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for CECS Level II Coaches

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SPECIFIC THEME: Supramaximal sprint runs

GENERAL THEME: The speed barrier and methods of overcoming it

Specific Theme

SUPRAMAXIMAL SPRINT RUNS

1 Introduction

High-speed sprinting is the most event-specific exercise that sprinters can do and should be the backbone of the training program during all phases of the training year (Dare & Kearney, 1988, p. 3289).

However, one of the problems most sprinters are facing after several years of training is the development of a movement stereotype. It does not matter how intensive and many-sided the training routines employed, a distinct rhythmical structure of the running stride will be formed. This stereotype, once firmly established, is known as the speed barrier (Borzov, 1983).

Several training methods and specific exercises, including the use of mechanical assistance, are recommended to overcome the speed barrier. The easiest way to fight the barrier is by employing downhill running on a slightly declined track. This can help to eliminate the already existing habits and assist in the development of new rhythmic structures (Borzov, 1983).

There are, however, much more sophisticated methods and devices to assist athletes in breaking through the speed barrier. All of the methods and devices presented below are described in more detail by Dintiman, Ward & Tellez (1998).

In spite of the benefits of overspeed devices, it must not be concealed that the use of these devices is categorically refuted by some coaches. Charlie Francis, for example, says that overspeed methods "are dangerous due to altered running mechanics and overstretching of muscles, and are based on the fallacy that stride length and stride frequency must be enhanced simultaneously" (Francis, 1997, p. 36). The only method of overspeed training which Francis advocates is running with the wind.

2 History of tow training

Although the use of tow training can be traced back as far as the 1920s and the era of Nurmi, it is generally agreed that the man who was primarily responsible for bringing it to a level of sophistication was Australian track coach Cecile Hensley.

In the mid-1950s, Hensley worked with sprinters and middle-distance runners and was constantly in search of new ways to make his athletes run faster. After exhausting the list of conventional speed-training methods, Hensley came upon the idea of towing athletes behind his car.

As a coach and physiologist, Hensley knew that one of the keys to running speed was stride rate, the number of steps one could take in a given period of time. One of the mechanisms that controls stride rate is the central nervous system. Thus, Hensley believed that tow training might condition the brain or central nervous system to alter the rate of impulses to the muscles and thus induce an accelerated stride rate. A few years later, research studies did show that tow training could increase the athlete's stride rate and running speed. By that time, however, Hensley had already used the tow training method to help develop several world-class athletes out of a band of formerly less-than-outstanding performers.

That was in 1956, and although the sports world hasn't exactly witnessed a tow-training renaissance, the method has been and continues to be used rather extensively in many countries. (Miller, 1984, pp. 7-8)

3 Towing devices

3.1 Towing with surgical tubing

Surgical tubing can force the athlete to take faster and longer steps and complete a 40m dash at world-record speed simply by providing the athlete with a slight pull throughout the high-speed portion of the sprint. A 20- to 25-foot piece of elastic tubing is attached to the sprinter's waist by a belt. The opposite end can be attached to another athlete or to a stationary object such as a tree or a goalpost to allow the athlete to work out alone. The athlete first backs to stetch the tubing 15 yards (about 20 yards total from his or her partner) and runs at three-quarters speed with the pull until he or she learns to adjust by keeping his or her balance and using proper sprinting form. After four or five practice runs, the sprinter should be ready for the full stride (Dintiman et al., 1998, p. 196).

3.2 Surgical tubing drills

- One end of the tubing is attached to a goalpost and the other to the sprinter's waist with the tubing tied in front. The sprinter stretches the tubing by walking backward about 20 yards. He or she then jogs forward toward the goalpost with the pull. This drill is repeated four times, two with a three-quarter speed run and two with a full-speed sprint. Within the next three sprints, the sprinter backs up an extra 5-8 yards each time to increase the pull and the speed of the sprint.
- The last part of the preceding drill is repeated, emphasizing a high knee lift.
- The sprinter completes 4-5 all-out sprints using a 3-minute rest interval. The sprinter should allow the

tubing to pull him or her at approximately a half of a second faster than his or her best 40-yard dash time. It takes only a slight pull to produce this effect. Two marks should be placed 40 yards apart so that the sprinter can be timed as he or she is being towed.

- The sprinter should choose a faster athlete and race him or her while being towed.
- The sprinter should do the quick feet drill by measuring one of his or her strides before placing 20 sticks at a distance of 2-3 feet shorter than his or her normal stride. The sprinter should then repeat the first drill described in this section, concentrating on rapid stride frequency.
- The sprinter should complete the two-person drill by attaching one end of the tubing to his or her waist and the other to his or her partner's back. He or she should then have his or her partner sprint 25-30 yards ahead against the resistance, and then stop. The athlete should now sprint toward his or her partner in the overspeed run. He or she should continue for 2-3 more repetitions before reversing the position of the belt. The previously towed athlete is now sprinting against resistance (sprint loading), while his or her partner is sprinting with assistance (overspeed training). This drill should be the last drill in the overspeed workout because it does not allow adequate time between each sprint to fully recover (Dintiman et al., 1998, p. 198).

3.3 Safety precautions for surgical tubing

- The tubing must be inspected before the first run of each workout by allowing the tubing to slide through the hand while backing up. Any rough marks should be carefully examined. If a nick is detected, the tubing must be discarded and replaced with another tubing.
- The knots on both belts must be inspected and retied if they are not tight or appear to be coming loose.
- The knot that ties the tubing to the belt must be examined to make certain that it is firmly in place and secure.
- After having attached the belt to the waist, a knot must be tied with the remaining portion to make certain it cannot come loose.
- Standing with the tubing fully stretched for more than a few seconds must be avoided. During this stretch phase, knots can come loose and tubing can break.
- Tubing that attaches to a belt around the waist should be preferred to a harness. With only slight differences in height between the athlete being towed and his or her partner, a broken tubing or a loose belt could snap upward and strike the sprinter in the eye. Tubing attached to the waist that does come loose when stretched is unlikely to produce any serious injury.

- The first several workouts should be run wearing shoes without spikes. Spikes are only allowed after the sprinter has fully adjusted to the high speed and can complete each repetition with correct form.
- Surgical tubing should be used on soft grassy area only (Dintiman et al., 1998, pp. 198-199).

3.4 Towing with the Ultra Speed Pacer

The Ultra Speed Pacer is a simple pulley device that relies on leverage. The pulley (fulcrum) is fastened to a fixed object in the gym or on the athletic field. Each side of the rope going through the pulley is attached to an athlete using a belt. As one athlete sprints at a 45-degree angle away from the pulley, the other athlete is forced to sprint toward the pulley while receiving considerable pull. After a few trials, both partners will easily determine how fast the angle sprinter should run to increase or decrease the pull. The device has the potential to provide a strong pull and produce very high stride rates, stride lengths, and sprinting speed. Because this device merely provides a straight pull at various speeds, one cannot use the drill described for surgical tubing with this device (Dintiman et al., 1998, p. 199)

3.5 Towing with the Sprint Master

The Sprint Master, which was developed by John Dolan and Michael Watkins, is precisely engineered to pull athletes at speeds faster than any human can sprint. It attaches to the goalposts of a football or soccer field or to the wall in a gymnasium and provides controlled, variable speed for each athlete. It is also a safe device and allows the athlete to merely release his or her grip if balance is lost.

> "Towing to force runners to take more steps than would otherwise be possible has improved stride rate and 40-yard dash times by more than 0.6 send." (Dintiman et al., 1998, p. 200)

The Sprint Master also allows full arm use while being towed at speeds of up to one second faster than the sprinter's best flying 40-yard dash time.

Athletes should use the following steps to start an overspeed program with the Sprint Master:

- Athletes should use the workout schedule shown in the table on the next page two to three times per week (every other day).
- The athlete should have his or her coach or friend pull him or her at approximately half of a second faster than his or her best flying 40-yard dash time. The operator quickly learns how to judge pace and can group athletes of similar speed together. It is also quite simple to place two marks 40 yards apart and time athletes as they are being pulled. The set screw on the machine can then be fixed at the proper speed.
- When being pulled, the athlete should grasp the tow-rope handles and accelerate slowly for 10-15 yards. The Sprint Master will then exert its proper pull as the athlete reaches full speed and will continue to pull him or her for the rec-

ommended 20-25 yards; longer distances tend to produce fatigue and cause the athlete to lose his or her balance. The athlete should pump his or her arms as he or she would in normal sprinting form instead of placing his or her hands and arms in front of the body and letting himself or herself be pulled in water-ski like fashion.

- The athlete should practice the art of letting go of the rope handles if he or she loses his or her balance. Very few runners fall at any towing speed once the operator learns the technique.

According to Dintiman et al. (1998, p. 201), operating the Sprint Master is easily learned. Speeds can be individually determined for each athlete, and the operator can make the pull safely.

Most of the towing drills described previously for surgical tubing cannot be used with the Sprint Master because this device allows only straight-ahead sprinting at various speeds.

Overspeed training using surgical tubing or the Sprint Master

Week	Reps	Overspeed distance (yards)	Rest (minutes)	Progression
1	3-5	10-15	2	Three-quarter speed runs only to acclimate
2	3-5	10-15	2	Maximum speed
3	5-7	15-20	3	Maximum speed
4	7-9	20-25	3	Maximum speed
5	7-9	20-25	3	Maximum speed
6-9	7-9	25-30	3.5	Maximum speed with weighted vest that progresses from one to five pounds over three weeks. Used for the final two reps of the workout only.

3.6 Treadmill sprinting

The treadmill is an excellent piece of equipment for overspeed training (Dintiman et al., 1998, p. 202).

The following guidelines were developed for use on the treadmill as an overspeed training technique:

- Athletes use a standard warm-up procedure and stretching prior to entry on the treadmill.
- A harness that also attaches to the support rails and allows free arm movement, balance, and safety is used. One spotter is also placed on each side of the treadmill.
- A one-week acclimation period is used to allow sprinters to adjust to entry on the treadbelt at high speeds and to treadmill sprinting.
- Because the treadbelt accelerates slowly and would introduce a fatigue factor if sprinters were required to jog, stride and sprint until higher belt speeds were reached, treadbelt speeds are preset prior to entry. After 6-8 practice attempts, sprinters can easily enter at high speeds.The so-called greyhound effect allows athletes to reach maximum speed in approximately two seconds.

> “Highspeed treadmill sprinting (up to a 9.8-second 100-meter dash) improves stride rate and speed in short distances.” (Dintiman et al., 1998, p. 202)

The sample program on the next page has been used in a number of experiments and has proved effective.

Although, generally, a supporter of treadmill sprinting Dintiman et al. (1998, p. 202) admit that this training method is not without special problems. The sprinting action produces a slight slowing effect each time the foot strikes the treadbelt; however aiding factors predominate and allow a faster rate for most individuals even without training. The braking or slowing effect when each foot strikes the treadbelt has been found to be greater for heavier athletes (over 200 pounds) and for athletes of all sizes in the initial stages of training and tends to be eliminated as acclimation occurs and form instruction is given. At high speeds beyond one’s maximum speed (in early training sessions), the braking effect almost reduces treadbelt speed to a sprinter’s maximum speed.

However, according to Dintiman et al. (1998, p. 203) most of the problems of treadmill sprint training can be overcome for athletes of all sizes by using an ample number of practice sessions at various speeds (acclimation), seeing that athletes master proper sprinting form, and avoiding a treadbelt speed too far beyond the subject’s present maximum speed (the point at which proper sprinting form cannot be maintained). Ongoing research with high-speed treadmill sprinting continues to show improvements in stride rate and length, with this effect carried over to unassisted sprinting.

High-speed treadmill sprint program

Purpose	Speed	Repetitions
Acclimation	90% of maximum	6-20 at 2-minute intervals for 10 seconds
Entry practice	75% under maximum 90% under maximum At maximum speed	10-30 for two seconds
Improved stride rate	1-2 mph and 3-4 mph above maximum speed	2-6 for 3-5 seconds allowing full recovery after each

Eight-week sprint-assisted program

(according to Dintiman, Ward & Tellez, 2003, pp. 190-191)

Week	Workout	Overspeed distance	Repetitions	Rest interval
1	1	½-speed runs toward the pull for 15 yd., emphasizing correct sprinting form	5	1 min.
		½-speed backward runs toward the pull for 20 yd.	3	1 min.
1	2	¾-speed runs for 20 yd. with perfect sprinting form	5	2 min.
		¾-speed backward runs toward the pull for 20 yd.	3	2 min.
2	3	¾-speed runs for 25 yd.	5	2 min.
		¾-speed backward runs toward the pull for 25 yd.	3	2 min.
		¾-speed turn-and-runs at a 45-degree angle for 25 yd. (left and right)	3	2 min.
2	4	Same as workout 3		
3	5	¾-speed runs toward the pull for 15 yd.	3	2 min.
		Maximum-speed sprints toward the pull for 15 yd.	5	2 min.
3	6	¾-speed runs for 20 yd.	3	2 min.
		Maximum-speed sprints for 20 yd.	6	2.5 min.
4	7	¾-speed runs for 25 yd.	3	2 min.
		Maximum-speed sprints for 25 yd.	6	3 min.
4	8	¾-speed sprints for 30 yd.	3	2 min.
		Maximum-speed sprints for 30 yd.	6	3 min.
5	9	¾-speed runs toward the pull for 15 yd	3	1 min.
		Quick feet, short step, low knee lift sprint for 15 yd. with rapid arm-pumping action	3	2 min.
		Quick feet, short step, high knee lift sprint for 15 yd. with rapid arm-pumping action	3	2 min.
		Maximum-speed pulls for 30 yd. rapid arm-pumping action	4	3 min.
5	10	Same as workout 9		
6	11	High-speed stationary cycling. With the resistance on low average, warm up for 5-7 min. until you perspire freely. Pedal at ¾ speed for 30 sec.	3	1 min.

Week	Workout	Overspeed distance	Repetitions	Rest interval
		Pedal at maximum speed for 2 sec. as you say “one thousand and one, one thousand and two, one thousand and three”	7	2 min.
		Pedal at maximum speed for 3 sec. as you say “one thousand and one, one thousand and two, one thousand and three”	3	2 min.
		Pedal at maximum speed for 5 sec.	6	2.5 min.
6	12	Same as workout 11		
7	13	Repeat workout 11		
		Two-man pull and resist drill for 100 yd.	2	4 min.
		Maximum-speed sprints for 25 yd.	6	3 min.
7	14	Same as workout 11		
8	15	¾-speed runs toward the pull for 15 yd	3	1 min.
		Quick feet, short step, low knee lift sprint for 15 yd. with rapid arm-pumping action	5	2 min.
		Quick feet, short step, high knee lift sprint for 15 yd. with rapid arm-pumping action	5	2 min.
		Maximum-speed pulls for 30 yd.	5	3 min.
8	16	Maintenance program		
		¾-speed runs toward the pull for 15 yd	2	2 min.
		Quick feet, short step, high knee lift sprint for 15 yd. with rapid arm-pumping action	2	2 min.
		Maximum-speed pull forward for 20 yd., plant right foot and sprint diagonally left for 20 yd. Repeat, planting the left foot and sprinting diagonally right for 20 yd.	3	2 min.
		Maximum-speed pulls forward for 30 yd.	3	2 min.

General Theme

THE SPEED BARRIER AND WAYS OF OVERCOMING IT

1 Introduction

The axiom that sprinters are born and not made is still popular with many coaches. However, the notion that speed is an inherited trait that cannot be measurably improved by training is not true. Although there is no doubt that to become a great sprinter, genetic gifts above and beyond the norm must be present, speed capacities can be maximized by using scientifically based training methods.

2 The formation of the speed plateau

As an athlete advances in a speed development program, it becomes more important to select the proper drills and exercises specific to a particular event, because as the athlete improves in skill and performance, the available range of exercises that optimally stimulate improvement narrows. The athlete's training program shifts from general preparation to more specific preparation for the competitive activity. Sprinters, for example, require specific exercises that include running at maximal velocity at short (20-80 meters) and long (150-300 meters) distances (Tabachnik, 1992, p. 76). To be effective, these exercises must be done using a great number of repetitions.

However, numerous repetitions of the same exercises form a dynamic stereotype in the central nervous system. The roots of this phenomenon, which in sprint training is called the speed barrier or speed plateau, are in the intensive, highly focused training that usually leads to monotony and creates both psychological and physical fatigue. In addition, maximal speed indicators are stabilized and, after some time, restrict the transfer toward a higher level of speed (Tabachnik, 1992, p. 76).

> "The speed barrier is very likely to occur in beginners who are introduced to narrowly sport-specific training too early, at the expense of general development." (Kurz, 2001, p. 188)

The speed barrier includes space, time, and frequency characteristics of the movement. This means that the athlete learns to move at a certain speed, and not any faster even though his or her abilities (such as strength, flexibility, or even reaction time) improve, and that the speed barrier or speed plateau is formed (Kurz, 2001, p. 186).

This means that the coaches are faced with a paradox: In order to improve speed abilities, the athlete has to run at maximal speed. But the more running at maximal speed in the training program, the earlier the athlete will experience a speed barrier or plateau.

3 How to avoid or overcome a speed plateau

There are two methods of avoiding or overcoming the speed barrier:

One is to encourage the athlete to exceed his or her highest speed result, remember this new sensation, and then try to repeat this sensation in the following workouts. For this purpose, the sprinter

- runs down a track inclined up to 3°,
- runs following a leader,
- runs with the wind,
- lets himself or herself being towed with surgical tubing, the Ultra Speed Pacer, or the Sprint Master,
- sprints on a high-speed treadmill.

The speed under these lightened conditions must be such that the athlete at some time in the future will be capable of showing it under normal conditions (Kurz, 2001, p. 187).

Sprint-assisted methods like towing "light up" the central nervous system, bringing into play great numbers of neurons. Lighting up the central nervous system means that sprint-assisted methods alter the timing of the nervous impulse to the effector muscles. In other words, these methods create some anticipatory firing, and this kind of firing enhances intramuscular coordination (Jakalski, 2000, pp. 97-98).

"The neuron recruitment level is definitely increased after overspeed towing." (Jakalski, 2000, p. 98)

Sprint-assisted methods also make the legs more responsive to ground reaction. It is theorized that the increase in horizontal momentum resulting from assisted sprinting alters the capacity for joint stabilization at the ankle and knee, thereby allowing for a greater transmission of force (Jakalski, 2000, p. 98).

The other method of breaking the speed barrier is the variation or contrast method. This method is based on the fact that the speed of forgetting characteristics of the dynamic stereotype is different for each characteristic. Spatial characteristics (form of movement) are remembered longer than temporal characteristics (speed and timing of movements). If the speed exercises are not performed for a certain time, memory of the time links characteristic for the speed barrier may disappear although the form of movement will still be intact. It takes 10-14 days after ceasing speed training for an athlete's speed to noticeably decrease. If in this period of rest from sport-specific speed exercises the athlete does directed and general speed and strength exercises, then after this period his or her speed may increase (Kurz, 2001, p. 187).

When using the variation or contrast method, it is very popular to use exercises that are similar to the competitive activity and improve special muscle strength. In the case of running under resisted conditions, the resultant development of take-off power and special muscle strength will lead to an improvement in stride length.

Examples of resisted conditions for example include

- uphill running,
- running in sand or in water,
- running with a weighted belt, and

- pulling a sled, tire or parachute.

Each of these exercises will allow the athlete to exceed the usual level of their driving effort and improve muscle power that can be transferred to normal running.

With both sprint-assisted and -resisted methods, it is important to stay within the so-called 10% neural window. This means that athletes should not be slowed down or accelerated more than 10% because, as the resistance becomes greater or smaller, the ground dynamics begin to change (Jakalski, 2000, p. 96).

"Overspeed training using surgical tubing is dangerous […]. Not only is there an obvious risk of having the cable snap back on the runner especially if the end slips out of a partner's hand, but because the tubing can't be released from the sprinter's body, at it returns to its pre-stretched position, athletes must often step gingerly in their coast-and-stop phase to avoid getting tangled. It is not uncommon to see sprinters forced into awkward and precarious movements at the end of a tow in an attempt to avoid tripping over long sections of uncoiled cable caught between their legs." (Jakalski, 2000, p. 99)

4 Dangers involved with assisted and resisted sprints

4.1 Assisted sprints

With assisted sprints, the athlete runs at greater velocities than he or she is at the time capable of. In theory, this allows the athlete's body to learn how to run at greater stride frequencies, which will then transfer to non-assisted sprints.

However, although assisted sprints can improve stride rate and elastic energy production, some athletes have a tendency to allow themselves to be pulled passively. This means that the athletes run with submaximal effort, which defeats the purpose of the exercise (Cissik, 2005, p. 22).

With **surgical tubing** adequate supervision is recommended at all times. Tubing can break if stretched too far, and belts can come loose if they are carelessly fastened (Dintiman et al., 1998, p. 198).

Downhill sprinting will increase horizontal velocity and stride length. However, declines greater than 3% may lead to excessive stride lengths that will result in increased braking during the sprint (Cissik, 2005, p. 22).

Sprinting with the wind has major limitations because it is impossible to control either the velocity or availability of wind. Further, since the wind velocity is never constant, it is hard to keep sprinters within the 10% window (Jakalski, 2000, p. 99).

In general, Cissik (2005, p. 22) recommends that when doing assisted sprints the following guidelines should be observed:

a) When being towed, distances should not cover more than 30-40 m.

b) Downhill sprints should not exceed an angle of 2-3° to prevent changes in mechanics.

c) Athletes should not achieve speeds greater than 106-110% of their maximum speed to prevent changes in running mechanics.

d) Sound technique must be emphasized during assisted sprinting.

> "If an athlete has an unstable motor pattern, sprint-assisted work will only make his mechanics worse by magnifying errors. Unless coaches have a clear method for keeping athletes within the 10% zone, runners can generate so much speed that they begin braking actions in an effort to avoid falling forward. As soon as athletes initiate any kind of braking action, they are being taught to stay on the ground longer, and their bodies quickly adapt to this incorrect stressor." (Jakalski, 2000, p. 99)

Because of the potential risks when doing assisted sprints, Jakalski (2000, p. 99) recommends avoiding these exercises, unless athletes are highly advanced in training age.

4.2 Resisted sprints

Unlike assisted sprints, resisted sprints (e. g. sprinting while pulling a weight) make the sprinting motion more difficult. The rationale behind resisted sprints is that it is believed that the resisted-sprint exercises will recruit more muscle fibers and require more neural activation. Over time this increased recruitment and activation will be transferred to non-resisted sprints, leading to an increase in speed (Cissik, 2005, p. 21).

One must be careful with resisted sprints because too much resistance may alter running kinematics in ways that are not desirable.

Lockie, Murphy, and Spinks (2003) compared 15m sprints where the athletes dragged unloaded sleds, sleds loaded with 12.6% of body weight, and sleds loaded with 32.2% of body weight. The 32.2% load resulted in a lowering of running velocity by almost 23%, a decrease in stride length by almost 24%, an increase in trunk lean by 15% (leading to an incomplete hip extension), and an increase in ground contact time by almost 20% (leading the athletes to spending more time on the ground). Similar results were found by Letzelter, Sauerwein, and Burger (1995) with female sprinters. They showed that sled towing runs over 30m with 2.5, 5 and 10kg loads "did not only produce slower times, but also changed stride frequency and even more, stride length. Also noteworthy were increased support times, changes in the upper body lean and the tendency of 'sitting' strides." (Letzelter et al., 1995, p. 86)

These findings show that overdoing resisted sprint exercises can have detrimental effects on sprinting mechanics. Therefore, these exercises should be used sparingly, with little resistance, and during specific times in the year (Cissik, 2005, p. 21).

"Competition exercises with additional loads are, as the 'most specific of specific exercises,' important training means. In sprinting, this applies in particular to towing resistance runs, However, precise information on the length of the runs and the level of additional loads is not available. Also missing is biomechanical information on the kinetic and dynamic influence values that bring about changes to the sprinting movements." (Letzelter et al., 1995, p. 86)

In order to make towing sprints safer, Cissik (2005, p. 22) recommends consideration of the following guidelines:

a) The resistance should not slow down the athletes by more than 10%; any more than that will alter the mechanics of running and potentially create bad habits.

b) Resisted sprints should cover 15-20m and provide for a gradual release to free running for 20-25m.

c) Proper sprinting mechanics must be emphasized throughout the performance of the exercise or the athlete may inadvertently be taught to run slowly and with bad technique.

"Combining sprint-resisted and sprint-assisted activities within a training session and then finishing with regular maximum velocity sprinting, a system known as contrast training, is a unique way to target the sprinter's neuro-motor pattern. However, keep in mind that you can't introduce this kind of training, do it a few times, and then think you've evoked a training stimulus. Contrast-train two times a week for a six- to eight-week period. Never do back-to-back sessions, because the nervous system takes longer to recover than the cardiovascular system. Allow at least 72 hours for recovery." (Jakalski, 2000, p. 100).

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