Plyometrics: Myths and Misconceptions

by: Vern Gambetta

Introduction
Zlyometric training is not a particularly new training method. Even though it has recently received much attention it has been a part of the training of athletes in a variety of sports for years. It just was not called plyometrics. The word plyometrics didn't appear in the training literature until the late 1960's. Scientific research has given us a fundamental understanding of the elastic properties of muscle and it's trainability. This has enabled the practitioner to more effectively apply plyometrics. Despite this increase in knowledge there is still misunderstanding concerning the application of plyometrics. There have been many exorbitant claims as well as much undeserved blame for injury and overtraining. I will attempt to clear up some of the myths and misconceptions by explaining factors that will help in more effective design and implementation of plyometric training.

What is Plyometrics Training?
Plyometric training is specific work for the enhancement of explosive power. It is a training method to be used in conjunction with other power development methods in a complete training program to improve the relationship between maximum strength and explosive power. In most athletic events there is seldom enough time to develop maximum strength which takes .5 to .7 sec. Most explosive/ballistic movements do not take that long. Therefore the premium is on generating the highest possible force in the shortest period of time and reducing or stopping this force at the end of the action. With this objective plyometric training has a primary role in training as well as rehabilitation programs.

Plyometric training enhances the tolerance of the muscle for increased stretch loads. This increased tolerance develops efficiency in the stretch shortening cycle of muscle action. During the stretching (eccentric lengthening phase) of muscle action a greater amount of elastic energy is stored in the muscle. This elastic energy is then reused in the following concentric action to make it stronger. The key to this is a short coupling time which is the time it takes for the muscle to switch from the lengthening/yielding phase to the shortening/overcoming work phase. This leads us to a fundamental principle of plyometric training: The rate, not the magnitude of the stretch, is what determines the utilization of elastic energy and the transfer of chemical energy into mechanical work.

PLYOMETRIC DEMAND RATING SCALE

Rating	Recovery Time	Example
1 = Very low stress	Recovery very rapid	Jump rope or ankle bounces or other similar low amplitude jumps
2 = Low Stress	Recovery rapid. One day required	Tuck Jump or other similar in place of jumps
3 = Moderate Stress	One to two days for recovery	Stair Jumps or other similar short jumps
4 = High Stress	Recovery slow. Two days required	Hops or bounds

		for distance or other similar long jumps
5 = Very High Stress	Recovery very slow. Three days required. Highest nervous system demand	Depth Jumps or other similar shock

The following factors must be considered when assigning training demand:

Basic Considerations

Training Load - The prime consideration in plyometric training, as with any training method, is the determination of the appropriate training loads. I have developed a rating scale to aid in quantifying this task. The rating scale is intended as a tool to help monitor the stress of plyometric training, especially as it relates to other high neuromuscular demand activities such as weight training and sprinting. The underlying premise is that an activity of high nervous system demand will take twice the recovery time for a similar load of metabolic work.

Displacement of center of gravity. Horizontal displacement is less stressful than vertical displacement. This is of course dependent on the weight of the athlete and the technical proficiency in performing the jumps.

Weight of the Athlete. The heavier the athlete the greater the training demand. What is a low demand in place jump for a 150 pound athlete can be a high demand jump for a 250 pound athlete.

Limb Involvement. Single support exercises are of greater training demand than double support. For example single repetitive hops are more stressful than repetitive double leg jumps.

Speed of the execution of the exercise. Higher speed of execution on exercises like single leg hops or alternate leg bounding will raise the training demand.

External load. Adding external load will significantly raise the training demand. It should be noted that external loading will slow down the movement thus negating some of the advantages of plyometric training.

Volume. The greater the volume of training the higher the greater the training demand. Essentially the volume of training can be high if the intensity of the plyometric activity is low. As a rule the younger the athlete both in term of training age and stage of development the lower the volume of plyometric activities.

Intensity. Greater intensity will raise the training demand. But it is important to remember that the nature of plyometric exercises demands high intensity work for optimum return. Generally the more advanced the athlete the greater the tolerance for a volume of higher intensity work.

Density. This refers to the number of times plyometrics is repeated within a particular training cycle. The greater the density the greater the training demand. As a general rule it is probably inadvisable to include more than three plyometric sessions in a seven day workout cycle.

Training Age. This is defined as the number of years an athlete is in a formal training program. At younger training ages the overall training demand should be kept low. With beginners the exercises or games should be of low nervous system demand and low motor complexity. It is possible to get a large number of contacts with minimum stress through game activities such as jump rope, jumping relays, etc.

Basic Strength. Conventional wisdom dictates that in order to begin plyometric training there are prerequisite strength levels which are necessary. Criteria such as the ability to squat two times body weight or leg press two and

one half times body weight are quite high and in many cases unreasonable. This is based on my practical experience, research, and the growing understanding of the physiological basis of plyometric training. This is not to say that basic strength is not important, rather it is only one of many factors that must be considered before beginning plyometric training. Strength is not the sole determining factor. For youth, high maximal strength levels are not necessary or realistic, especially considering relatively low body weight involved.

To begin to incorporate plyometric training in a program the prime concern is strength in the stabilizing muscles in order to prevent injury. Stabilization strength level can be determined by several simple easily administered and interpreted tests (Table #1). If the athlete is unable to satisfactorily perform these tests then he or she should begin on a remedial program of balance and stabilization exercises to bring these qualities up to acceptable standards before incorporating plyometrics into the training program.

The next concern after stabilization strength is eccentric strength. Eccentric strength is the limiting factor especially in more complex high volume and high intensity plyometric training. Without adequate levels of eccentric strength rapid switching from eccentric to concentric work becomes very inefficient.

It is possible to evaluate eccentric strength through stabilization jump tests (Table #2) and observation of basic jumping exercises. If on observation you see an excessively long amortization phase and a slow switching from eccentric to concentric work then eccentric strength levels are not adequate and the training should be remedial and low in volume and intensity. The specific goal before any emphasis on plyometric training should be to raise the level of eccentric strength to an acceptable level.

Skill. Proper execution of the exercises must be continually stressed regardless of the proficiency level. For the beginner It is especially important to establish a sound technical base upon which to build the higher intensity work. Jumping is a constant interchange between force production and force reduction leading to a summation of forces utilizing all three joints of the lower body: the hip, knee, and ankle. The timing and coordination of all limb segments will yield a positive ground reaction force which results in a high rate of force production. Table #3 is a checkpoint guide for skill analysis. This checkpoint is especially valuable when coupled with high speed video.

A key element in the execution of proper technique is the landing. The shock of landing is not absorbed exclusively with the foot, rather it is a combination of the ankle, knee, and hip joints working together to absorb the shock of landing and then transfer that force. The proper utilization of all three joints will allow the body to use the elasticity of the muscles to absorb the force of landing and then utilize that force in the subsequent movement.

This is not to minimize the importance of the foot strike. The foot strike is on the full foot in order to use the foot to help absorb the shock. It is incorrect to land either completely on the heel or on the ball of the foot. This type of landing will transfer high impact forces through the bone and the ankle and knee joints rather than allowing the muscle to absorb the shock. The athlete should react to the ground as if the ground is hot to emphasize quickness off the ground. Loud slapping noises on landing indicates that the landing technique is incorrect and the exercise should stop.

Upright carriage of the torso is necessary in order to insure proper projection of the center of mass and avoid undue strain on the lower back. Correct postural alignment is directly related to core (torso) strength. If the athlete is having problems holding the torso erect during the movements, this problem should be addressed immediately through a core strengthening program. This program should consist of exercises to strengthen the abdomen and the spinal erector muscles as well as the rotational muscles of the trunk. The arms make a significant contribution both in terms of balance and in force production. Research has shown that the arms can contribute up to 10% to the jump. It is important to learn to use the arms to transfer momentum to the whole body through a correct blocking action. It has been my experience that the torso position and the synchronization of the arms are the aspects of technique that are most difficult for the beginner to master.

Progression. A well defined progression will go a long way to eliminating some of the inherent risk of plyometric training. The following sequence is one that I used over the years. Do not be in a hurry, master each step before proceeding. Within each step there can be built in increasing levels of difficulty depending on the level of athlete and their aptitude for learning. Appropriate beginning activities include jump rope, hop-scotch, sack races, various jumping and hopping relays to reinforce the natural movement patterns. Double leg takeoffs are preferable to single leg takeoffs at the beginning stages. The amplitude of the movements should increase as the level of mastery of the exercises raises. It is of paramount importance that there be continual emphasis on coordination, fluid movement and

reinforcement of correct motor patterns regardless of what step in the progression. The progression in teaching and training is:

1. **Landing** - The goal is to teach proper foot strike, use of ankle/knee/hip, to absorb shock and correct body alignment. Begin with a simple standing long jump with a two foot landing. This should be a sub maximal jump with the emphasis being on "sticking" the landing. Land quietly on a full foot and absorb shock by bending the ankle knee and the hip. Repeat several times until comfortable then hop out onto one foot. The objective is the same. Repeat until comfortable.
2. **Stabilization Jumps** - To reinforce correct landing technique and raise levels of eccentric and stabilization strength. The same as the last step. The main difference now is that the athlete will hold the landing position for a five count. Repeat until the athlete can stick and hold three hops on each leg for a five count.
3. **Jumping up** - To teach the takeoff action and the use of the arms. Start with a stable bench or box that is knee height. Jump up onto the bench. Emphasize a forceful swing of the arms to transfer momentum to the whole body. Progress to mid thigh height. The first three steps should be accomplished within the first teaching or training session.
4. **In Place Bouncing Movements** - To teach quick reaction off the ground and vertical displacement of the center of gravity. Begin step four which is the start of the second session by reviewing the first three steps. This will serve as a good warm-up as well as a review of the concepts. This step entails teaching an ankle bounce movement, which is essentially like jumping rope without the rope. Then teach a tuck jump emphasizing quick reaction off the ground while bringing the knees to the chest. Keep the torso erect. Also check to see if the athlete has the balance and body control to stay in one place. If they cannot then you should not move on. In this session also teach a scissors jump in order to lead up to the cycling action of the legs that will come into play in the next step. This all should be accomplished within the second session.
5. **Short Jumps** - To teach horizontal displacement of the center of gravity. Begin by reviewing the previous four steps. Start with three consecutive repeat standing long jumps (Two foot takeoff & landing) and progress to five repeat standing long jumps. Do the same thing up stairs. Jumping onto every other stair. Teach the single leg hop. Work up ten consecutive hops on each leg. Emphasize the cyclic action of both the hopping and the free leg. The action should resemble a single leg run. Repeat this step for two to workouts before progressing to the next step.
6. **Long Jumps** - To add more horizontal velocity. In this step teach alternate leg bounding and various combinations of hops and bounds carried out for ten to twenty contacts. This is as far as most athletes should progress in the first year of training. It is possible to increase the volume, intensity and complexity of the workouts by adding exercises and combinations of the three six steps.
7. **Shock Jumps** - High nervous system demand. This is an advanced form of training that requires a large training base. This consists of jumps down off of boxes or rebound jumps over hurdles placed at mid thigh height or higher. The training stress is high therefore this method should be used judiciously. It is inappropriate for the beginner.

Conclusion

Plyometric training has tremendous potential as a training method for all sports that require explosive power. Improperly introduced and taught it is a high risk low return training activity. To optimize the returns it is necessary to follow the general guidelines set out in this article.

To review a Balance and Stabilization Testing procedure go to the conclusion of this article on Vern's website at http://www.gambetta.com/articles/a97008.html

Vern heads his own consulting firm, Gambetta Sports Training Systems. He was the conditioning consultant for the US Men's 1998 World Cup Soccer team. In 1996-1997 he was conditioning coach for the Tampa Bay Mutiny Major League Soccer team. He was Director of Conditioning for the Chicago White Sox Minor League Program from 1987 to 1996. Vern is recognized internationally as an expert in training and conditioning and has worked with world class athletes and teams in a variety of sports. He is a popular speaker and writer on conditioning topics, having lectured and given seminars and clinics throughout the United States, Canada, Japan, Australia and Europe.

Vern's coaching experience spans 30 years at all levels of competition. He has coached both cross country and track and field. At Santa Barbara High School he coached boys' and girls' track teams to a combined record of 81 wins and 12 losses. From 1977-1982, he headed the women's track and cross-country program at the University of California, Berkeley. His cross-country teams won three Region 8 titles and finished in the top ten at Nationals four consecutive years. Vern received his BA from Fresno State University in 1968 and his teaching credential with a coaching minor from UCSB in 1969. In 1973-74, Vern attended Stanford University and obtained his MA in Education with an emphasis in physical education.

Visit Vern's website at www.gambetta.com