply having a collection of exercises that you can use as a coach to develop your swimmers' strength and power is a bit like having a recipe and only knowing the ingredients. What you need to know is how to put it all together – how much of each ingredient should you use, in what order and for how long.

The key thing to remember when putting together a

Box 2: Programming principles

Sets

When developing strength and power, your swimmers should be working low reps, which means they will be able to use more sets. You should be looking at no more than 20 sets per training session, which limits swimmers to about seven exercises per training session (that's why you need to pick exercises that are whole body to give you maximum impact). Remember you are not 'isolating' muscles, so there should not be lots and lots of exercises in this type of programme.

Reps

Your swimmers will be working within the one to eight rep range. If they are developing 'absolute' strength they will work at the top end of the rep range (between five to eight reps). To improve their **relative strength**, they will need to be working at the bottom end of the rep range (between one to four reps). The total number of reps for a session will be between 12 and 100 reps.

Recovery

Strength and power development is intense. The very nature of this type of training requires greater recovery periods for the musculoskeletal and neural systems. Anything from two to five minutes' recovery between sets is acceptable.

strength programme for a swimmer is that it is not your job as the strength and conditioning coach to overload the swimmer with even higher volumes of training. Your swimmers' strength programmes should focus on developing strength and explosive power, which means high-intensity and low-volume training. Box 2 (*above*) shows how these exercises can be combined.

Training tempo

Most programmes I see begin and end with the three programming principles given in box 2. A lot of coaches neglect the importance of lifting tempo. For muscles to develop strength, they need to spend time under tension (TUT). Tempo is simply a method that good coaches use to adjust the duration of the rep (*ie* TUT).

It is typically written as a three digit formula: Eccentric:

Table 1: Example of conditioning programme for an elite breaststroke swimmer

Session One (40 minutes)			**Date:**							
			Record weight lifted for all sets							
Exercise		**Comments**	**Rep/set**	**Tempo**	**Rest**	**Weight**				
1	High pull	Warm up	5-5	X	60					
2	Power clean	Feet spacing at start, shoulders in front of bar	4-4-4-4	X	180					
3	Front squat	Weight through heels, finish with hips	5-5-3-3	10X	120					
4	Stiff-leg deadlift	Maintain back posture	5-5-5-5	20X	120					
5A	DB bench press		5-5-5	11X	90					
5B	Inverse pulls	Keep arms straight, controlled lowering of bar	5-5-5	112	90					
6										
7										
8										
9										

NB – in reps/set column, each set is listed; eg 5-5-3-3 is two sets of five reps followed by two sets of three reps

Isometric pause: Concentric. When it comes to strength development the TUT for a lift may look like 2 0 1 (three-second lift with a longer eccentric phase, no pause and a quick concentric phase. If performing an explosive movement you may simply use an 'X' to indicate that the exercise is performed as quickly as possible.

Is the use of tempo necessary? Some will argue that it over complicates the programme, but my argument is that at the very least it informs the coach and swimmer how you want the reps to be completed. There is a huge difference in training effect if you complete a squat with an X 0 1 tempo compared to a 3 2 3 tempo. The first will develop explosive strength; the second will develop control and stability.

Putting it all together

Table 1 shows an example of a typical cross training programme that I've used in the past when working with elite swimmers. The obvious thing to note is that there are no 'sport-specific' exercises in this programme (no metronomes, no breaststroke movements), but there are plenty of exercises that will have an enormous transfer of training effect over to the start and turns.

This programme was for an elite breaststroke specialist developing relative strength. As you can see it adheres to the principles discussed in the previous sections:

- Exercises – just six exercises used in this session. The exercises included Olympic lifts and their assistance exercises such as high pull, front squat and stiff-leg deadlift;

- Sets and reps – the inverse relationship between sets and reps is observed with no more than four sets of each exercise performed;

- The inverse relationship between number of sets and number of exercises is also observed with no more than 20 sets spread throughout the six exercises.

Summary

This programme should only act as an example of how you put the 'ingredients' together. It was developed for a specific swimmer, but it's highly likely that this programme would have limitations if replicated in its entirety with all your swimmers.

However, as a coach you need to start thinking about how dry-land cross training can influence swim performance, decide on the exercises you are going to use to develop the appropriate strength and power qualities, before finally putting it all together using the training principles outlined in this article. Circuit-based training sessions still have a place in the overall swimming programme, but you should be thinking about incorporating some of the lifts outlined in this article into a specific strength and power training session.

Practical implications

- Land-based cross training to build strength in swimmers provides real benefits and is usually preferable to simply adding more and more swim training volume;
- A land-based programme should be aimed at developing transferable strength and power with a few key exercises, and should not try to replicate swimming movements.

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Concentration training; the ultimate cross training tool for life in the fast lane!

At a Glance

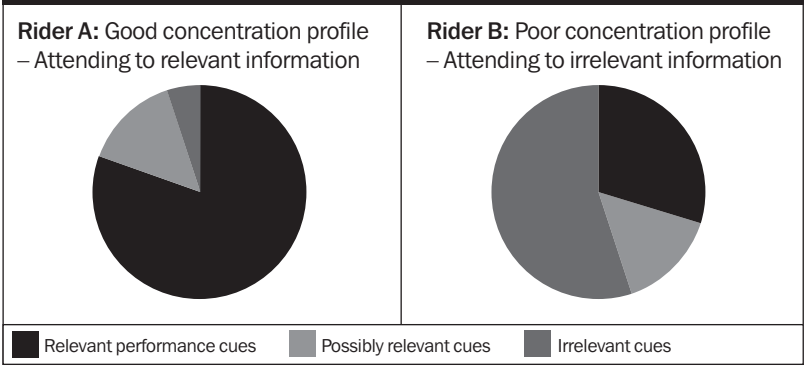
- The importance of concentration for accurate and rapid decision making in motorsport is outlined;
- Concentration styles associated with success are explained;
- Practical methods are given for developing concentration skills.

Concentration is crucial for success in many sports and as **Andy Lane** *explains using motorsport as an example, a bit of 'psychological cross training' can reap real dividends for those under pressure!*

Success in motorsport requires high-level decision-making skills [(1)]. It also involves managing risk, as racers place their lives at risk in pursuit of sporting success. Although physical danger is an antecedent of anxiety, many athletes indicate that their primary source of anxiety relates to a desire to achieve personal goals [(2)].

Motor sport racers are no different. This perception might seem counterintuitive when the apparent dangers of the sport are considered. Winning racers go faster than their less successful counterparts, and, in doing so, must take greater risks. As a result, the winning racer is faced with many decisions on how fast to take certain sections of the course and, as each section carries a risk of falling off or crashing, racers need to make split-second decisions at speed, where the margin for error is minimal.

Figure 1. Concentration profiles of two riders



What is concentration?

Concentration is a term used in everyday language. In post-event interviews with high-profile athletes, a failure to concentrate is a commonly cited explanation for poor performance. Not surprisingly therefore, concentration is a concept the layperson feels that they understand immediately. However, improving concentration skills is not simply a case of trying harder to concentrate. It is a case of knowing what to concentrate on and focusing attention on these factors.

Concentration is defined as *'the process by which all thoughts and senses are focused totally upon a selected object or activity to the exclusion of everything else*[3]*.'* It is worth emphasising here that concentration is a process that changes over time and that maintaining the intensity and focus of concentration requires effort. Recognising this factor is important because it means that concentration can vary in both intensity and focus. We can be focusing on the key parts of performance at one moment, but be distracted the next. It also suggests that expressing concentration in terms of a percentage is a helpful way of examining the concept.

The percentage of effort given to focusing on relevant cues is important. Figure 1 (*above*) graphically illustrates the concentration profile of two racers. Both racers are concentrating equally hard, but, while one racer is focusing predominantly on

relevant cues, the other is focusing on irrelevant performance cues. The key skill is to be able to identify the relevant performance cues at each moment of competition.

Given similar physical and tactical skills, and provided both racers were matched for equipment, Racer A is likely to win in a race-off. Racer A will be able to respond immediately to attacks, take corners using the best line, identify risks within the course, such as potholes, being blinded by the sun, and so on.

'As emotions intensify, both relevant and irrelevant cues are ignored, and performance begins to deteriorate'

Dimensions of concentration

Anecdotal reports from post-race analyses of racers often reveals the phrase 'I needed to concentrate more' being cited as a reason for poor performance. Thinking of concentration as a single phenomenon is not helpful. As a starting point, it can be broken down into broad versus narrow and external versus internal concentration. This leads to four possible combinations, revealing four different attentional styles (*see figure 2 below*).

It is important to highlight that all four attentional styles, are useful at times, and racers need to be able to switch attentional styles. Clearly, racers need to be able to switch attention – a broad-external style is useful for planning and deciding when to attack, a narrow-external style is needed to deal the vehicle immediately ahead of you. Examples of concentration errors applied to motor sport are described in table 1 *(overleaf)*.

Figure 2: Characteristics of different concentration (attentional) types

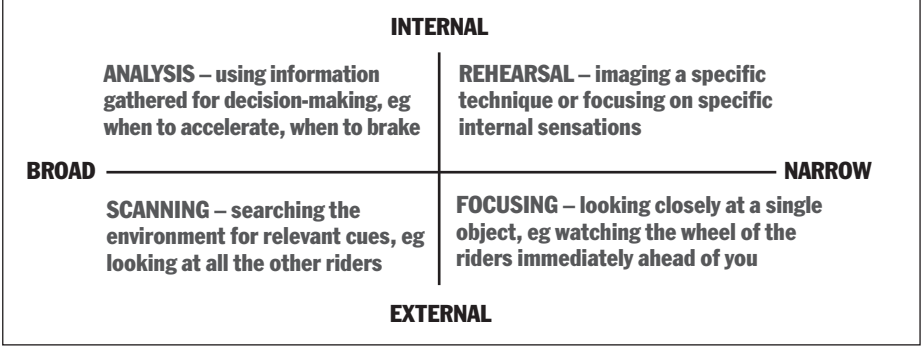


Table 1: Examples of errors in concentration applied to motorsport

Concentration category	Examples of errors in concentration			Your turn. Think back to when you lost concentration. Categorise errors into the four categories. You might find that you are prone to one type of concentration error
	Example 1	Example 2	Example 3	
External focus too narrow	*Failure to notice an opponent*	*Failure to notice course conditions*	*Missing important performance related details*	
External focus too broad	*Failure to focus on the racer in front of you*	*Making simple errors, gear change errors, going over bumps, racers slowing down in front*	*Attending to unimportant detail*	
Inappropriate narrow internal focus	*Saying negative things to yourself*	*Becoming fixed on a particular thought or feeling and missing important things going on around you*	*Worrying about a recent mistake*	
Inappropriate broad internal focus	*Over-analysing situations*	*Not racing in the here and now, ie going over the past in your mind or anticipating the future*	*Daydreaming*	

Concentration and performance relationships

Many factors influence concentration. Motivation to succeed in the task is clearly important, and, when individuals increase effort, they tend to focus more sharply on the task-at-hand[4]. Identifying relevant concentration cues is difficult. In fast changing motor sports, there are a multitude of different cues that person could be attending to. Reflecting on how to improve performance in terms of developing concentration plans can be helpful.

By reflecting on performance after each race, a racer can evaluate whether he or she was concentrating on relevant or

irrelevant performance cues. Likewise, athletes should set concentration plans as goals for future races. If athletes set goals to concentrate on key performance cues and improved their skills accordingly, then improved performance should follow, since improved concentration and performance go hand in hand.

Emotion-concentration interplay

Emotions influence concentration. As emotions intensify, concentration tends to narrow. Initially, increased emotions, such as anxiety and excitement, can be helpful for concentration. Anxiety is characterised by feelings of nervousness and tension, coupled with negative thoughts about performance. Excitement is characterised by feelings of adrenaline and liveliness, coupled with optimistic thoughts on performance success. Both excitement and anxiety affect concentration in a similar way. Initially, high arousal narrows attention, making it easier to ignore irrelevant cues, with performance improving accordingly. However, as emotions intensify, both relevant and irrelevant cues are ignored and performance begins to deteriorate.

Individuals need to be able to control their emotions to reduce the risk of poor decision-making. For example, consider the case of a racer, overtaken because of lapses in concentration, who subsequently becomes angry. The racer may then increase efforts to reovertake. However, individuals tend to take poorly calculated risks when over-aroused, as their attentional control becomes clouded.

'Intense and emotional states, such as anger and tension, lead to taking poorly calculated risks with a low chance of success'

To illustrate how this can be detrimental to performance, we looked at the relationships between emotions and performance in subjects who filled in a concentration grid [5]. (This is a numerical grid of 100 numbers that have been randomised, and is a simple method of assessing narrow-external concentration. The individual is asked to circle numbers in order, starting from an arbitrary number.)

We were interested in the effects of unpleasant emotions, such as tension and anger, on concentration. Specifically, we were interested in whether increased anger and tension were

Table 2: Examples of key performance cues and concentration

	Before the race	Early stages of the race	Middle of the race	Nearing the end of the race
How you felt	'Nervous, uncertain'	'Angry'	'Excited', 'Happy'	'Fatigued'
Your go				
What you were thinking (concentrating on)	'I need to win this race to maintain funding' 'Selectors are watching'	'Poor start, felt I was cut up. Wanted to overtake [name]'	'Made up lost ground due to errors in opponent. On the wheel of leader.'	'Struggling to maintain speed, arms exhausted.'
Your go				
How I would like to feel	'Excited and nervous'	'Relaxed', 'Control'	'Excited', 'Relaxed' 'Control'	'Excited, relaxed, fatigued (I have given my all)'
Your go				
What I would like to be concentrating on	'Poised, like the machine and I are one'	'Learning to ride the course as fast as possible'	'Focusing specifically on the here and now'	'Focusing specifically on the here and now'
Your go				

helpful for performance in a task requiring a narrow-external concentration style. We used a group of who scored high on a standardised competitiveness personality scale. The group completed a series of concentration grid tests. We manipulated emotions by having half the group perceive that they performed poorly after completing the first concentration grid test, with the other half believing they performed to expectation.

As expected, students who performed poorly reported increased anger and tension towards the next concentration grid performance. Subsequent emotion-concentration grid relationships showed that high anger was associated with a range of unpleasant thoughts and other emotions, and also poor concentration performance. Specifically, anger was

associated with unsuccessful performance coupled with feelings of fatigue and depression.

The key point is that athletes need to recognise the effects of changes in emotions during performance. One of the most powerful effects of changes in emotions is on the control of attention. In this study, athletes needed to engage in strategies to regulate their anger, refocusing thoughts before completing the next concentration grid. Athletes who managed their emotions successfully demonstrated better concentration.

'Research shows that emotions influence risk-taking behaviour; intense and emotional states, such as anger and tension, lead to taking poorly calculated risks, with a low chance of success'

Risk-taking

Taking risks is a necessary element of a number of sports. Risk is the probability that a difficult situation will turn into a success or a disaster. In motor racing terms, risk is the balance between attaining sporting goals against incurring possible personal injury. Motor sport racers will push the boundaries of risk during competition. It is important to recognise the concentration skills of elite racers. The ability to make accurate decisions at speed requires knowledge of the likely consequences of making a poor decision. Elite racers identify parts of the environment that can influence their performance much earlier than novice racers. Further, they have learned to deal with difficult tasks through repeated success.

Research shows that emotions influence risk-taking behaviour. Intense and emotional states, such as anger and tension, lead to taking poorly calculated risks, with a low chance of success. People take much greater risks when highly emotional. Further, they take risks with a low chance of success. If a racer becomes angry because of being overtaken, his/her goal becomes to reduce anger by re-overtaking. This is, of course, a normal thought for motivated people. However, it is important to assess course conditions, the capability of the equipment, and the physiological state of the other racer when deciding when to overtake. If goal directed behaviour is focused on reducing anger by achieving a highly difficult goal, it is possible that poor performance will result due to over-arousal.

Arousal that is beyond the optimal level for the individual is associated with missing key performance cues. An awareness of the tendency to become highly emotional, and its impact on concentration, emphasises the value in learning strategies to manage concentration.

Concentration training

Think back to a recent competition in which you performed well, and try to immerse yourself in how you felt and thought during this race. Spend some time doing this, and then write down how you felt at the start, in the middle, and near the end of the race. For example, if you felt nervous at the start, consider why you felt nervous. It might be that the race was very important, or it might be that you had set a challenging and, possibly, too difficult goal. It is common for athletes to become anxious when trying to achieve highly important and highly valued goals.

After you have done this, write down what you should be thinking about at the key stages in your next race. It might help if you picture yourself as a super elite racer and then ask yourself the question, 'What will *they* be thinking of'? Write down what you think are the key performance cues to ensure success – these cues should be your goals for performance (*see table 2 on previous page*).

If you can direct all of your concentration to these performance cues, it is likely that successful performance will take care of itself. You need to be immersed completely in focusing on the key points needed in order to deliver the task successfully.

Self-talk focusing on concentration

Self-talk is a useful strategy to help a number of psychological concepts. In this instance, self-talk is used to improve concentration skills. An 'if-then' approach has been shown to be an effective method of aiding concentration [6].

Self-talk is effective when it is used frequently, and individuals need to remind themselves that positive self-talk can lead to positive emotions. It is worth emphasising that this should be an

Table 3: Self-talk associated with self-doubts on the start line

Aspect of skilled performance	Key performance cues	Distracters	Self-talk reminders
Anxiety that I will make poor decisions when fatigued.	Feeling fatigued near the end of the race. Associating poor performance with fatigue and poor decision-making.	Concentrating on symptoms of fatigue and subsequently slowing down or not taking corners assertively.	'If I feel fatigued, then I will focus on relaxing my shoulders.' (Or another part of the body that should be relaxed.) 'If I feel fatigued, then I will remind myself of times when I overcame fatigue to be successful.' 'If I feel fatigued, then I will concentrate on specific performance cues, focusing everything on how to be effective over the next 30 seconds.'

active process, whereby if-then rules are used on a daily basis and spoken out aloud as a strategy to reinforce your personal commitment to using them. Table 3 shows an example of if-then self-talk to help with self-doubts on the start line.

Physiological effects of improved concentration

There's an interplay between physiological and psychological factors, because physiological states affect concentration. For example, dehydration is associated with poor decision-making in numerous studies and athletes can potentially dehydrate, due to the physical nature of sport.

Motorsport racers are no different and, it has been well documented that motor sport needs high levels of physical fitness [7]. Strength requirements are considerable, and given that races can last over two hours, it should not be surprising that dehydration can inhibit performance. Athletes should identify the extent to which they may be hampered by dehydration, and think about hydration status and performance during previous races and training sessions.

It follows, therefore, that improvements in physiological fitness will have a number of positive effects, including the possibility of improved concentration.

Summary

Many sports require high-level concentration skills. Concentration refers to the intensity in which a racer focuses their attention in terms of a width (broad-narrow) and depth (internal-external) continuum. The ability to control attention is crucial for success and the ability to identify the likely causes of poor concentration represent the starting point for intervention work. An awareness of factors that influence concentration, such as concurrent emotional and physiological states, is also important, and interventions that focus on enhancing and developing concentration-focused goals, using concentration focused self-talk and an awareness of physiological factors, are likely to be beneficial.

Practical implications

- Training exercises to improve concentration skills should be considered by any athlete whose sport requires high levels of concentration;
- Athletes should try and focus concentration on relevant cues and use concentration management strategies such as self-talk and emotional control.

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Cross training with Pilates – why it works but why its trendiness can be a problem

At a Glance

- The key principles and benefits of Pilates as a cross training exercise are outlined;
- The importance of accuracy and specificity in Pilates instruction are explaned.

Once the best-kept secret of the dance community, Pilates has been embraced by singers, models, athletes and actors. **Ulrik Larsen** *explains its power, but warns that care is needed in its instruction*

In the world of working out, Pilates is fashionable. Who in Hollywood *doesn't* do Pilates? It seems you can't flip through a magazine or turn on the TV without coming across someone famous crediting Pilates exercise for their sleek physique.

There are two categories of Pilates. The first version, practised widely in gyms and studios, I will call 'fitness Pilates'. Almost anyone who has been exposed to Pilates through a video or gym class has been doing some kind of fitness Pilates. The second category is a sports therapy version which is gaining international popularity among physiotherapists and other injury specialists, called 'clinical Pilates'.

In this article I am concentrating on fitness Pilates: what it is and what it can help you achieve when used as a cross training method. I also raise some important questions for those involved in the industry, because the bottom line is that there are greatly varying levels of quality, accuracy and effectiveness in the Pilates world.

The benefits of Pilates

The kinds of results you can expect from an accurate, educated and well designed programme include:

- Improving strength, flexibility and balance;
- Toning and building long, lean muscles without bulk;
- Challenging deep abdominal muscles to support the core;
- Engaging the mind and enhancing body awareness;
- Reducing stress, relieving tension and boosting energy through deep stretching;
- Restoring postural alignment;
- Creating a stronger, more flexible spine;
- Promoting recovery from strain or injury;
- Increasing joint range of motion;
- Improving circulation;
- Enhancing mobility, agility and stamina;
- Improving the way your body looks and feels.

Pilates in a nutshell

Fitness Pilates is a method of exercise and physical movement designed primarily to stabilise the trunk (the 'core'), producing more effective stretching, strengthening and balancing of the body. Through systematic practice of specific exercises coupled with focused breathing patterns, Pilates has proved itself invaluable as a fitness endeavour and an important adjunct to professional sports training and physical rehabilitation.

It was developed in the 1920s by the German boxer, circus performer and exercise innovator Joseph Pilates, and began to gain a following when dancers he was working with discovered it could create long, lean muscles and a strong, streamlined physique. Pilates' system didn't really hit the big time, however, until the 1990s.

Fitness Pilates can condition the body from head to toe with a no- to low-impact approach suitable for all ages and abilities. It requires patience, attention to detail with your body and consistent practice. Behind each of the benefits (listed right) there are physiological and technical justifications, but success depends entirely on understanding the basic principles and practices of Pilates and doing it right.

Pilates is such a versatile exercise system that it is beneficial for a wide variety of conditions. Some fitness facilities target a

particular kind of clientele or rehabilitative issue, such as pregnancy, back care, seniors, the unfit and so on. Pilates is also appealing because it can be practised in different contexts: at home in front of a video, as part of a class in a gym/health club, or in a studio setting. Exercises can be done on mats, with swiss balls, with elastic tubing or rings, or on some weird and wonderful contraptions unique to Pilates with names such as the Reformer, Trap Table and Thoracic Barrel.

'The emphasis of a good Pilates session is on the quality (rather than quantity) of movement'

Ideally fitness Pilates is practised in a studio under the careful supervision of a certified instructor, either one-on-one or in small group sessions. A well trained specialist knows how to tailor a Pilates regime to meet individual needs and abilities, monitoring movements to ensure correct form for optimum results.

The emphasis of a good Pilates session is on the quality (rather than quantity) of movement; not on how much you can sweat and lift but on how well you can stay true to the principles of good movement. Only certain types of yoga can deliver similar improvements, hence the new fashion for 'Yogalates'.

There are various fitness trends and gurus who claim to incorporate Pilates within whatever discipline they are promoting. The important thing to watch for when assessing these options is how well they subscribe to the basic practice and principles of Pilates. Lots of hype, celebrity testimonials and equipment doesn't necessarily equate to better results.

Stability, flexibility, durability

The foundation stone of the Pilates movement is the concept of *core stability*. A stable trunk, or mid-section, is the best platform from which to develop whole-body muscular strength and endurance (durability), balance and flexibility. Having a stable 'centre' allows you to move in a way that reduces energy wastage (poor technique and fatigue), tissue overload (injury), and muscle confusion (poor alignment/imbalance). Pilates' balanced approach ensures that no muscle group is overworked; the body operates as an efficient, holistic system in sport and daily activity.

Our bodies need some degree of stability before they can function in any context. The greater an athlete's initial levels of

'The future credibility of the whole Pilates industry depends on not sacrificing specificity and accuracy'

stability, the easier it is for their body to acquire the specific requirements of their sport. On the other hand, poor core stability will short-circuit any attempts to improve your flexibility or durability.

Nowhere is this more true than with athletes hell-bent on pushing their bodies to the limit: without a stable trunk they will endlessly battle with injury and poor performance and will never reach their full potential.

Hence, muscle and joint *stability* is the key prerequisite for the efficient development of muscle *flexibility* and *durability*. And the principles and equipment of fitness Pilates help to achieve this better than most, if not all, other exercise systems.

The 6 C's

There are several variations of Pilates principles, ranging from those that Joseph Pilates pioneered, to contemporary adaptations incorporating modern understandings of fitness, anatomy and biomechanics.

Some forms offer five basic principles to describe what it is all about, while others stress nine. The six principles that I believe define Pilates best are The six principles that I believe define Pilates best are: concentration, control, centering, conscious breathing, core alignment and coordination (*see box opposite*):

These principles are quite different from other forms of exercise such as an aerobics class, running, or a weights session. However, Pilates can greatly enhance the benefits of other types of exercise, which makes it a great cross training tool. For example, when you have learnt how to use your abdominals properly to stabilise your trunk, even cardiovascular exercise such as running becomes an avenue to further train your abs.

Has fitness Pilates lost the plot?

Certainly some of what fitness Pilates purports to offer taps deeply into the fundamentals of how humans can improve, restore and maintain safe and efficient movement patterns. However, in the current explosion of popularity, fitness Pilates is in danger of becoming its own worst enemy. By forgetting its basic

The 6 C's

● **Concentration** – That all-important mind-body connection. Conscious focus on movement enhances body awareness. Focusing the brain on the body part enhances proprioception (the fine-tuned sense of how bits of your body move).
● **Control** – It's not about intensity, rather it's about the empowerment of being able to have a definite and positive impact on a body part through the activation of critical stability muscles. Ideal technique brings safe, effective results.
● **Centering** – A focus on the specific muscles that stabilise the pelvis and the scapula underlies the development of a strong core and enables the rest of the body to function efficiently. The correct muscles must be taught to hold for extended periods of time at a low level. Consequently, all action starts from a stable core.
● **Conscious breathing** – Deep, conscious diaphragmatic patterns of inhaling initiate any movement, help to activate deep stabilising muscles and keep you focused.
● **Core alignmen**t – Maintaining a 'neutral' position (joints held in mid-position by deep stabilising muscles) is the key to proper alignment, and this leads to good posture. You'll be aware of the position of your head and neck on the spine and pelvis, right down through to the legs and toes.
● **Coordination** – Flowing movement results from brain and body working perfectly in synergy; the aim is smooth, continuous motion, rather than jarring repetitions. Pilates has a grace and elegance to its movement that comes from working 'smarter', not 'harder'. Repetition is used to 'cement' good movement into your brain.

practices and principles, it can lose all of its power to transform, and may end up creating disillusionment and, at worst, injury.

I speak from experience: working as a physiotherapist in the sports and fitness industry, I hear weekly about the injuries created in Pilates classes by well-meaning instructors with upwards of 30 people in their care. Yet, as I have outlined above, the list of potential benefits of Pilates is extensive – and I truly believe that, given some simple keys, many people can unlock the door to those rewards. The keys they need are *accuracy* and *specificity*.

Key 1: Accuracy

Accuracy relates to *how* fitness Pilates is taught: the method, the environment, the context. The success of the system relies heavily on the careful education and monitoring of a client by a correctly trained teacher. The question must be asked: does the

advantage of teaching 30 clients in a class outweigh the disadvantages of 50-90% of them getting it wrong?

From experience, I know that it can take up to 30 minutes of one-on-one attention and direction from me before a patient learns to isolate and activate the correct muscles for even one new movement pattern. And then they have to practise it!

I believe one-on-one training must remain the basic initial learning tool for the Pilates method.

Key 2: Specificity

Specificity relates to what is being taught. We're talking about the critical word in exercise philosophy here: *you get what you train*.

So, if you are doing Pilates and strengthening the wrong abdominal muscle group, you will get good at tensing the wrong muscle, but never achieve correct stability. Or if you have not been shown correctly how to move around your pelvis in order to hold a neutral spine, your brain will learn an incorrect movement pattern and your body will be setting itself up for injury.

The greater the specificity, the greater chance of success with our goal to deliver true stability to our bodies. *Are you training the right thing?* If not, you are undermining your own efforts to achieve stability, however dedicated you might be.

The future credibility of the whole Pilates industry depends on not sacrificing specificity and accuracy, which are the elements that set it apart. Whether you are taking up Pilates for the first time or have been going to classes for years, spend a minute

Practical implications

- Pilates training can yield a number of benefits for a wide range of sports and should therefore be considered as an effective cross training strategy;
- Those new to Pilates training need to ensure that they are instructed correctly to reap the potential benefits, especially with regard to accuracy and specificity.

reflecting on how well your training meets the principles and keys to good practice outlined here.

Notes

Notes