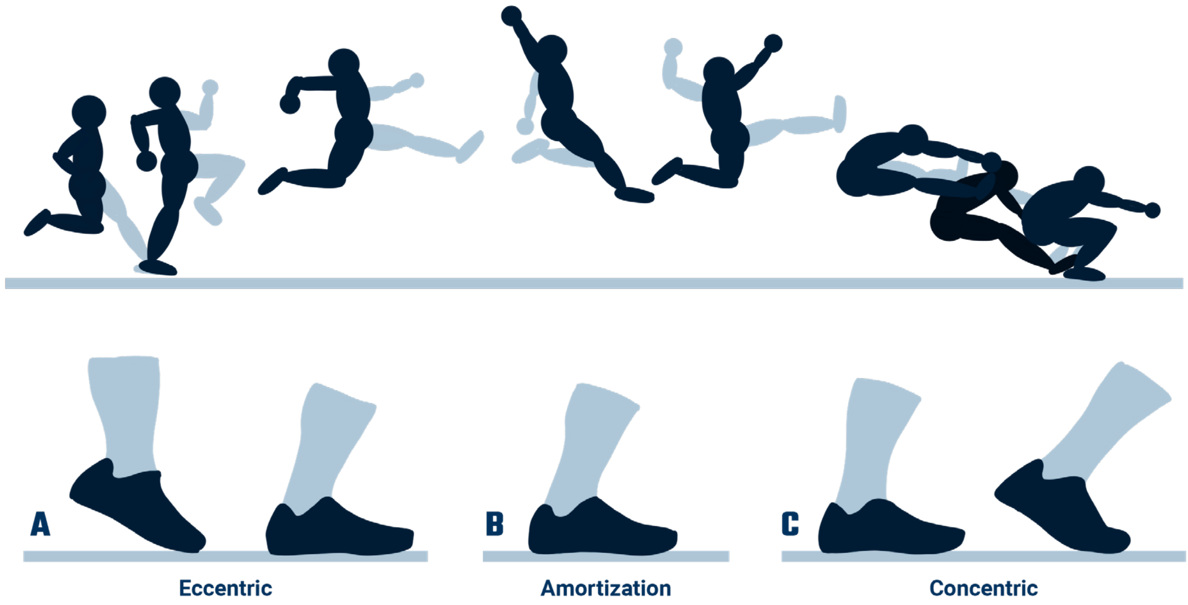
Plyometrics

Plyometrics are exercises in which the muscles exert maximum force in short periods of time, with the goal of increasing power (speed-strength). This training focuses on the athlete's ability to switch from an eccentric to a concentric contraction in a rapid or "explosive" manner, such as in jumping or bounding exercises. Since its introduction in the early 1980s, two forms of Plyometrics have evolved. In the original version of Plyometrics, created by Russian scientist Yuri Verkhoshansky, it was defined as the shock method. In this, the athlete would drop down from a height and experience a "shock" upon landing. This in turn would bring about a forced eccentric contraction which was then immediately switched to a concentric contraction as the athlete jumped upward. The landing and take-off are executed in an extremely short period of time, in the range of 0.1- 0.2 seconds. The shock method was an effective method used by athletes to improve their speed, quickness, and power after development of a strong strength base. Rather than using the term Plyometrics to indicate exercises utilising the shock method, it may be preferable to use the term explosive or true Plyometrics which can be considered the same as the Plyometrics originally created by Verkhoshansky. The shock method created was the result of studying the actions that occur in running and jumping. It was found that the landings and take-offs in these two skills involved high ground reaction forces that were executed in an extremely quick and explosive manner. For example, time of execution of the landing and take-off in jumping was close to 0.20 seconds and in sprinting it was approximately 0.10 seconds. The second version of Plyometrics, relates to doing any form of jump training regardless of execution time. Such jumps cannot be considered truly Plyometric since the intensity of execution is much lower and the time required for transitioning from the eccentric to the concentric contraction is much greater, making it more ballistic in nature as opposed to Plyometric. As a result, it is important to distinguish which type of "Plyometric" exercise is used in order to determine its effectiveness and potential to receive the benefits associated with Plyometric training.

Stretch Shortening Cycle

The mechanism of the stretch shortening cycle (SCC) is the predominant factor that makes Plyometric effective and consists of three distinct phases, the lengthening (eccentric) component, the amortisation (transition) phase and the concentric component. The lengthening phase is the pre-stretch of the muscle whereby the muscle is lengthened and elastic energy is generated to provide a greater and faster contraction during the subsequent concentric contraction. The amortisation phase is the transition time between the eccentric and the concentric components; this is often referred to as the ground contact time. The amortisation phase needs to be a short as possible or the elastic energy generated will be dissipated. The concentric phases is normally referred to as the take-off or push off during a jumping or bounding movement, and the amount of force produced and rate of force development will be dependent upon how much pre stretch occurred within the muscle and how quick the amortisation phase was performed. An example would be to use the elastic band analogy, for example if you were to flick an elastic band, the further the band was pulled back (stretched) and released the further the elastic band would travel, similarly to what happens to a muscle during a Plyometric action. In order for an exercise to be classed as a true Plyometric exercise the amortisation phase must be less than 0.2s.

Fig 19. Different Phases of the Stretch Shortening Cycle



Plyometric Assessment

Before prescribing Plyometric exercises to an athlete their ability to effectively perform a Plyometric movement needs to be assessed to ensure that they not only possess the necessary technique and physical qualities required but are also not at risk of injury through technical or strength deficiencies. The following questions need to be answered to determine how competent an athlete is and therefore what level of Plyometric training they are ready for;

- Can the athlete perform the movements well? (squatting, jumping & landing)
- Are they strong enough to absorb / reduce the impact forces (stiffness)?
- Do they possess symmetry? Left vs. Right?
- Are the reactive? (Efficiency of SSC)

Table 15

Phase 1 (Movement screen)	Phase 2 (Strength testing)	Phase 3 (jump testing)	Phase 4 (RSI testing)
Bi-lateral squat Unilateral squat Box jumps Ankle mobility (dorsi-flexion)	Squat strength (1-3rm) - 1.5 x BW SL squat or leg press strength	Squat jump CMJ EUR Single broad jumps (bi-lateral & unilateral)	30cm drop jumps (RSI) Repeated CMJ's (10 for time) Repeated broad jumps

As illustrated in table 15. The screening process should consist of four different components; Phase 1 the movement screen should be used to assess the athlete's ability to perform basic movement patterns in a controlled environment. Phase 2 consists of assessing the athlete's lower body strength. It is recommended that an athlete can squat 1.5 x body weight before they engage in high intensity Plyometric training. If an athlete presents with poor strength levels, then it is more appropriate to spend time developing this quality before trying to improve speed. Phase 3 involves measuring an athlete's explosive qualities through the implementation of various jump tests and phase 4 examines the athlete's Plyometric ability or more specifically the reactive strength index (RSI). The RSI involves an athlete performing a drop-jump on a contact mat or force platform.

The test was developed to measure how an athlete copes and performs during Plyometric activities by measuring the muscle-tendon stress and their reactive jump capacity. It demonstrates an athlete's ability to rapidly change from an eccentric motion into a concentric muscular contraction and is an expression of their dynamic explosive vertical jump capacity. The index is a useful tool for monitoring an athlete's reactive jump capacity and comparing against normative values, in addition to monitoring training progress. It can also be used to provide recommendations for an athlete's optimal drop height for Plyometric exercises. RSI can be measured by using the either of the following methods;

- Method 1: RSI = Jump Height / Ground Contact Time
- Method 2: RSI = Flight Time / Ground Contact Time

Plyometric Training

Plyometric exercises range from simple bouncing during a warm-up to an intense series of jumps and bounds during heavy training periods. With any risk from training, coaches need to ensure the right mechanics of the exercise is done properly and the right ways to teach the movement patterns and should replicate those movement patterns closest to the sport. The following aspects must be considered when it comes to designing a Plyometric session or programme;

- **Take off and Landing** — how does the athlete take off and land, either from one foot or two? Taking off with either one or two feet may not be a clear indicator of output since many single leg actions with run ups may have a lot of forces such as bounding after a fast acceleration. Many sports require a take-off and landing from 1 leg, therefore consideration must be given to this within the training programme, although not before the athlete has mastered taking off and landing from two legs. Landing is the primary variable that classifies the Plyometric activity. Hops differ from bounds because they stay on the same foot from take-off to landing, and bounding requires an alternation of each leg and can be only one on foot at a time. Efficient landing mechanics must be developed on both two and then one leg, ensuring that ground contact times remain short enough to be classed as a Plyometric exercise.

- **Loads** — it is recommended that only body weight is used when Plyometric training. It is important to remember that Plyometrics are used to develop speed, therefore by increasing the athletes weight will conversely slow down their RFD that they can produce during an exercise. Although the use weighted vests can be used for certain exercises such as depth jumps. Since the single leg demands of bounding and hoping are high, it is not necessary to add external load. Instead jump / hop distances or heights can be increased to apply progressive overload.

- **Force Direction** — are the predominant forces required for the athlete's sport either horizontal or vertical in nature. Plyometric exercises involve either jumping vertically (depth jumps) or horizontally (bounding). The exercises selected should be the ones that have the highest dynamic correspondence to the sport in terms of direction and amplitude of force production.

- **Volume** – plyometric training volume can be determined through both sets x reps and / or more commonly total number of foot contacts. There are some general guidelines on the recommended number of foot contacts based upon the training age of the athlete (beginners 50-100, intermediate 100-150 and advanced 150-200). Although these guidelines are much generalised and don't take into the consideration the phase of the macrocycle or the intensity of the exercises that are being used. A common-sense approach is recommended when it comes to implementing Plyometric exercises i.e. start with low volume-low intensity and progressively increase the intensity of the drills as the athlete(s) becomes more competent. Quality over quantity is key when it comes to Plyometric training.

Exercise Selections and Progressions

The exercise selection should be based upon the level and abilities of the athlete. Plyometric exercises can be placed into a continuum from low complexity – low intensity to high complexity – high intensity with novice athletes working on exercises at the beginning of the continuum and advanced athletes working on exercises towards the end of the continuum. Plyometric exercises complexity is based upon the following factors;

- Intensity - Jump height and landing height (low – high)
- Bi-lateral or unilateral take off and landings (Bi-lateral – Cyclical – Unilateral)
- Direction of movement / force (Vertical – Horizontal – Multidirectional)

Plyometric Exercise Progressions

Table 16

	Level 1	Level 2	Level 3	Level 4	Level 5
Vertical	Squat jump	Box jump	1 leg box jump	Depth jump	1 leg depth jump
Horizontal	Broad jump (double)	Linear leap	1 leg linear leap	Bounding	Resisted bounding
Lateral	Lateral jump (double)	Lateral lead	Lateral hop	Lateral leap to box	Diagonal bound-ing
Reactive 1	Pogo jumps	1 leg pop jumps	Pop-float-skip	SL pop-float-skip	MB OH pop-float-skip
Reactive 2	Tuck jumps	1 leg tuck jumps	High hurdle jumps	MD hurdle jumps	MD hurdle & box jump combos

This table gives some examples of different Plyometric exercise progressions based upon either increasing the intensity, complexity or direction of force.

Plyometric Coaching Points

It is important that Plyometric exercises are coached and executed correctly in order to optimise the force production, whilst also minimising the risk of injury. The following points are key things to be emphasised when coaching Plyometrics with an athlete;

- Maintain good posture – head and chest facing forward (athletic position)
- Land on mid-forefoot, the heels should not contact the floor
- Minimise ground contact times – landing on hot coals
- Maintain ankle dorsiflexion – Toes to shins
- Avoid knee valgus

Further reading

- High-Performance Training for Sports. Joyce D, 2014.
- Plyometrics for Athletes at All Levels: A Training Guide for Explosive Speed and Power: A Training Guide
- for Athletes at All Levels. Pire N, 2006
- High-Powered Plyometrics, Radcliffe J. 2015