Training for Power II – Elastic Strength

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Dynamic strength may be expressed as concentric strength eccentric strength or elastic strength. Concentric strength is defined as that involved in overcoming a resistance, e.g. lift a weight. As we have argued before¹, it is best developed in the weights room. Eccentric strength is expressed in resisting an external force, e.g. in lowering a weight or resisting collapse during landing while bounding or running. Elastic strength is the most complex to define, since it includes a mixture of (a) explosive, voluntary concentric contraction, (b) a reflex concentric contraction triggered by the stretch reflex, and (c) elastic recoil of the series elastic component (s.e.c). The s.e.c. consists of the tendons and connective tissue of muscle which store potential energy during resistance to stretching. This potential energy can be explosively released and appropriate training facilitates this. The relative contribution of these three components depends on the nature and speed of the movement concerned, the more rapid and explosive the movement (e.g. the take-off in the long jump or during each stride of a sprint), the less the voluntary concentric component involved and the greater the reflex and elastic components. The latter two, while positively related to the gross and concentric strength the athlete can express, are best trained by recoil-type exercises - plyometric exercises². Since the term 'plyometric' seems to encompass such a variety of different exercises and effects, the remainder of this article attempts to illustrate some of them.

Hurdle Jumping

Two-footed jumps over 6-8 very low hurdles spaced about 1.25m apart. The athlete concentrates on elastic recoil off the ground (with a mental target time of I/10th of a second). The coach looks for upright body posture, minimal flexion of the knees during the amortization phase, and good use of the hip flexion and arms. The emphasis must be on quality, not quantity. Some transfer of effect might be attempted by a short, explosive sprint of 20m after the last hurdle in each set.

Hurdle heights may be progressively increased, with a concomitant increase in the landing and take-off stresses. There comes a point when the dwelling time on the ground increases to where the nature of the exercise changes. With the hurdles at 3'3" to 3'6", the athlete might be asked to exaggerate the effects by concentrating on resisting collapse during landing - developing eccentric strength in the legs, while subsequently flexing the knees and employing concentric strength to clear the hurdles.

Variations on the above theme include setting the hurdles so that they are progressively higher, or alternating high and low hurdles. In each case the coach needs to consider the desired effect and whether the hurdle heights, quality of execution, age, and standard of the athlete are appropriate.

Yet another variation includes the interjection of a very low, very fast very firm-priming jump between hurdles.

To alter the exercise markedly, the hurdles may be arranged in a dry and raked sand pit. The concentric element and the demands on the calves, Achilles tendon and lower foot are amplified.

An arrangement of low hurdles in some form of grid can be used for hurdle jumps sideways.

The well-conditioned senior athlete may include hopping over hurdles in his routine. This is both stressful and dangerous and should not be undertaken lightly. Any progression in hurdle height must be very gradual and carefully monitored. More or higher are not necessarily better, and at every stage the coach needs to question the specificity and value of the exercises attempted. Hurdles may be replaced by any other suitable obstacles.

Steps

A short flight of 20-30 wooden stadium steps permits a variety of hopping and bounding exercises that, depending upon the height and width of the steps can be demanding, challenging and competitive. Bounding up the steps 1 or 2 at a time can be employed for concentration on elastic recoil - 3, 4 or 5 steps at a time for increasing demands on concentric strength.

Hopping up increasing numbers of steps at a time makes for similar changes in emphasis and stress. Variations such as hopping '2 steps up and 1 step down' can make demands on mental concentration co-ordination and strength.

Variations such as hopping sideways up the steps, using either the near foot or the far foot, also change the demands on muscle groups, balance, co-ordination and strength but should be attempted with care. Where a short run-up of 2 or 3 strides is possible, triple jumping up steps might be attempted.

If longer flights of steps are available, bounding up them 1,2 or 3 at a time might be timed, introducing a further challenge to power and strength endurance. Concrete steps should be avoided.

Bounding

Bounding (landing on alternate feet) can be performed for speed, distance and height, and on grass or synthetic surface. In each case the effect is altered slightly. Bounding for **speed** should concentrate on the speed of elastic recoil. Bounding for **distance** increases the dwelling time on the ground, sometimes to periods longer than occur during sprinting, hurdling or jumping, and the eccentric and concentric components of leg strength are emphasised. Stroking the ground backwards with the foot, as triple jumpers do, seeks to conserve horizontal momentum, and the emphasis shifts to timing and co-ordination. Bounding for **height** concentrates on eccentric and elastic strength.

Bounding or hopping on a softer grass surface (or ongym mats indoors) considerably reduces the elastic component involved and, while gentler on growing limbs, may negate the effect sought. The concentric component is increased and the ankle might be worked harder. With young athletes, if elastic strength is sought, it might be more appropriate to limit the number of ground contacts on a synthetic surface, as well as the height md distance of the bounds. In my experience, hopping and bounding indoors, even on a sprung floor, frequently leads to athletes reporting shin pains, and I avoid it completely except for demonstration purposes.

Hopping

Exactly the same variations and arguments as above apply to hopping (landing on the same foot).

Measuring hops for distance is remarkably effective in revealing imbalances in strength or co-ordination between the legs. Marked imbalances may call for remedial action

This is perhaps an appropriate point to address the question of 'how old should the athlete be before he or she should be exposed to plyometric training?' Of necessity, the answer is equivocal - it all depends! Light hopping bounding and running is all part of play (or should be) and should be encouraged in young athletes at any age. Such moderate, intermittent stress on the skeleton helps the bones to grow stronger and longer. Young girls who are not permitted to compete in the triple jump, cam be taught the skills of the event while they have the aptitude and a favourable strength/ weight ratio. Common-sense should dictate that the run up be kept short. Equally, common-sense should indicate that the number of ground contacts in bounding type exercises be limited and varied when dealing with young athletes. Again when post-puberty boys are going through the phase when bone growth exceeds muscle growth and co-ordination suffers, any emphasis on plyometric exercises is clearly contra-indicated. Any progression in elastic strength through the course of the athlete's development should be very gradual. However, a progression is necessary if one is to avoid the breakdown that often accompanies the sudden injection of plyometric training into an older athlete's programme.

Box Work (Depth or Drop Jumping)

A selection of sturdy boxes ranging in height from 30 to 70 cms permits a wide variety of exercises to develop both eccentric and elastic strength. Dropping off boxes of lower height allows the athlete to concentrate on the speed and extent of elastic recoil. Any progression in height should be very gradual. The higher boxes may be used to develop eccentric strength through resisting collapse during landing. Some coaches have advocated boxes up to 1m in height for such exercises. The landing stresses are high in such situations and no attempt to include elastic recoil is recommended except for superbly conditioned athletes.

The character of the exercises may be changed by hopping or bounding from box to box set at different distances or at different heights. This increases the range of movement and more closely simulates the forward momentum required in most athletic events. The pawing or stroking action of the 'active' foot can be encouraged m such rangy movements. This is particularly important in minimising impact and maximising forward momentum.

Hurdles may be included as obstacles to be cleared in box work, particularly where the height of recoil is the objective.

Performing box work on grass has little to recommend it for reasons mentioned earlier.

Timekeeper's stands, steeplechase barriers and benches may all be employed for depth jumping work at the track.

Medicine Balls

The range of exercises possible using medicine balls is only limited by the imagination. Max Jones describes about 75 exercises in his new BAF booklet³. Tenke and Higgins⁴ describe 300. To develop elastic strength requires recoil and a smart counter movement. Balls ranging in weight from 2 to 7 kg are suitable.

Weight Training

It must be obvious by now that elastic strength in the arms and shoulder girdle is more difficult to implement. Medicine balls are useful, but the resistance offered is low (the impact on landing during dynamic hopping or bounding may be several times body weight). Lifting weights fast does develop **power**, but does not directly train elastic strength. Attempting recoil-type exercises with heavy weights is dangerous.

Complex Training

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Maximum benefit is believed to accrue from a combination of exercises that have carry-over benefits to the event itself. For example, a jumper might begin a session with heavy squats using a barbell (less than 5 reps), immediately follow this with two-footed hurdle jumps on

the track, and complete the combination set with some short approach jumps into the pit. The sprinter may complete the same set with some short, explosive sprints. Similarly, one might use combinations of squat, squat jumps with weighted jacket, and bounding, jumping or sprinting. The thrower may combine the inclined bench press with putting heavy and light shots. The objective, of course, is to choose a combination of exercises that are as specific to the event as possible and that contribute a combined training effect on concentric, eccentric and elastic strength requirements of the event. Performing the combination in rapid sequence is thought to promote a carry-over effect from one form of training to the next. The necessary proximity of weights room to track is a luxury few of us enjoy.

Choice of Plyometric Exercises

The choice of exercises within a session and their order should be planned. One might choose a sequence that begins the session with exercises that are fast, explosive and designed for developing elastic strength (low hurdle jumps; low drop jumps), work through exercises that develop concentric strength (standing long jump; high hurdle jumps) and finish the unit with training for eccentric strength (higher drop jumps). Alternatively, one might organise such a progression within a set of exercises. The coach must be armed with a battery of exercises to ensure variety. In our own group, we tend to begin with low hurdle jumps, progress to bounding and hopping on the track, continue with either steps or box work and miss with an enjoyable medicine ball work out for abdominals and upper body. When it snows, we are content with a very hard session on the stadium steps!!

Progress with beginner or developing athletes must be slow. Chu¹ suggests that (a) if an athlete cannot lift 1.5 times his body weight in a single repetition squat to parallel or (b) execute in 5 seconds 5 squats to parallel with 60% of his body weight, than further resistance training is a prerequisite to starting regular plyometric training. For the first 4-8 weeks of training, it may be advisable to hop or bound on grass. Depth jumping provides the highest intensity of training effect and should be reserved for strong and well conditioned athletes.

A judicious mixture of 1 or 2 plyometric units of training, 2-3 weight training units, and 1-3 units of speed training per week, during winter preparation is adequate power work for most explosive athletes.

¹Sabnis D and Vince A (1995) training for Power.

Athletics Coach 29: 20-24.

²Chu D A (1993). Jumping into Plyometrics, Leisure Press, Champaign, Illinois.

³Jones M (1995). Medicine Ball Training. BAF Instructional Books, 1995.

⁴Tenke Z and Higgins A (1992). Medicine Ball Training