Plyometrics:
The Link Between Strength and Speed

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“Plyometrics” is a term which became popular amongst coaches in track and field circles in the mid to late 70’s. It has migrated from Europe and there were hints of Eastern Bloc secret training techniques. Plyometrics rapidly became known as drills or exercises aimed at linking sheer strength and speed of movement to produce an explosive-reactive type of movement often referred to as “power.” Naturally, the idea of such drills or exercises met with widespread approval by those coaches and athletes dealing with jumping, lifting, throwing or sprinting activities.

The exact evolution of the term “plyometrics” is not clearly known. Fred Wilt (5) has stated that term may have found its origin in the Greek word “plethyrein” meaning “to increase.” The roots of the word may also have been tied to the Greek origins “pilo” meaning more and “metric” to measure. Regardless, the term now relates to specific exercises which encompass a rapid stretching of a muscle(s) that is undergoing eccentric stress and followed by a concentric, rapid contraction of that muscle(s) for the purpose of developing a forceful movement over a short period of time.

In theory, the “stretch” or “myotatic” reflex which exists within all muscles is capitalized upon to accomplish this rapid movement. Prior to explosive-reactive movements, a “cocking-phase” can be observed. A slight lengthening of a muscle, done rapidly, will result in a faster, more effective movement in the opposite direction. This idea is not limited to athletic conditioning as Knott & Voss (2) have used this concept in the development of the Proprioceptive Neuromuscular Facilitation (PNF) system of muscular rehabilitation in the late 60’s.

Lengthening a muscle rapidly has been referred to as “eccentric” in nature. Whether the type of contraction we are discussing is “eccentric” as we tend to think of the term (under stress load) or not is one of the semantic problems in plyometrics. The easiest visualization of a “stretch-reflex” is the knee jerk test experienced during an annual physical. Muscle receptors (spindles or intrafusal fibers) lie within the body of skeletal muscles (extrafusal fibers). These spindle receptors are sensory in nature and are sensitive not only to the amount of stretching they undergo, but also the rate of stretching. Since they are sensory they transmit the information of a muscle being rapidly lengthened to the spinal cord and through one synaptic junction to the motor horn cells that supply motor information to the extrafusal fibers. The result is a protective reflex activity of the extrafusal fibers to re-

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verse the lengthening process and to rapidly shorten the muscle (concentric contraction).

It has been well established that the faster a muscle is lengthened, the greater the concentric force developed (1). The result is a more forceful movement devoted to overcoming the inertia of an object; be it the individual’s own body (running, jumping) or an external object (shot put, blocking bag, etc.).

With this over simplification of the physiological processes in mind, the problem now becomes one of exploiting this concept. The great Russian jump coach, Veroshanski, was one of the first to publish drills and exercises for developing the “total neuro-muscular system” (4). The essence of plyometrics, then, is to develop the nervous system so that with minimal stress to the lengthening of muscle and in turn develop the ability of the muscle to shorten rapidly with maximal force.

It follows that the overload principle is the tenet of exercise to apply in this case. The Europeans found that by repeatedly dropping from specific heights they could stress a muscle spindle system and create a positive change in performance. Veroshanski published specific recommended heights for one and two foot landings and labeled these exercises “in-depth” jumps. This Russian coach followed several guidelines in the establishment of training programs utilizing these exercises, and a revolution began.

Explosive-reactive power was the goal. The goal can only be accomplished by treating each exercise attempt as a maximal effort. The neuro-muscular system utilizing the “stretch-reflex” principle demands that each effort require the utmost in concentration and physical effort.

In his early work, Veroshanski described his in-depth jumps as a straight-line drop from heights of .75 and 1.10 meters. This drop requires that the athlete step-off a box (not jump) and upon making contact with the ground, move his body directly upward as rapidly as possible. The essence of the movement is that it be a “touch and go.” The athlete must be mentally ready to reverse the dropping motion at the instant they feel the ground contact.

The time from ground contact to reversal of movement is known as the “amortization” phase. It is desirable that this time be minimal to a point within reason. The athlete must undergo some split second of neurological processing prior to accomplishing take-off. This is a process that can be developed and improved. Hence, the rationale for plyometric training is at hand.

It is noteworthy that not all sport movements are directly upward. Many are composed of horizontal as well as vertical force. Thus, another form of plyometric exercise developed, named “bounding.” Bounds are an exercise form in which the athlete directs himself over the ground in both single, double, or alternating leg movement patterns. Since the athlete is covering ground and the height from which he drops is controlled by angles of take-off projection and landing, the exercise and its inherent “amortization phase” becomes more complex.

“Hopping” activities are really a sub component of “bounds.” Hopping activities are both single and double legged in take-off and landing activities. Hops are generally shorter in attempted distance than bounds.

This leads to a clarification of the usefulness of these activities; the why, where, and when of plyometrics. If the nature of the exercise is directed toward improving a specific skill such as single or double leg take-offs vertically for such sports as basketball, volleyball, and jumping events for heights, then those movement patterns should be approximated as closely as possible by the plyometric exercise; in this case, in-depth jumps.

If the need is for horizontal force development, the plyometric exercise should favor movement in a linear direction. The development of lateral movement power is one of the most over-looked areas of training by all athletes. A simple recognition of the forces necessary to stabilize the hips in a one legged stance (running, one-foot jumping, cutting, etc.) should be enough to generate some thought into planning and development of this aspect of the conditioning program.

Plyometrics have often been credited with development of acceleration, and absolute speed in running. They can do this only if planned for and with careful consideration of the exercises used. If acceleration is a desirable skill for improvement, then short (distance) intense, plyometrics of high frequency (leg cycle or turn-over) would be the exercises of choice. It is generally accepted that leg cycle or turn-over is a most difficult trait to improve. Acknowledging that it is capable of small improvements, one must realize that leg frequency must be closely associated with force developed against the ground. Acceleration in running is the art of overcoming the inertia of one’s own body at an ever increasing rate. Pushing back against the running surface and more rapid leg movement are both paramount to success in this activity.

Sustaining peak speed once it is attained is considered to be that characteristic known as “absolute speed.” The worst enemy of the runner is “deceleration,” or dropping below the peak speed of movement attained at the end of acceleration. This becomes a skill requiring the maintenance of leg frequency and maximum push against the ground. Attacking the problem of sustained speed generally requires plyometric drills which project the athlete linearly at angles specific to running and for high numbers of efforts or repetitions. Thus, bounding often encompasses distances close to or even beyond 100 meters. Distances beyond this may result in too much of a sustained effort and fatigue will cause rapid deterioration in the skill level of the athlete.

In summary, plyometrics are an exercise system unto themselves. They are based on a physiological principle; namely, the myotatic or stretch-reflexes, which supports their rationale. They have a researched history and although while they are not a panacea for all power training ills, they have a valuable place in all conditioning programs. It is a system which provides the ultimate in flexibility and variety of training. Only the imagination of the user limits their variability and potential.

Bibliography


