# SECTION 3

## THE TRIPHASIC NATURE OF ATHLETIC MOVEMENT

# 3.1: THE IMPORTANCE OF TRIPHASIC TRAINING

The revelation that led to the creation of the triphasic undulating block system and ultimately this book occurred in the fall of 2003. I'm very fortunate to work at a university with an engineering department willing to loan out its $20,000 force plate to a bunch of meatheads over in the athletic building. A huge thanks must go out to that entire department as well as the wealthy guy who donated the money for it. Now, I'm not any smarter than the next guy. I don't claim to be a genius, but I've been blessed with two gifts—logical reasoning and critical thinking. These gifts have allowed me to make certain connections and realizations with training that have enabled me to come up with a training model that generates incredible results for athletes of all sports.

At the time, I had two track and field athletes—throwers—who had me perplexed. One of these athletes (let's call him Ben) was a potential world-class thrower. He could throw the shot over 65 feet. The other athlete, Tommy, was an average D-1 thrower. He had trouble breaking 55 feet. Aside from the large throwing discrepancy, the loads they used in the weight room were basically the same. Nothing jumped out that you could point a finger at and say, "Ah ha, that's why Ben is so good!" or "That must be why Tommy is struggling." I couldn't figure out what the limiting factor was that caused a difference of over ten feet between their top throws. I knew it had to have something to do with their rate of force development (RFD), but I wanted to understand specifically how it applied to their throws. More importantly, I wanted to understand, physiologically, what made the difference between world class and average.

To find some answers, I decided to test their bench press using the force plate. I chose this exercise for two reasons.

1) Specificity: The bench press has direct carryover and transferability to the throwing motion.

2) At the time, both athletes had the same bench press max—415 pounds. Because they both had the same max, it eliminated one of the variables that contributes to RFD—max strength. The other variable is time (which we will talk about in short order).

Wanting to see how Ben and Tommy produced force explosively, I used the band method on the bench press so that I could see acceleration throughout the entire range of motion on the lifts. Without the extra band tension at the top of the movement, both athletes would have had to decelerate the bar halfway through the concentric phase or the bar would fly out of their hands. This early deceleration would skew the results. The band tension ensured that both of them, Ben and Tommy, would drive the bar as hard as they could, generating a high rate of force through the entire range of motion. For those of you not familiar with the banded bench method, the hyperlink gives you a visual of the exercise — Bench press band method

The bar was loaded with 205 pounds (50 percent of their 1RM) and 90 pounds of band tension (20 percent of their 1RM). At the top of the press, each athlete would be moving 70 percent of their 1RM. Both athletes were instructed to bring the bar down hard and fast, stopping it at their chest, and reaccelerating the bar upward as fast as they could. It should be noted that neither athlete bounced the bar off his chest. (I will talk about the importance of this detail in a moment.)

The graph below shows the results recorded by the force plate. The x-axis (horizontal axis) depicts time in hundredths of a second. The y-axis (vertical axis) represents power in watts. In essence, the graph is showing how much force each athlete absorbed and displaced in a given amount of time. Ben's repetition is shown by the dark blue line while Tommy's is shown by the red line. The actual repetitions are taking place during the "V" shaped segment of the lines in the middle of the graph. The descending line of the "V" is the eccentric or yielding phase of the bench press. The bottom, or point, of the "V" is the isometric or static phase, and the line ascending from the bottom of the "V" is the concentric or overcoming phase.

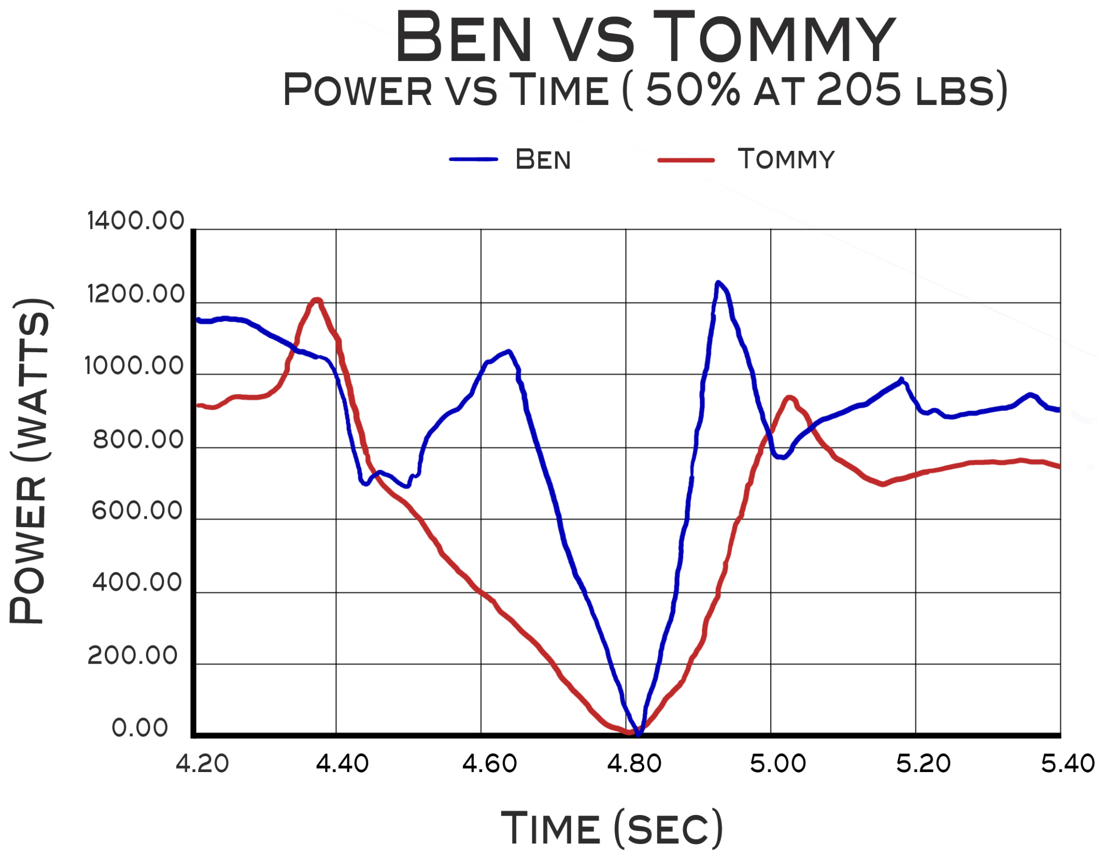


**Figure 3.1:** Graph comparing the ability of Ben and Tommy to absorb and displace force during a maximal dynamic contraction. Notice the athlete that can absorb eccentric force more quickly has a higher power output in the resulting concentric phase.

As soon as I saw the graphical printout for the first time, I realized what separated Ben and Tommy. While both athletes could produce the same amount of maximal force in the bench press (each with a 415-pounds 1RM), Ben could absorb more force eccentrically at a higher velocity. This is where it was essential to make sure that neither athlete bounced the bar off his chest. If they had, they would have eliminated their stretch reflex and lost power in reaccelerating the bar. Instead, the absorbed energy went directly from the bar into their arms, shoulders, and chest, maximizing both the stretch reflex and the stretch shortening cycle (SSC) before being recoiled back into the bar and reaccelerated upward (I'll speak more about the stretch reflex and SSC later.) The graph (figure 1) shows that Ben was able to load up his muscles with more energy to use concentrically, enabling him to accelerate the bar faster than Tommy did, producing more power. Applying this same idea to throwing, Ben could store more energy in his muscles during the stretch of his windup, thus applying more force to the shot before it left his hand than Tommy could. When Ben's shot left his hand, it was powered by a jet engine. When Tommy's shot left his hand, it was powered by a propeller.

You have just learned the key to improving sport performance in every athlete. It isn't about who is the strongest, although many coaches incorrectly believe this to be the case. The key to improved sport performance is producing more force in less time. This results when an athlete can absorb more force eccentrically, allowing him, in turn, to apply higher levels of force concentrically in less time. In other words, the athlete who has the narrowest "V" wins every time. Looking back at Ben and Tommy's graph, it becomes very clear—sport performance is about which athlete can absorb more force, enabling the athlete to produce more power. It's all about the "V" baby!!

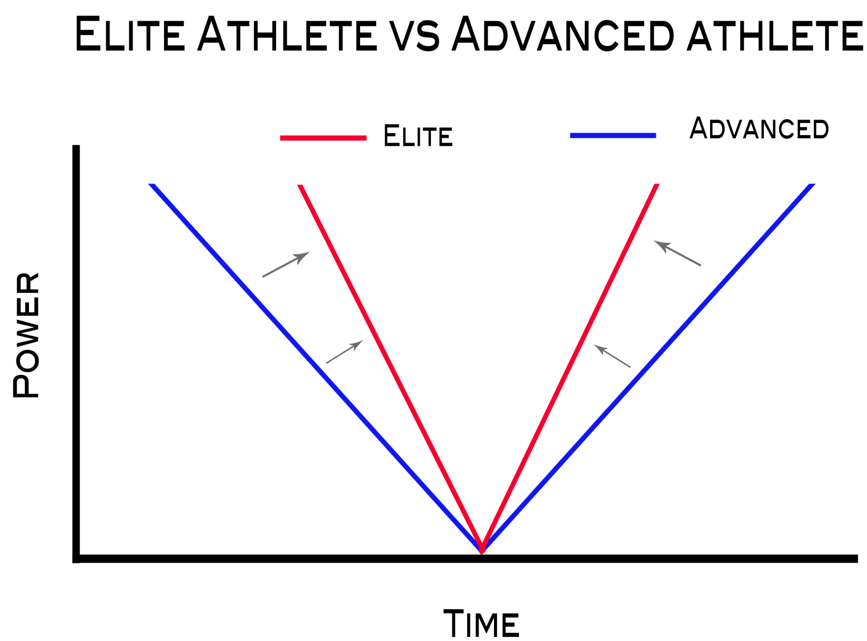


**Figure 3.2:** Graph showing the tri-phasic "V" of an elite athlete (red) verses an advanced athlete (blue). This holds true for any maximal effort, dynamic contraction.

Have you ever noticed that Adrian Peterson breaks a lot of arm tackles? The reason isn't because his legs are huge or because he keeps pumping his knees. Granted, those are contributing factors, but there are many average runners whose legs are just as huge and who pump just as hard. The reason Peterson is able to break so many tackles is because he gets defenders out of position to make a solid tackle in the first place. How does he do that? He has superior triphasic muscle action. When Adrian Peterson goes to make a cut, so does the defender. However, Peterson can decelerate his body more quickly by absorbing more kinetic energy eccentrically in a shorter amount of time, come to an isometric stop, and then explode concentrically in a new direction. The defender meanwhile takes a few hundredths of a second longer to completely decelerate his body. He can't absorb eccentric force at the same rate as Peterson, so he takes longer to decelerate. He has to spread the force out over a longer period of time to reduce the net effect on this muscles. This results in a longer deceleration period as well as less force absorbed into the stretch shortening cycle to be used during the concentric contraction. When the defender does finally make his cut and tries to make the tackle, Peterson is already out of his break and reaccelerating. It's too late. The extra couple hundredths of a second it takes the defender to decelerate has cost him. His only option is to dive at Peterson's legs and try to make an arm tackle.

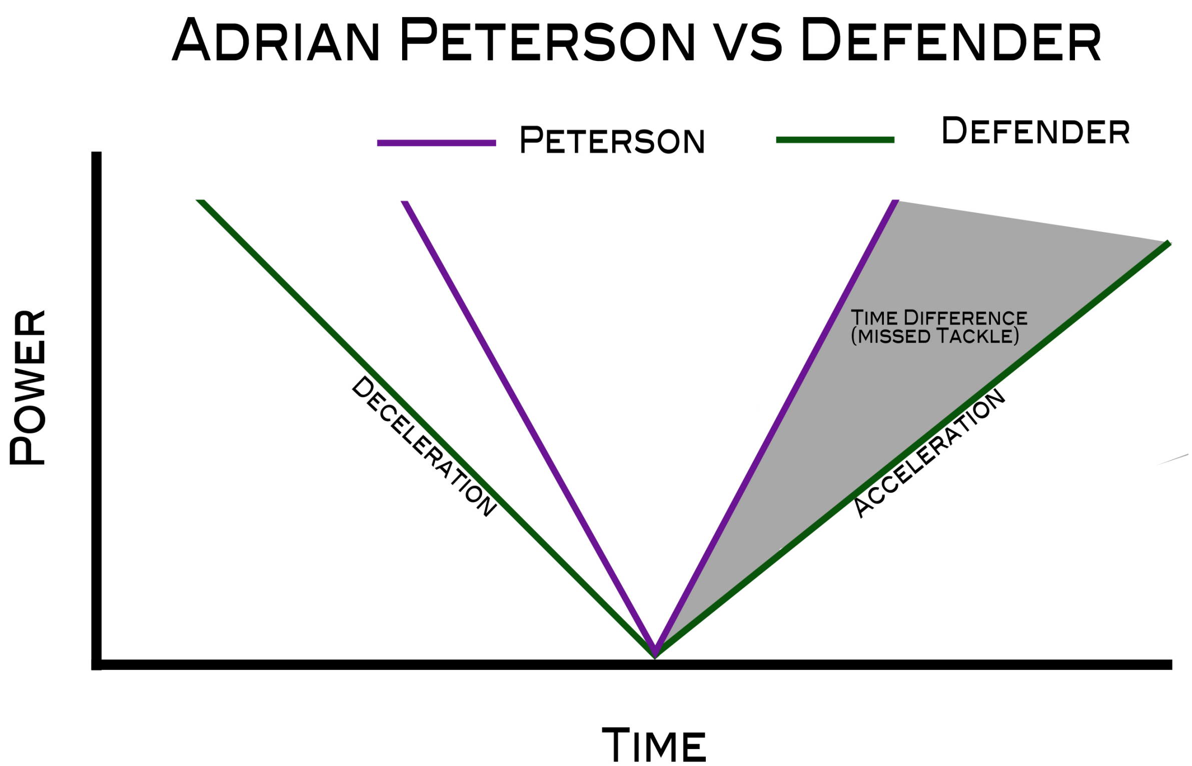


**Figure 3.3:** Graph depicting the difference in rate of force production and power output of Adrian Peterson and a defender. The shaded area shows the increased time it takes the defender to accelerate compared to Peterson.

Many traditional training methods teach athletes how to expel energy; little time and effort is spent teaching them to absorb it. That is the entire point of the triphasic method—learning how to eccentrically and isometrically absorb energy before applying it in explosive dynamic movements. It is important to note that triphasic training and the “V” are improving and referring to maximal dynamic movements only. During a maximal effort dynamic contraction, you will never see the eccentric portion of the “V” at a shallower angle than the concentric portion. The body can't generate more force than it can absorb maximally. If an athlete deliberately slows the rate of the eccentric contraction such as during a slow tempo squat, it's possible for the eccentric rate of force absorption to be less than the resulting force output. However, in anaerobic sports, an athlete never deliberately gives less than 100 percent effort in competitive movements.

As a strength and conditioning coach, you must remember that athletes aren't powerlifters. They must be strong but only to the extent that can benefit them in their sport. Every dynamic human movement has a time frame, a limited amount of time in which an athlete has to produce as much force as possible. Ben was a world class thrower because he could generate more explosive strength (defined as maximal force in minimal time) in the time frame it took to throw a shot. Here are some examples of dynamic movements and their allotted time for force development:

| TABLE 3.1: Time to Maximal Force Development | |
|---|---|
| Dynamic Actions | Time (seconds) |
| Sprinting | 0.08–0.12 |
| Jumping | 0.17–0.18 |
| Shot Put | 0.15–0.18 |
| Powerlifting | 0.8–4.0 |

Looking at table 3.1, it's clear that an athlete doesn't have much time to produce force. Numerous studies have been done showing that the average person takes 0.3 to 0.4 seconds to generate maximal muscular force and sometimes longer—up to 0.7 seconds.[12] Usually these studies are performed by hooking subjects up to an electrocardiogram (EKG) and having them perform a

[12] Khamoui A, Brown L, Nguyen D, Uribe B (2011) Relationship between force-time and velocity-time characteristics of dynamic and isometric muscle actions. *Journal of Strength & Conditioning Research* 25(1):198–204.

maximal isometric contraction. Then researchers look to see how long it takes the muscle to reach its peak force level. With almost all athletic, dynamic movements taking less than 0.2 seconds to complete, athletes will never develop their full force potential during competition. The only sport that does this is powerlifting, where athletes have upwards of three or four seconds to develop all the power they can muster. As a result, it is imperative that you train your athletes for force development, not just maximal strength!

Figure 3.4 shows how large the gap actually is between maximal strength and dynamic strength.[13] The line represents the force development curve of an athlete with the actual rate of development represented by the slope of the line. The dashed line to the right depicts the time it takes the athlete to develop 100 percent of his maximal muscular force (F*m*). The dashed line to the left shows how much force the athlete could produce given a time constraint. In this case, the athlete produced 50 percent of his F*m* in 0.14 seconds.

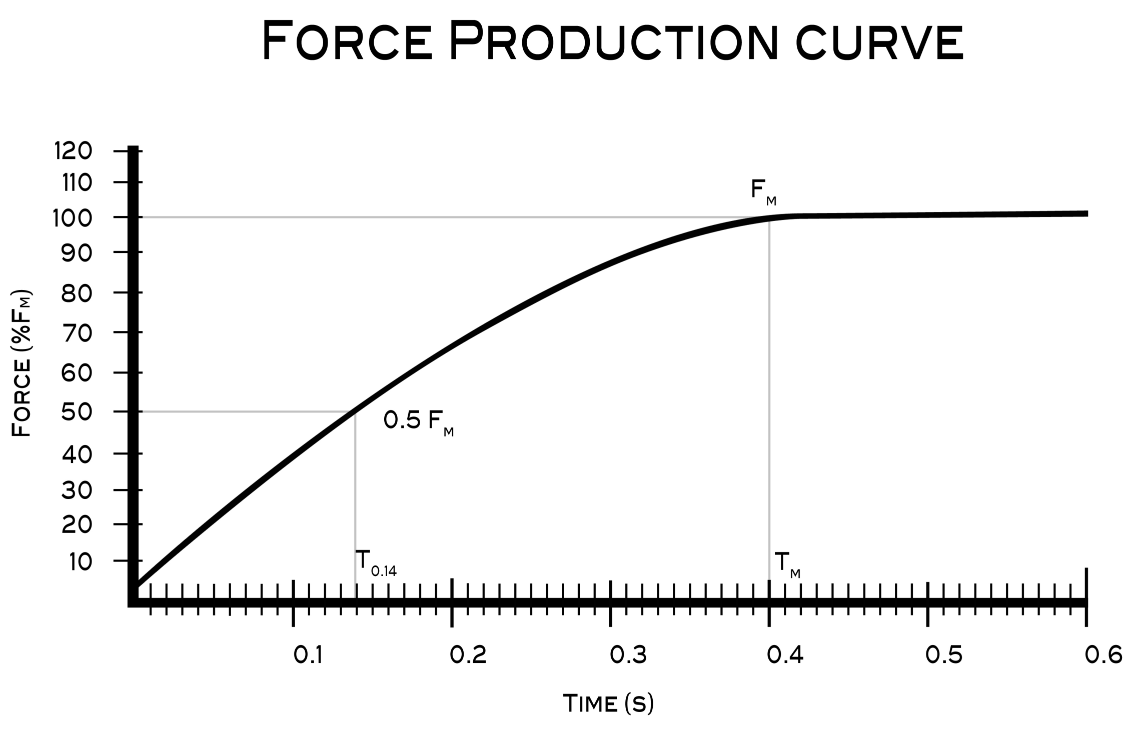


**Figure 3.4:** Graph depicting the difference between maximal muscular force (F*m*) and dynamic force production. It takes roughly 0.4 seconds to develop F*m*, yet most sports only allow 0.14 seconds or less to develop dynamic force.

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[13] Zatsiorsky VM, Kraemer WJ (2006) *Science and Practice of Strength Training*. Champaign, IL: Human Kinetics.

The goal of all athletes should be to increase the slope of the line, in essence shifting the force line to the left and enabling them to produce a higher percentage of their maximal muscular force (F*m*) in the period of time allotted for their sport. In other words, the goal is to shrink the time difference between their maximal strength and dynamic strength. For further reading on the subject, I highly recommend the book *Science and Practice of Strength Training* by Vladimir Zatsiorsky and his explanation of the explosive strength deficit.

Let's go back and look at what Ben and Tommy's graphs would look like. First, let's look at Tommy's. Looking back at our "time to maximal force development table" we see that a thrower has about 0.15 to 0.18 seconds to develop force before the shot leaves his hand. We'll give Tommy the benefit of the doubt and give him the full 0.18 seconds. In the graph below, you will see the red line extending upward from the x-axis at 0.18 and running into the force development curve at a point that correlates on the y-axis to 61 percent. This means that within the time constraint of throwing a shot, 0.18 seconds, Tommy only has enough time to develop 61 percent of his maximal force behind the shot to propel it.

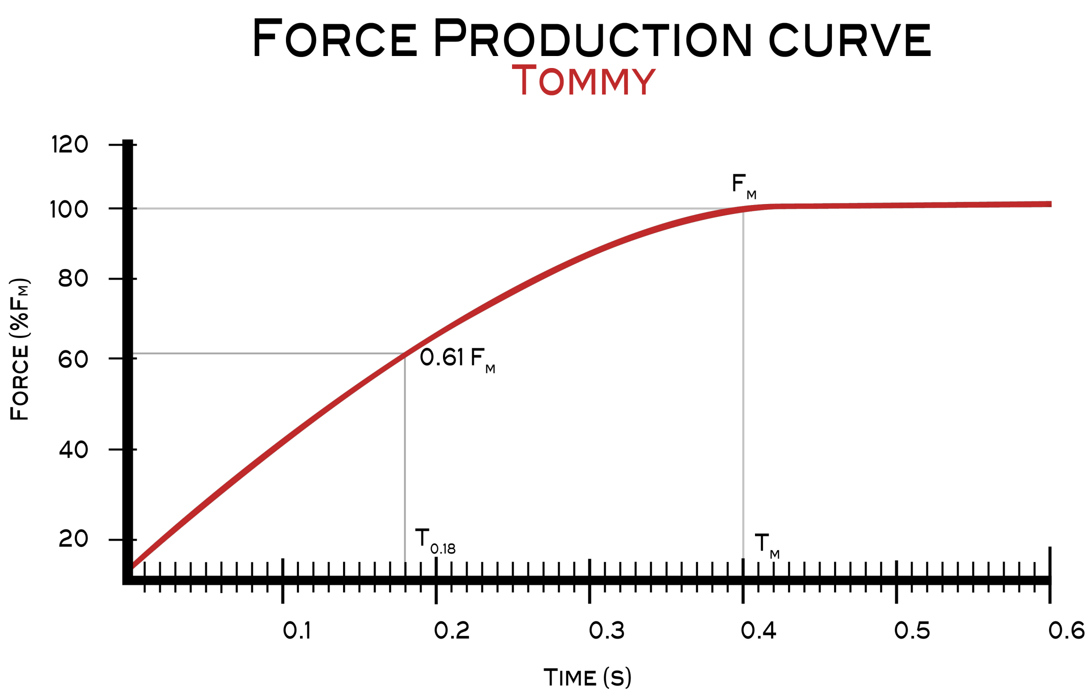


**Figure 3.5:** Graph depicting the theoretical force production curve for Tommy. Notice that in 0.18 seconds, Tommy only produces 61 percent of his F*m*.

Now let's take a look at what Ben's graph would look like. Below you see the same basic graph but now with a blue line extending up from 0.18 seconds on the x-axis. However, the difference is that Ben's force production line is shifted to the left; its slope has increased. The blue line intersects the force development curve at a point associated on the y-axis with 78 percent. This means that Ben, again with the same time constraints as Tommy, could develop 78 percent of his total force behind the shot before it left his hand—a difference of nearly 20 percent!

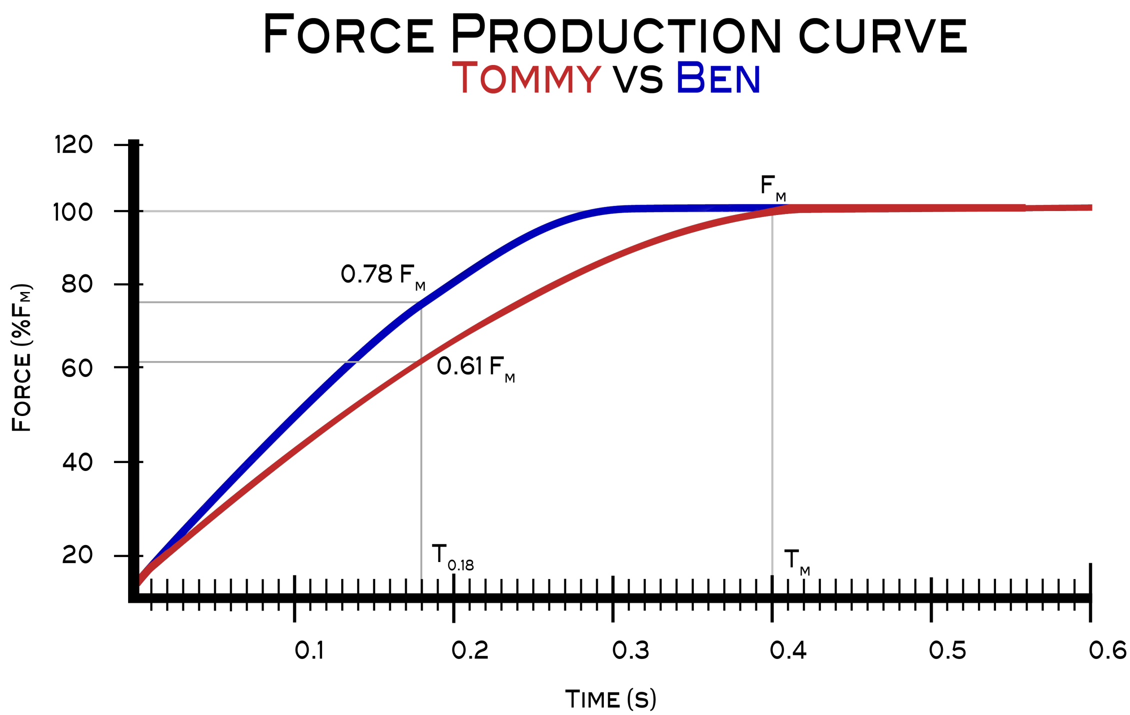


**Figure 3.6:** Graph comparing the force production curves of Ben and Tommy. Ben's curve (blue line) is shifted up and to the left of Tommy's (red line). This shift shows that in the same amount of time (0.18 seconds), Ben can produce 17 percent more of his F*m* than Tommy.

The concept of needing to increase an athlete's RFD is nothing new. I wish I could take credit for it, believe me. But the concept is one that the Russians have known about for decades, researching RFD and training methods since the early 1960s. They came up with a great training method to try and enhance it. *Accommodated resistance*, which is the use of chains, bands, or weight releasers to modify a load to match an athlete's RFD curve, was created to try to maximize an athlete's explosive contraction. The use of these implements allowed the athlete to push all the way through his entire range of motion without having to decelerate the bar at the end, allowing for pure explosive concentric contractions. This concept was identified by Fred Hatfield and termed compensatory acceleration.

The shortcoming of these methods is that they focused solely on the development of explosive strength by emphasizing the concentric phase of dynamic movement. My epiphany—my 'light bulb going off' moment in 2003—was when I first looked at that printout and realized that we (and by "we" I mean strength and conditioning coaches) were approaching the development of force from the wrong angle. The key to improved force production, and thus sport performance, doesn't lie in the concentric phase. In order to develop explosive strength and do so in a manner that is transferable to sport, you must train the eccentric and isometric phases of dynamic movements at a level equal to that of the concentric phase.

I have used the force plate with hundreds of athletes and on dozens of different dynamic movements—everything from plyometric jumps to squats to presses. In every instance, the results come back the same. The better athletes, defined as being those with higher rates of force production, are the ones who can absorb more kinetic energy eccentrically. The steeper the left line of the "V" going in, the steeper the right side of the "V" going out (assuming a maximal dynamic movement).

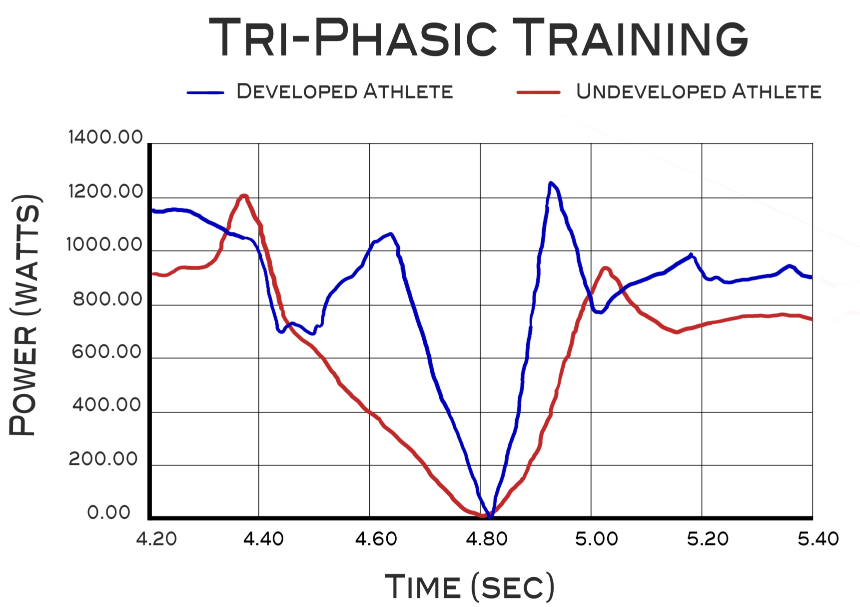


**Figure 3.7:** Tri-phasic "V" depicting elite (blue) and advanced (red) athlete.

Look at the original printout again in Figure 3.7 (and get used to it because you're going to see it about a dozen more times in this book). This is the key, folks. It's the Holy Grail of improved sport performance. Don't think of this graph as depicting two separate athletes anymore. Imagine the graph as depicting the same athlete at different times during his development. The red line is the athlete when he first walks through your doors. The blue line is where the athlete will be by the time he walks out two, three, or four years later. The lines are the same athlete, but one shows the results of an athlete developed using the triphasic undulating system of training while the other is in the early stages of development. Your new goal as a strength and conditioning coach is to narrow that "V" as much as possible.

# 3.2: ECCENTRIC PHASE

Once I realized the importance of the eccentric phase and the role it plays in dynamic movement, I had to answer two more questions—why is it so important and how do I train my athletes to improve it? First, let's address the "why."

An eccentric action can be defined as one in which the proximal and distal attachments (closest to and furthest away from the center of the body) of the muscle move in opposite directions from each other. In other literature, this is often referred to as the lengthening (or yielding) phase as the muscle is stretched due to the force of an imposed load. Now, make sure you read this next sentence very carefully. ***Every dynamic movement begins with an eccentric muscle action.*** I'll write it again. ***Every dynamic movement begins with an eccentric muscle action.*** For example, when an athlete jumps, his hips perform a slight dip, eccentrically lengthening the quads and glutes before takeoff. Counter movements or pre-loading such as the hip dip in jumping are paramount in force production of an athlete. The eccentric yielding of a muscle puts in motion a series of physiological events that pre-load a muscle, storing kinetic energy to be used in an explosive, concentric dynamic movement.

When athletes train the eccentric phase of a movement, they are actually training two physiological processes that contribute to force development. One of them is the most powerful human reflex in the body—the stretch reflex. The other, whose force producing abilities are dependent upon the stretch reflex, is a close second in terms of force production and is called the stretch shortening cycle (SSC).

## STRETCH REFLEX

The net force production of the stretch reflex is comprised of the sum of two proprioceptive nerve signals:

1) **Muscle spindles**, which act as neuromuscular stimulators

2) **Golgi tendon organs (GTO)**, which act as neuromuscular inhibitors

When trained eccentrically, these produce a stretch reflex within the muscle structure that is responsible for explosive, dynamic movement.

The stretch reflex is induced by intramuscular sensory receptors called muscle spindles running parallel to the muscle fibers within a given muscle. The spindles' job is to relay information to the brain via the central nervous system (CNS) about the amount of force acting on a muscle. As the stretch or force on a muscle increases, the muscle spindle will relay information to the brain (afferent neural pathway) telling it how hard it must contract to overcome the force acting on it and return to its original length. The greater the signaling of the muscle spindle, the harder the resulting signal of contraction from the brain (efferent neural pathway). The muscle spindle doesn't know the athlete is trying to lift a weight or make a cut on the field. Its only concern is to stop the eccentric lengthening of the muscle. The primary function of the muscle spindle is to tell the brain how hard it must contract a muscle to overcome a load.

While muscle spindles signal how hard to contract, Golgi tendon organs (GTO) tell the brain when to relax. GTO are found within the tendons attaching muscle to bone. Unlike the muscle spindles, which measure changes in length, the GTO measure changes in the force being placed on a muscle. Inhibitory mechanisms, such as the GTO, are necessary to prevent the muscles from exerting more force than the connective tissues can tolerate. This is referred to as autogenic inhibition. For all intents and purposes, the GTO act like the body's emergency cutoff switch. If the force or stretch being placed on a muscle reaches a point where continued muscular tension will result in serious structural damage (muscle or tendon tearing), the GTO signal an inhibitory muscle reflex (figure 9). The ensuing decrease in muscle tension is intended to prevent serious injury to the muscle structure.

However, we know that this system can be overridden and allow a person or athlete to produce levels of force that are much higher than his normal maximums. An example of a seemingly superhuman feat of strength would be a mother lifting a burning car off her four-year-old daughter. When these people are examined after exceeding their usual maximum strength, there is often significant damage to the musculoskeletal structures, suggesting that the autogenic inhibitory mechanism was deactivated. Numerous studies have also shown that dynamic and ballistic stretching protocols known to help inhibit the GTO response lead to improved force production during both maximal strength and explosive strength testing.[14] While it would not be good to completely shut off this safety measure, training has been shown to reduce the GTO inhibitory impulse, allowing muscles to reach greater levels of force production.

At first glance, the GTO look like good guys. They are looking out for you; they've got your back. They would never let anything bad happen to you. Of course, the problem is that this isn't true. In reality, the GTO act as an overprotective mother. Most people's GTO appear to come pre-set with a "kill switch" set nearly 40 percent below what the structure can actually handle before serious damage occurs.[15] Ultimately, untrained GTO are terrible for the development of explosive power, because they limit an athlete's potential to absorb high levels of force.

When you train the eccentric phase of dynamic movement, you are training these proprioceptive structures of the muscle, the muscle spindles and GTO. In order to maximize an athlete's force producing ability, a coach must use methods in training that will decrease the inhibitory effect of the GTO while maximizing the excitatory response of the muscle spindle. During the eccentric phase of a squat, a stretch is applied to the quadriceps, hamstrings, and glutes that produces via the stretch reflex a muscular contraction. At the same time, the GTO from each of those muscles interpret the force acting on them and cause an inhibitory reflex. If an athlete isn't used to handling high levels of eccentric force, the resulting concentric muscle action will be weakened.

The goal of the eccentric phase is to improve the neuromuscular synchronization of the afferent/efferent neural pathway between the muscle spindle, CNS, and muscle while desensitizing the GTO, allowing the athlete to absorb higher levels of force without triggering an inhibitory GTO reflex. The athlete who can eccentrically absorb more kinetic energy will be able to produce

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[14] Jaggers J, Swank A, Frost K, Lee C (2008) The acute effects of dynamic and ballistic stretching on vertical jump height, force, and power. *Journal of Strength & Conditioning Research* 22(6):1844–49.

[15] Nelson A, Guillory I, Cornwell A, Kokken J (2001) Inhibition of maximal voluntary isokinetic torque production following stretching is velocity-specific. *Journal of Strength & Conditioning Research* 15(2):241–46.

more concentric force and take advantage of the second physiologic muscle action—the stretch shortening cycle.

## STRETCH SHORTENING CYCLE

The SSC, as it relates to the eccentric phase, is responsible for the absorption of kinetic energy within the muscle and tendon. Elasticity means that a structure is able to resume its normal shape (length) after being distorted (lengthened). When a muscle and its attaching tendon are stretched, the elastic energy is stored within these two structures to be used later during the concentric phase. Think of it as stretching a rubber band or loading a spring. The more energy an athlete can absorb, the more energy he can apply dynamically.

The amount of energy that can be absorbed and used by the SSC is largely dictated by the combined effect of the stretch and GTO reflex. Other contributing factors are motor unit recruitment and rate coding, which will be addressed later. However, the percentage that each contributes to total force production is heavily debated among physiologists. Physiologists do agree, however, that the intensity of the eccentric contraction dictates the signal from the muscle spindle and how hard a muscle contracts. Simultaneously, the GTO signal the brain to relax the muscle to avoid injury. The sum difference of those two signals is the remaining energy (force) that is absorbed into the muscle/tendon to be used in the concentric phase. You can think of this as a formula:

**Stretch Reflex – Golgi Tendon Organ Reflex = Force Production**

The amount of force an athlete can eccentrically load into a muscle/tendon is directly proportional to the amount of force he can apply. This is a principal law of physics known as *the law of conservation of energy*, and no, we aren't going to go into a physics dissertation. Just trust me.

Let's go back to the "V" so you can see exactly what I'm talking about. When you look at the graph below, you begin to see that there is a correlation between the eccentric and concentric phases. The steeper the eccentric line is coming into the bottom of the "V," the steeper the concentric line is leaving the bottom of the "V." The greater the velocity of stretching during the eccentric contraction, the greater the storage of elastic energy. This goes back to what we went over with the stretch reflex, GTO reflex, and the SSC. The athlete who can handle higher levels of force through an increased stretch reflex and inhibited GTO reflex will be able to apply more force concentrically due to higher levels of absorbed kinetic energy applied through the SSC.

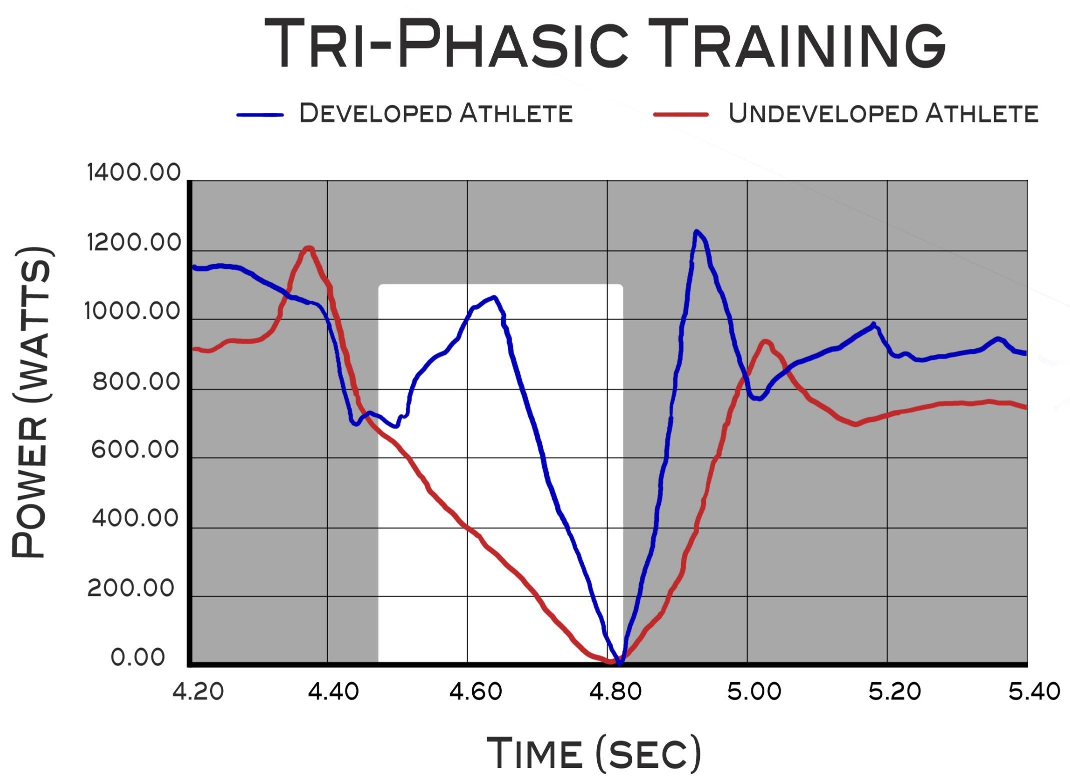


**Figure 3.10:** Graph showing the importance of a well trained stretch reflex and inhibited GTO. The developed athlete (blue line) can absorb/withstand higher levels of eccentric force than the underdeveloped athlete (red line). This leads higher rates of force production and higher power outputs during the concentric phase.

I promise you that you'll never see an athlete whose "V" comes in with a gradually descending line (figure 3.10, red line) and leaves with a steeply ascending line (figure 3.10, blue line) in a maximal effort dynamic movement. That's because it's impossible according to Newton's second law of motion:

> *The acceleration of an object as produced by a net force is directly proportional to the magnitude of the net force, in the same direction as the net force, and inversely proportional to the mass of the object.*
>
> - Sir Isaac Newton

In layman's terms, that means the force applied by an athlete is directly proportional to the energy he first absorbs. For every athlete I checked, if the eccentric line was shallow, meaning the line had a more gradual downward slope (remember slope is rise/run so that means the athlete is absorbing less force over a given amount of time), the concentric line was also shallow, meaning it had a more gradual upward slope.

I should interject that there are limits to this law. It doesn't apply with certain external variables such as high loads. If an athlete dropped fast with a 100 percent max squat, it would be impossible for them to absorb all that force eccentrically. As a result, their GTO reflex would outweigh the stretch reflex. The muscle would relax to prevent serious structural damage, and the athlete will be crawling out from under the bar. This is irrelevant anyway because an athlete doesn't have the time to produce 100 percent of his maximal force potential within the time constraints of dynamic movement. Remember, these laws and the examples I have referenced only apply when an athlete is performing a dynamic action with maximal intent. Submaximal effort during any of the three phases will result in altered force production patterns.

Now that you have an understanding of "why" it is important to train the eccentric phase of dynamic muscle action, let's get to the "how." The next part of this section will show that you can maximize the power of the stretch reflex, reduce the inhibition of the GTO reflex, and turn your athletes into SSC powerhouses.

## HOW TO APPLY ECCENTRIC MEANS

The most effective means in applying stress to the athlete to improve the eccentric qualities outlined above is to have them perform large, compound movements with an accentuated (slow) eccentric phase. The extended time under eccentric tension allows both the muscle spindle and GTO to adapt and "feel" higher levels of stress than would be present during normal, dynamic lifting. This stress response will potentiate the muscle spindle and inhibit the GTO, leading to an improved SSC and increased force production.

As a coach, you must remember that eccentric specific work is extremely taxing on an athlete's nervous system. Studies have found that eccentric training recruits fewer total motor units compared to concentric training.[16] This, in turn, increases the amount of stress placed on each of the recruited motor units, which can lead to fatigue. In addition, some research has shown that eccentric training seems to preferentially recruit Type II, high threshold/fast twitch motor units, motor units that are imperative in the development of anaerobic power.[17] Due to the volatility of these means, a coach must understand their capabilities and know when to use them to maximize adaptation.

Because eccentric training places large amounts of stress on the athlete, eccentric specific work should only be performed with large, compound exercises at the beginning of a workout. As an athlete progresses, becomes more advanced, and adapts to higher levels of stress, eccentric means can be introduced throughout the workout. The remainder of the workout should consist of exercises that work the specific parameter being trained within the athlete's current block with loads that fit within the undulation for that day.

For example, an athlete who is on a strength block with an undulated load goal of 80 percent will perform heavy, slow eccentric back squats at the onset of the workout with a load that equals 80 percent of his 1RM (for sets and reps, see table). Once complete, the athlete will proceed through the rest of the workout using exercises with loads of 80 percent (in keeping with the undulated model). These exercises are to be performed with a dynamic focus, moving the load as fast as possible.

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[16] Owings T, Grabiner M (2002) Motor control of the vastus medialis oblique and vastus lateralis muscles is disrupted during eccentric contractions in subjects with patellofemoral pain. *The American Journal of Sports Medicine* 30(4).

[17] Howell et al. (1995).

Table 3.2 shows the rep ranges and sets that constitute the eccentric loading variables. In addition, the loading variables are allocated by color, showing the parameters for each mesocycle:

**Table 3.2: Eccentric Loading Parameters and Their Respective Mesocycle**

| Load | Total Time of Eccentric (seconds) | Rep Range | Sets | Mesocycle |
|---|---|---|---|---|
| 85% | 5–6 (Assisted) | 1–2 | 1–2 | Above 80% |
| 80% | 5–6 (Assisted) | 2–3 | 2–3 | |
| 75% | 6–8 | 3–4 | 3–4 | 80-55% |
| 70% | 6–8 | 4–5 | 4–5 | |
| 65% | 6–8 | 5–6 | 5–6 | |
| 60% | 6–8 | 5–6 | 5–6 | |
| 55% and below | Eccentrics not implemented with these loads | | | Below 55% |

To maximize the eccentric adaptation and ensure the safety of the athlete, there are a couple rules I follow. Based on what I've seen over the past twenty years, following these rules yield the best results for my athletes when performing eccentric focused work:

**1. Due to the intense stress placed on the athlete by eccentric training, its application should be limited to large, compound exercises.**

When an athlete is first exposed to eccentric training, their physiological system will likely only be able to handle one compound exercise per workout (as always, certain "genetically gifted athletes" are the exception to this rule). This exercise should be placed early in the workout while the nervous system is fresh, allowing for maximal focus on the parameter being trained. As athletes progress, that is to say as their training age increases (two to four years of experience), a coach is able to introduce additional eccentric training throughout the workout. This is possible because the athlete has adapted and is able to handle higher levels of stress without excessive fatigue. For example, a more advanced athlete can start a workout with heavy eccentric back squats and then add eccentric Romanian deadlifts and single leg eccentric dumbbell squat.

**2. Never perform slow eccentrics with loads greater than 85 percent of an athlete's 1RM.**

This rule is based on my own risk/reward analysis. To me, the risk is far too great to have an athlete with a weight close to, at, or above his 1RM load his body for an extended period of time. I've seen torn pecs and quads, blown backs, and screwed up shoulders. At the end of the day, you can get the same physiological adaptation using lighter loads for longer times with half the risk.

**3. Always spot the athlete when performing slow eccentrics.**

This is a widely practiced rule when an athlete is trying to lift heavy loads, but some coaches may not see the need when using lighter, submaximal loads. You must remember that when performing eccentrically focused training, you're maximally taxing the eccentric minded nervous system and the physiological structures it supports, even with submaximal loads. As you can see in Table 3.2, as the load decreases, the time of the eccentric increases. The resulting increase in time under tension means an athlete's muscular system could give out at any point during the lift, so proper spotting is crucial.

**4. Always finish an eccentric focused lift with an explosive, concentric movement.**

As a coach, the most important aspect of performance that you're constantly trying to improve within the athlete is his nervous system. Every jump, cut, and throw an athlete makes begins with an eccentric lengthening of the muscle and ends with an explosive concentric contraction. The neurological pathways that signal these contractions are entirely different and independent of one another. Each time the athlete's nervous system transitions from the eccentric to the concentric phase, it has to change its firing pattern to initiate the next part of the movement. The signal has to jump switchboards, if you will. It is imperative to an athlete's success that this process is as fluid and seamless as possible. The bar will not necessarily move fast, especially using heavy eccentric loads, but the intent to accelerate the bar, changing over from an eccentric to a concentric signaling pattern, must be trained every time an athlete performs a repetition.

In sections four, five, and six of this book, I'll show you how to take these eccentric means and rules of application to build programs for your athletes that effectively maximize the kinetic energy absorption capabilities of their stretch reflex while optimizing the explosiveness of their SSC. For now, simply understand which types of exercises should be used as well as the loads and repetition ranges associated with each. Table 3.3 outlines some, but not all, possible eccentric focused exercises.

| TABLE 3.3: EXAMPLE EXERCISES WITH ECCENTRIC MEANS | |
|---|---|
| **EXERCISE** | **COACHING POINTS** |
| Back Squat - Eccentric | 1. Set up with the bar on the back of the shoulders.<br>2. Keeping the chest up and the back flat, sit back as if to a chair.<br>3. Descend into the bottom of the squat in the prescribed time.<br>4. Once the time has been reached, explosively fire up back to the start. |
| Front Squat - Eccentric | 1. Set up with the bar on the front of the shoulders.<br>2. Keeping the chest and elbows up and the back flat, sit back as if to a chair.<br>3. Descend into the bottom of the squat in the prescribed time.<br>4. Once the time has been reached, explosively fire up back to the start. |
| RDL - Eccentric | 1. Grab the bar just outside of the thighs with the feet shoulder width apart.<br>2. Keeping the back flat and the chest up, bend the knees slightly.<br>3. Allow the bar to slide down the thighs for the prescribed time.<br>4. Once the time has been reached, explosively fire up back to the start. |
| Bench Press - Eccentric | 1. While laying on your back, grab the bar one thumb length away from the knurling.<br>2. Unrack the bar, keep the shoulders pulled back, and pull the bar into the chest.<br>3. Lower the bar in the prescribed time until it touches the chest.<br>4. Once the time has been reached, explosively fire up back to the start. |
| DB Shoulder Press - Eccentric | 1. Begin standing with a dumbbell in each hand, palms facing each other.<br>2. Press the dumbbells up explosively to begin the exercise.<br>3. Lower the dumbbells back to the shoulders in the prescribed time.<br>4. Once the time has been reached, explosively fire up back to the start. |
| Cambered Bar Squat - Eccentric | 1. Using a cambered bar, set up just as you would for the back squat.<br>2. Keeping the chest up and the back flat, sit back as if to a chair.<br>3. Descend into the bottom of the squat in the prescribed time.<br>4. Once the time has been reached, explosively fire up back to the start. |
| Close Grip Bench - Eccentric | 1. While laying on your back, grab the bar with the pointer on the edge of the knurling.<br>2. Unrack the bar, keep the shoulders pulled back, and pull the bar into the chest.<br>3. Lower the bar in the prescribed time until it touches the chest.<br>4. Once the time has been reached, explosively fire up back to the start. |

# 3.3: ISOMETRIC PHASE

Understanding the eccentric phase is only one-third of the battle. Knowing how an athlete can increase power output through improved eccentric muscle action is useless unless that athlete has a way to harness that power to use concentrically. The isometric phase poses a unique challenge in that it is both the hardest of the three phases to explain and the most important to understand. It is difficult to describe due to its duration; it is practically instantaneous with a nearly indistinguishable beginning and end. Yet, it is imperative to understand its impact on force development.

Essentially, the isometric phase is the energy transfer station of all muscular actions, turning absorbed eccentric energy into explosive, concentric actions. Once again, I had to answer two questions—why is the isometric phase so important as it relates to dynamic athletic movement and how do I train my athletes to improve it? First, let’s answer the “why” question.

The term itself, isometric, is a combination of the Greek roots “iso,” which means “same,” and “metric,” which means distance—same distance. An isometric action can be defined as one in which the proximal and distal attachments of a muscle don't move in relation to each other; muscle length remains constant. It occurs when the force being exerted by a muscle equals the force being imposed on it by a load. Now, part of that definition—muscle length remains constant—isn't entirely accurate. It would be more precise to define an isometric action by saying that it's the joint angle, not the muscle, that remains constant. During an isometric phase of dynamic movement, a muscle moves quite a bit, albeit very minutely. Remember, we are talking about an isometric *contraction*. I often find people getting confused during this phase because they fail to think of an isometric action as a contraction. They envision an isometric action as a hold or a state of non-movement. They probably get that from all those iso-squat holds their high school football coach had them do with a 45-pound plate over their heads as punishment for starting a food fight in the cafeteria. No? Didn’t happen to you? Never mind then.

When you begin to think of the isometric phase as a contraction, you realize that it is trainable—just like every other muscle action. Similar to the eccentric phase, the isometric phase has two neurological processes that need to be trained to maximize the force transfer from the eccentric to concentric contractions. When muscles need to increase their level of force production, as in the instance of decelerating and stopping an eccentric contraction, they have two options:

1) **Motor unit recruitment:** Increase the number of muscles fibers that fire.

2) **Rate coding:** Increase the rate at which each of these fibers fire, which increases muscular tension.

I firmly believe that the neural pathways stimulating each of the phases are independent of one another. The neuron pathway in charge of signaling an isometric contraction is different than the one stimulating the eccentric, and that pathway is different from the concentric signaling pathway. At the very least, the signaling frequencies or rates are substantially different enough that the body must learn how to maximize the effectiveness of each phase independent of the others. Training just the eccentric or isometric phase doesn't make a more dynamic, explosive athlete. All three phases must be trained to maximize their unified effect. A study by Gordon and colleagues (1998) found that there isn't any significant enhancement of maximal concentric force when training with only accentuated eccentric resistance.[18] That piece of information is vastly important to strength and conditioning coaches, as it shows that each phase of the system must be trained independently of the others to improve the net effect—dynamic force production. By increasing the amount of motor unit recruitment as well as the rate coding of an athlete's isometric phase, we enable that athlete to produce more force in less time.

## MOTOR UNIT RECRUITMENT

Motor unit recruitment is dictated by the size principal—a recruitment pattern based on the size of the motor neuron and the number of fibers it innervates. Think of the motor neurons arranged from smallest to largest like you see in Figure 3.11. In addition to being allocated by size, research has conclusively shown that the larger motor neurons innervate primarily Type II or fast

[18] Godard M, Wygand J, Carpinelli R, Catalano S, Otto R (1998) Effects of accentuated eccentric resistance training on concentric knee extensor strength. *Journal of Strength and Conditioning Research* 12(1).

twitch muscle fibers. As the force imposed on a muscle increases, additional larger motor neurons are recruited.

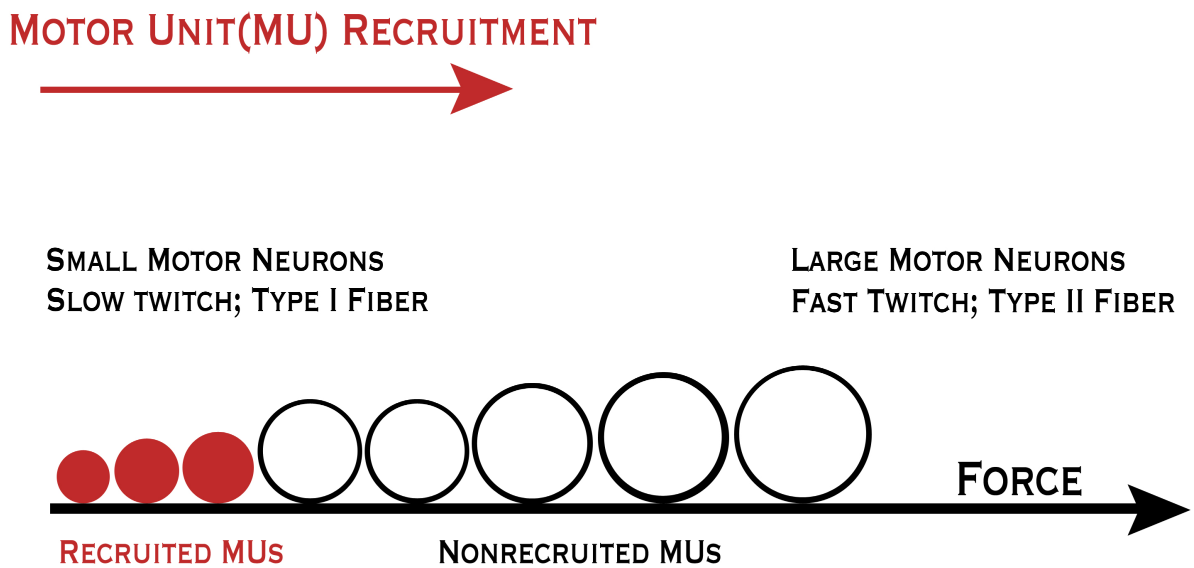


**Figure 3.11:** Size principle of motor neuron recruitment. The motor neurons are arranged according to their size. The small motor neurons innervate slow twitch fibers while large motor neurons innervate fast twitch fibers. When the muscle force increases, the motor neurons are activated (recruited) according to size from small to large. In this figure, the required force is slow and only small motor neurons are recruited. When the force builds up, the number of active motor units increases and the fast motor units are recruited. Adapted from Brooks, Fahey, & Baldwin (2005).

As an example, think of motor unit recruitment as one of those games you would play at the state fair or Six Flags, the one where you walk up and give a guy five bucks to swing a sledgehammer as hard as you can and hit a base that shoots a small weight up a pole, trying to ding the bell at the top to win a stuffed toy. This game usually has a set of lights that runs up the pole from the base to the bell. When you hit the base, the lights turn on in order from the base up to the highest point that the weight reaches before gravity wins out and it falls back down to earth. The harder you hit the base, the more lights turn on as you produce more force to propel the weight upward.

The same basic thing occurs during the isometric phase of dynamic movement. The more force that is applied eccentrically (the sledgehammer), the higher the resulting level of motor unit recruitment must occur (more lights turn on) to decelerate and stop the load. The only difference between an athlete's nervous system and the lights on the pole is that the athlete must be trained to respond instantly to increased levels of force. By improving the isometric strength of athletes through muscle recruitment, you are enabling them to ping a higher light on the pole, activating larger, higher end, fast twitch motor units. This enables more force to be absorbed into the stretch reflex and SSC, the result of which will be a higher level and rate of force development.

## RATE CODING

As a general rule, the firing rate or discharge frequency of a motor neuron can vary widely. Rate coding is the primary responder when a muscle needs to build intramuscular tension quickly to overcome an imposed load. To do this, the nervous system is taught to increase the frequency of signaling discharge of a motor unit's alpha motor neuron. Going back to Physiology 101 for a second, recall that the signal strength of a motor neuron never changes. If the nervous system needs to increase the force of a contraction, it increases the frequency of the signal, causing numerous contractions to happen in quick succession. Each signal is called a twitch. All these smaller twitches or mini-contractions build on one another until the muscle reaches a state of tetanus—the muscle's absolute peak force.

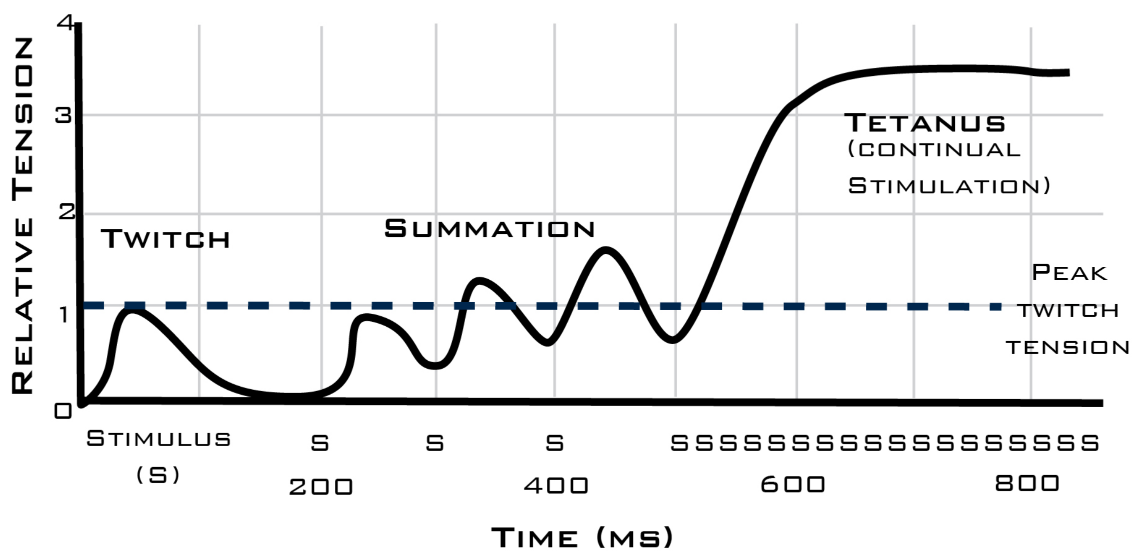


**Figure 3.12:** Example of rate coding in a muscle. One twitch (or signal) from the nervous system doesn't produce much tension (force). If twitches follow in quick succession, however, as seen in the middle of the figure, tension (force) begins to build. Maximal tension or tetanus occurs when numerous twitches occur in quick succession (far right of figure). Adapted from Brooks, Fahey, & Baldwin (2005).

Looking at Figure 3.12, you can see that one single twitch (the far left of the figure) has little effect on increasing total muscular tension (force). However, if three or more twitches are signaled from the alpha motor neuron, innervating the muscle in quick succession (as shown in the middle of the figure), the tension from the twitches is the sum total of the twitches, raising the total level of tension (force) within the muscle. If dozens of twitches are signaled instantly by a well-trained alpha motor neuron, as seen in the right portion of the graph, the muscle reaches a state of tetanus or maximal force production.

It is important to understand that rate coding is a response variable. By that I mean that the muscle must be taught to respond to a certain situation through training. As it pertains specifically to the isometric phase, an athlete's nervous system must respond to high levels of eccentric force instantly. By increasing the rate coding of its isometric motor neuron pathway, the muscle builds tensions quickly, bringing the load to a halt. Remember, the eccentric action is controlled by a separate neural pathway independent of the isometric action. When an athlete performs an isometric contraction to stop the force imposed by a load, he is in essence flipping a switch to a different power grid. There isn't any time to wait for that system to boot up. It has to come online instantly or the athlete loses potential energy transfer from the eccentric phase.

## COORDINATION OF CONTRACTILE MECHANISM (RATE COUPLING)

In addition to the neurological improvements brought about through increases in motor unit recruitment and rate coding, I believe there is a third component trained using isometric methods that further shows its importance. I'm going to admit that I don't have any research that backs this up. This is my opinion. However, I feel very strongly that I'm correct. I have formed this opinion by spending years strength training, working with thousands of athletes, and reading more muscle physiology books than I care to recount.

I think we can agree, especially when it comes down to the processes of the human body, that athletes are only as strong as their weakest link. In affirming that, I believe that the actual physiological process of muscle contraction itself is the third, trainable component of an isometric contraction. This training applies to all three phases of dynamic movement. However, I think it has special importance with the isometric phase, so I will outline it here.

Go perform an isometric squat. Squat down to parallel and hold it from sixty seconds to two minutes. At some point in that time frame, your legs are going to start to shake uncontrollably. That, ladies and gentlemen, is the myosin cross-bridge coupling system becoming more and more inefficient as some part of the contractile mechanism begins to fatigue and fail. You can't tell me that this isn't a trainable muscle quality. Improving this mechanism is essential to the development of a strong, instantaneous isometric contraction, the result of which is increased RFD.

Just a moment ago, I talked about rate coding and the importance that high signaling frequency plays in muscle twitch (contraction) summation. Every time a muscle contracts, it performs hundreds, if not thousands, of smaller, mini-contractions that all add up to one big contraction. Now, I won't turn this into a physiology book. Nonetheless, I think a quick review of the contractile mechanism, specifically as it relates to isometric contraction, is warranted to better understand the big picture: the training of the isometric phase.

You can break every muscle twitch (remember that the sum of which is your total force during a contraction) down into ten individual steps, each with a process essential to muscle contraction.

## Muscle Fiber Twitch (Contraction):

1) Muscle contraction initiated by signal from alpha motor neuron
2) Action potential signals release of acetylcholine (Ach), opening sodium ion gates into cell membrane
3) Acetylcholine (Ach) binds to receptors on motor end plates, releasing sodium (Na+), which enters the cell, depolarizing muscle fiber
4) Depolarization travels down the T-tubules of the muscle fiber, releasing stored calcium ions (Ca2+) into the sarcoplasm from the sarcoplasmic reticulum
5) Ca2+ binds with troponin along the actin (thin) filament, moving the attached tropomyosin band and exposing active binding sites

6) Myosin globular heads from the myosin (thick) filament bind to the exposed active sites on the actin filament.
7) The myosin head tilts, locking the actin filament in place and shortening (or preventing further lengthening) of the muscle
8) Myosin head detaches from actin filament when adenosine triphosphate (ATP) binds to the globular head
9) ATP is split by ATPase into adenosine diphosphate (ADP) and phosphate (P), releasing energy
10) Energy release recocks the globular head of the myosin filament, priming it for another contraction

Each of those ten steps takes place every single time an alpha motor neuron shoots a signal down its axon to thousands of myosin cross-bridge sites—every single time! If that doesn't already seem like a lot to do for one muscle twitch, understand that all ten steps must take place in less than one hundredth of a second or 0.01 seconds during the isometric phase of dynamic movement. That is ridiculous, and yet your body does it on a daily basis over and over again. The timing and efficiency that must take place is unfathomable. Of course, if you had more time, the above example would be much easier. But sport isn't about "more time," remember? Sport is about who can produce more force in *less* time.

Understand that when I talk about an isometric contraction, I am referring to it in terms of dynamic movements. Actual maximal isometric force takes 0.3 to 0.7 seconds to accumulate in a muscle, depending on which study you look at. This level of maximal force is irrelevant to the athlete. The only thing that matters is the amount of isometric force that can be produced between the eccentric and concentric phases of maximal dynamic movement.

Based on this understand of a muscle contraction, some questions that need to be asked are, what happens if the rate of muscle twitches can't keep up with the signaling frequency? What happens if one of the ten steps in a muscle contraction lags behind the rest? Where is the weak link? What is the limiting factor? It is imperative that every step of a muscular contraction operates as a well-oiled machine, occurring exactly on cue so that it doesn't impede the next step. This is important for all muscular contractions—eccentric, isometric, and concentric—but it is especially imperative for the isometric phase.

During the isometric contraction of a maximal dynamic movement, high rates of intramuscular tension must be attained instantly. The myosin heads in the contractile mechanism have less than 0.01 second to attach to the actin filament, stopping the eccentric lengthening of the muscle. A mechanism that is trained to grab and stop 5000 N is capable of transferring more energy to the subsequent concentric contraction than a mechanism that can only stop 1000 N. Athletes are only as strong as their weakest link. Having an underperforming isometric contraction results in less force available for absorption and a subsequent decrease in force output.

Take a basketball player for example. The player has 0.01 seconds to produce an isometric force great enough to completely stop the energy of the eccentric contraction, loading his quadriceps before reaccelerating concentrically and jumping for a rebound. The athlete who can jump higher and quicker will get the ball. For the sake of this example, let's assume that the athlete has 1000 myosin cross-bridge sites that can attach during an isometric contraction. This best case scenario assumes three things:

*1)* The athlete recruits the largest, most explosive motor units (*motor unit recruitment).*

*2)* The athlete's nervous system is efficient enough to signal each of those motor neurons, innervating the entire quadriceps (*rate coding).*

3) The athlete's contractile process is trained well enough to perform all 10,000 steps (ten steps per twitch times 1000 myosin cross-bridges) in 0.01 seconds, maximizing the total force potential *(rate coupling).*

If any of the above three components of isometric strength are undertrained or lagging behind the others, the athlete won't be able to perform at an optimum level. Some research has shown that muscles look to increase force through the improved recruitment of more motor units.[19] Other

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[19] Deschenes M (1998) Short review: rate coding motor unit recruitment patterns. *Journal of Strength and Conditioning Research* 3(2):34–39.

studies have found that the main mechanism in isometric force production is rate coding.[20] My point is that failure to train any of these components will result in the diminished rate of force production for the athlete.

It is imperative that the athlete can forcibly bring the eccentric load to a halt instantly. Research has shown that improved neuromuscular action, through improved recruitment, coding, and coupling by means of isometric training, leads to improved RFD.[21] The athlete who can stop the eccentric stretch of a muscle the quickest is going to benefit with an improved stretch reflex as well as have more energy absorbed into the musculoskeletal structure to be used in the SSC. To maximize this conduit of energy transfer, an athlete needs a fast developing, transitioning, isometric contraction. Any delay between eccentric and concentric phases will result in lost energy from the SSC, as this energy store begins to dissipate as heat the instant it is absorbed.

When you look at Figure 3.13, this becomes very apparent. At some point on the graph, both lines have a transition point—a point where the line changes from a negative, eccentric slope to a positive, concentric one. That point, that exact instant, is where the isometric contraction takes place. As I said before, the difficulty in understanding the isometric phase is that you can't really see it. You have a good idea of "about" where it is, but it is impossible to pinpoint. It is not like the eccentric phase where there is an entire line you can see and follow. Yet this single point is hugely important, as it acts as the springboard that launches the force from the stretch reflex, the SSC, into the concentric contraction. The harder the stop, the better the total force recoil from the stretch reflex and SSC and therefore a more explosive dynamic action. If you were to bounce a basketball, would it bounce higher off concrete or sand? The concrete is solid, allowing nearly full transfer of the kinetic energy of downward motion of the basketball to be transferred back into an upward movement. The sand on the other hand acts as a decelerator, dispersing the eccentric energy into the granules and limiting the kinetic recoil.

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[20] Behm D (1995) Neuromuscular implications and applications to resistance training. *Journal of Strength and Conditioning Research* 9(4):264–74.

[21] Burgess K, Connick M, Grahm-Smith P, Pearson S (2007) Plyometric vs. isometric training influences on tendon properties and muscle output. Neuromuscular implications and applications to resistance training. *Journal of Strength and Conditioning Research* 21(3):986–89.

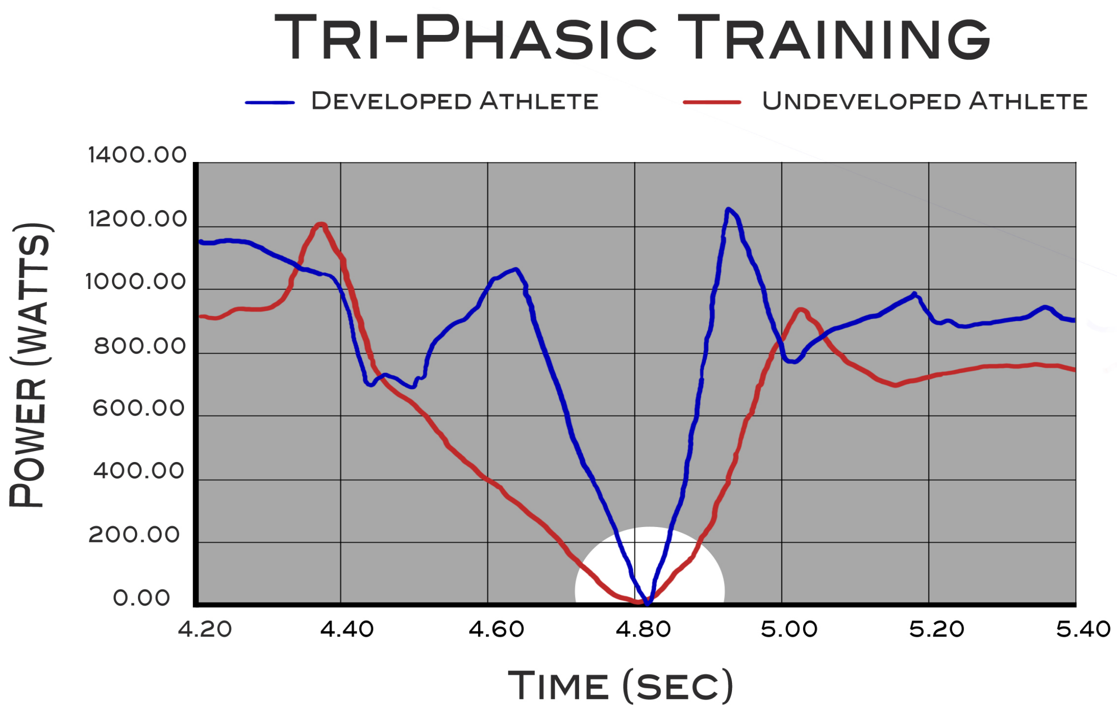


**Figure 3.13:** Example highlighting different isometric contractions and their resulting concentric rate of force development (RFD). In looking at the white section of the graph, notice the developed athlete (blue line) has a much better defined point at the bottom of the "V." This point is his isometric contraction. Compare that to the much wider, almost rounded point for the isometric contraction of the underdeveloped athlete (red line). The narrower the angle of the "V," the steeper the successive concentric contraction (increased RFD).

To better understand the importance of a strong, immediate isometric contraction and the role it plays in force production, I want you to think of it in terms of hitting the brakes in your car. In the first scenario, you're out driving and you can see the stoplight up ahead of you turn red. You take your foot off the gas and start to apply slow, even pressure to the brake, bringing the car to a nice, slow stop over a distance of let's say two hundred feet (I'm assuming that you're a responsible driver). You barely feel any recoil at all when the car ceases all forward motion and stops. This is because there was little to no energy built up in the brakes of the car. Think of braking over the two hundred feet as a long, slow, eccentric contraction. Little to no energy is built up in either the stretch reflex or the SSC. When the car finally stops, performing an isometric contraction, there is only a small amount of energy for it to recoil in the opposite direction (according to Newton's Laws). As a result, you, the driver, barely feel the car rock back.

Now, in a second scenario, let's say you are on a country road driving up the cabin for the weekend. You are still a responsible driver, going the speed limit of 55 mph when all of a sudden Bambi's crazy twin brother, Bernard, jumps out on to the road only fifty feet in front you. Barely having time to react, you slam on the brakes. The car comes to a screeching halt and you get thrown back into your seat. The violent recoil is the result of energy absorbed by the brakes during the abrupt stop. As opposed to the first scenario, this car mimicked a strong, fast eccentric contraction, loading the musculoskeletal system (the brakes) with an enormous amount of kinetic energy. When the car was abruptly stopped by a strong isometric contraction, all the energy was expelled through the stretch reflex and the SSC, catapulting you back into your seat.

That, right there, is the importance of a strong, hard hitting isometric contraction. It plays the role of a catalyst that puts in motion a series of events, the result of which dictates the difference between high RFD and low RFD, between great athlete and good athlete. Looking back at the isometric graph (Figure 3.13), you can see the relation between the eccentric and concentric lines. This relation exists due to the strength and efficiency of the isometric phase. If an athlete has poor isometric strength, it forces a slower rate of energy absorption. It is impossible for an underdeveloped athlete to absorb energy, eccentrically, at the same rate as a well developed one. The underdeveloped athlete's isometric components aren't efficient enough to transfer that much power to the concentric phase; it overloads the circuit. As a result, the underdeveloped athlete must absorb energy at a slower rate, resulting in a reduced stretch reflex and less power to transfer through the SSC to concentric movement.

Specific attention to isometric training will result in improved force and power outputs for an athlete. Improving the qualities of the nervous system in this regard allows for high amounts of energy to be absorbed through the efficient sequencing and work of recruitment, coding, and coupling rates—diverting maximal energy from the eccentric directly to the concentric with little to no loss of energy. This enables an athlete to maximize the power of both the stretch reflex as well as the SSC. Add these to a strong, concentric contraction, which we will learn about in the next section, and it gives the athlete the appearance that he is jumping off a trampoline instead of a sand pit.

## HOW TO APPLY ISOMETRIC MEANS

High load isometrics should be performed at the onset of an athlete's workout. These can be viewed as facilitating a potentiation effect for the remainder of the workout, as the high level of intramuscular tension that takes place during isometric work activates a greater number of high threshold motor units. In essence, it "turns them on" for the rest of the workout.

Isometric contractions aren't as neurally taxing as eccentric focused training. This is mainly due to the reduced time under tension (TUT) of the muscle. As a result, lightened load isometrics can, and should, be used throughout the entire workout to further improve an athlete's force absorption qualities. Understand that when I say "lightened," I mean assistance lifts; exercises that use lighter loads compared to large compound movements. For example, a dumbbell lunge uses lighter relative loads than a back squat. If an athlete is presently performing a strength block at 85 percent, the dumbbell lunge should be performed with a weight that is 85 percent of his 1RM in that exercise. This load, however, would be much lighter, overall, than the athlete's load when performing a isometric back squat. Often implemented with assistance exercises such as lunges or close grip pressing, lightened load isometric work helps to further build the adaptive qualities needed within an athlete's physiological system to absorb ever higher levels of force. There are two possible ways to apply isometric means to training:

1) **Resisted load isometrics** consist of performing a dynamic movement with an isometric pause at its midpoint (between the eccentric and concentric phase) or resisting a load at a specific position and not allowing the joint angle to change. These exercises are performed through their entire range of motion with an eccentric, isometric, and concentric phase. However, the isometric phase is accentuated. Resisted load isometrics are usually performed by large, compound exercises with medium to high loads on the bar.

The position of the isometric or specific joint angle is dictated by the demands of an athlete's sport to ensure transferability. Isometric strength only transfers five to ten degrees from where the parameter is trained. That means if your athlete only squats down to 45 degrees but he makes his cuts or jumps on the field from 65 degrees (a difference of 20 degrees), the isometric parameter he trained so hard to improve won't transfer. He won't be able to absorb high levels of force at that angle. Find what joint angle(s) your athletes explode from in their sport and make sure that they're trained properly in the weight room.

Table 3.4 shows the rep ranges and sets that constitute the resisted isometric loading variables. In addition, the loading variables are allocated by color, showing the parameters for each mesocycle:

**TABLE 3.4: Resisted Isometric Loading Parameters And Their Respective mesocycle**

| Load | Total Time of Isometric (seconds) | Rep Range | Sets | Mesocycle |
|---|---|---|---|---|
| 85% | 3–4 (Assisted; help up) | 1–2 | 4–5 | Above 80% |
| 80% | 3–4 (Assisted; help up) | 2–3 | 4–5 | |
| 75% | 4–5 | 3–4 | 3–4 | 55–80% |
| 70% | 4–5 | 4–5 | 3–4 | |
| 65% | 4–5 | 5–6 | 3–4 | |
| 60% | 4–5 | 5–6 | 3–4 | |
| 55% and Below | Isometrics not implemented with these loads during this training cycle | | | Below 55% |

2) **Push/pull isometrics,** like the name implies, push or pull against immovable resistance. Similar to resisted load isometrics, the joint angle of the athlete won't move. However, in this case, the athlete starts at the specific joint angle being trained. This isn't a dynamic movement. The only contraction that takes place is an isometric contraction. These exercises are usually

performed in a rack or up against a wall with the bar being pushed or pulled against pins. These aren't differentiated between heavy or lightened load isometrics. They should be performed at the end of a workout because they are the equivalent of doing maximal effort work and are extremely taxing on an athlete's nervous system. If performed at the onset of a training day, it is unlikely that the athlete's nervous system would be able to perform quality work afterward.

Table 3.5 shows the rep ranges and sets that constitute the push/pull isometric loading variables. In addition, the loading variables are allocated by color, showing the parameters for each mesocycle:

**Table 3.5: Push/Pull Isometric Parameters And Their Respective Mesocycle**

| Load | Total Time of Isometric (seconds) | Rep Range | Sets | Mesocycle |
|---|---|---|---|---|
| 85% | 5-6 | 1 | 3-5 | Above 80% |
| 80% | 5-6 | 1 | 4-5 | |
| 75% | 6-8 | 1 | 3-4 | 55-80% |
| 70% | 6-8 | 1 | 3-4 | |
| 65% | 6-8 | 1 | 3-4 | |
| 60% | 6-8 | 1 | 3-4 | |
| 55% and Below | Isometrics not implemented with these loads during this training cycle | | | Below 55% |

To maximize the isometric adaptation and ensure the safety of the athlete, there are a couple rules I follow based on what I've seen over the past twenty years that yield the best results for my athletes when performing isometric focused work:

**1) Hit the ground like a brick.**

The main goal of performing isometric work is to teach the athlete's physiological structure (muscular, connective, and skeletal) to absorb energy instantly. When performing a resisted load isometric, the athlete must perform the eccentric portion quickly, pulling the bar down before trying to instantly stop its momentum. Oftentimes, an athlete will lower the bar quickly during the first eighty-five degrees of the eccentric range of motion (ROM) and then decelerate it slowly over the remaining fifteen degrees before actually reaching the isometric. This drastically reduces the force needed to be absorbed to stop the eccentric motion of the bar while also reducing the training effect of the repetition. They *must* hit the isometric like a brick hitting a pavement floor—no give whatsoever! It can't decelerate over ten to twenty degrees. It must stop within only two, one, or none!

| TABLE 3.6: ISOMETRIC COMPARISON | | |
|---|---|---|
| ISOMETRIC BACK SQUAT | OBSERVATIONS | LINK |
| INCORRECT FORM (POOR ISOMETRIC ACTION) | 1) SLOW ECCENTRIC<br>2) SLOW DECELERATION OF THE BAR<br>3) REDUCED ISOMETRIC STRESS | BAD ISOMETRIC |
| CORRECT FORM (OPTIMAL ISOMETRIC ACTION) | 1) FAST MOVING ECCENTRIC<br>2) INSTANT DECELERATION OF THE BAR<br>3) HIGH ISOMETRIC STRESS | GOOD ISOMETRIC |

**2) Squeeze it!**

I've found that the best coaching cue is to tell athletes to squeeze their muscles as they hit the isometric contraction. I find that it helps them visualize the physiological action taking place and increases the speed of the firing rate, helping build intramuscular force more quickly. To help new athletes learn and understand this concept, have them get into their isometric position without any load placed on them. For example, if you're teaching the back squat, have the athletes squat down to where they will be performing the isometric contraction during their sets. Once they have squatted down, tell them to squeeze their legs and glutes as hard as they can for several seconds. Once they understand what the isometric contraction should feel like, they can begin their work sets.

**3) Always spot the athlete when performing loaded isometric work.**

As I pointed out in the previous eccentric section, this is a widely practiced rule when an athlete is trying to lift heavy loads, but some coaches may not see the need when using lighter, submaximal loads. You must remember that when performing isometrically focused training, the athletes are deliberately trying to create as much force as possible to stress the absorption qualities of their system. With every rep, they're pushing the limits of the isometric nervous system and accompanying physiologic structures. It is not uncommon to see athletes hit their isometric contraction like a brick and then be unable to lift the load concentrically without the assistance of a spotter. When pushing the limits of the human body, diligent spotting is always essential.

**4) Always finish an isometric focused lift with an explosive, concentric movement.**

Every movement an athlete makes in competition is triphasic—eccentric, isometric, and concentric. The neurological pathways that signal these contractions are entirely different and independent of one another. Each time the athlete's nervous system transitions from the isometric to the concentric phase, it has to change its firing pattern to initiate the next part of the movement. The signal has to jump switchboards if you will. It is imperative to an athlete's success that this process is as fluid and seamless as possible. If there is any lag time between these signals, energy absorbed during the eccentric phase will be lost as heat to the environment, decreasing the contribution of the stretch reflex and SSC to power development. The intent to accelerate the bar, building intramuscular force quickly and recruiting intermuscular recruitment neurally, must be trained every time an athlete performs a repetition.

| TABLE 3.7: Example Exercises With High Load Resisted Isometric Means (Main Compound, Perform at Onset of Workout) | |
|---|---|
| **Exercise** | **Coaching Points** |
| Back Squat - Isometric | 1. Set up with the bar on the back of the shoulders, keeping the chest up and the back flat.<br>2. Sit back and descend into the bottom of the squat rapidly.<br>3. Once in the bottom, become a statue and pause for the prescribed time.<br>4. Once the time has been reached, explosively fire up back to the start. |
| Front Squat - Isometric | 1. Set up with the bar on the front of the shoulders, keeping the chest up and the back flat.<br>2. Sit back and descend into the bottom of the squat rapidly.<br>3. Once in the bottom, become a statue and pause for the prescribed time.<br>4. Once the time has been reached, explosively fire up back to the start. |
| RDL - Isometric | 1. Grab the bar just outside of the thighs with the feet shoulder width apart.<br>2. Keeping the back flat and the chest up, lower the bar rapidly along the thighs.<br>3. Once the bar passes the knees, become a statue and pause for the prescribed time.<br>4. Once the time has been reached, explosively fire up back to the start. |
| Bench Press - Isometric | 1. While laying on your back, grab the bar one thumb length away from the knurling.<br>2. Unrack the bar and pull it rapidly toward the chest.<br>3. Right before the bar hits the chest, stop it completely and pause.<br>4. Once the time has been reached, explosively fire up back to the start. |

## TABLE 3.8: Example Exercises With Lightened Load Resisted Isometric Means
(Assistance, Performed Throughout Workout)

| Exercise | Coaching Points |
|---|---|
| DB Walking Lunge-Isometric | 1. Holding a pair of dumbbells, take a moderate step forward.<br>2. Keeping the chest up and the back flat, descend into the bottom of the lunge.<br>3. Lower yourself until the back knee is just above the ground and pause.<br>4. Once the time has been reached, explosively fire through and step forward. |
| Incline DB Bench | 1. Holding a dumbbell in each hand, set up on an inclined bench.<br>2. Beginning the dumbbells near the shoulders, pause for the prescribed time.<br>3. Be sure to keep the chest up, the lower back arched, and the eyes toward the ceiling.<br>4. Once the time has been reached, explosively fire up and back to the start. |
| DB RDL | 1. Holding a pair of dumbbells, begin with the arms just along the thighs.<br>2. Keep the chest up, the back flat, and the knees slightly bent.<br>3. Lower the dumbbells along the thighs rapidly until just below the knees and pause.<br>4. Once the time has been reached, explosively fire up and back to the start. |
| DB Row - Isometric | 1. Hold one dumbbell in the hand and use the other to stabilize the body on a bench.<br>2. Keeping the back flat, pull the dumbbell rapidly into the ribs.<br>3. Allow the dumbbell to return slightly toward the ground and pause.<br>4. Once the time has been reached, explosively fire up and back to the start. |
| Bench Press Reactive Drop Pause Toss | 1. While laying on your back, grab the bar one thumb length away from the knurling.<br>2. With a spotter, rapidly drop the bar until it is just about to hit the chest.<br>3. Pause with the bar right above the chest.<br>4. Once the time has been reached, explosively throw the bar as high as possible. |

| TABLE 3.9: Example Exercises With Push/Pull Isometric Means | |
|---|---|
| **Exercise** | **Coaching Points** |
| Isometric Chest Hold | 1. Set up on the three boxes, placing the hands on the edge of the first two.<br>2. Keeping the abs and back tight, pull into position and pause.<br>3. While in the bottom, keep the body perfectly still.<br>4. Once the time has been reached, explosively press yourself up. |
| Bench Press Rack - Isometric | 1. While laying on your back, grab the bar one thumb length from the knurling.<br>2. Using a spotter, press the bar into a fixed support in the weakest position.<br>3. Press as hard as possible for the prescribed time.<br>4. Once the time has been reached, rack the bar. |
| Hip Flexor Iso Prone | 1. Set up with one foot on a bench and the hands on the ground in the plank position.<br>2. Keep the foot not on the bench straight.<br>3. Keep the body in a straight line and be absolutely still.<br>4. Once the time has been reached, switch legs and repeat. |
| Single Leg Iso Deadlift | 1. Set up with a bar under a fixed support and a bench behind.<br>2. One foot should be elevated to the rear with the other in front of the bar.<br>3. Grab the bar and pull into the fixed support at the weakest position.<br>4. Once the time has been reached, switch legs and repeat. |
| Isometric Ball Groin Squeeze | 1. Using a Swiss ball, place the knees just outside of the edge.<br>2. In an athletic stance, squeeze the ball using the groin muscles.<br>3. Squeeze the ball for the prescribed time.<br>4. Once the time has been reached, rest and repeat for desired sets. |
| Hex Bar Iso Deadlift | 1. Set up using a hex bar under a fixed support.<br>2. Keep the feet shoulder width apart, the back flat, and the chest up.<br>3. Pull the bar as hard as possible into the fixed support.<br>4. Once the time has been reached, rest and repeat for desired sets. |

# 3.4: CONCENTRIC PHASE

The concentric portion of the triphasic model is the sexy phase of dynamic muscle action. It's the rock star, the front man that gets all the attention. You never walk into a gym and ask someone, "How much can you eccentrically lower to your chest?" No! Hell no! You walk up and ask, "How much do you bench?" The implication is that you're asking how much weight he can concentrically lift by pushing it off his chest. The concentric portion is the measuring stick used to evaluate all athletic performance. How much can an athlete lift? How far can he jump? How fast can she run? These are all performance measures based on force output measured in the concentric phase. Specifically as it relates to dynamic movement, the concentric phase is the measure of an athlete's rate of force development (RFD).

By definition, the concentric phase is an action in which the proximal and distal attachments of a muscle move toward one another. It refers to a muscle producing enough force to overcome a load, shortening the length of the muscle. This explanation has also lead to the concentric phase being referred to the "overcoming phase" in some literature.

In any dynamic movement, the RFD of the concentric contraction is aided by the combined force of the stretch reflex and SSC. Remember that the amount of potential energy stored within the musculoskeletal structure is dependent on the preceding eccentric and isometric contractions. When we understand how the concentric phase works in conjunction with these phases, we see why the concentric phase is imperative for maximizing explosive strength, RFD, and ultimately, performance. Would Nolan Ryan have been as intimidating without his fastball? Would Muhammad Ali have been as great if he couldn't throw a punch? Would Walter Payton have been as sweet if he couldn't cut? The answer to all these examples is an emphatic "No!" An athlete who can quickly build and absorb energy is nothing if that energy can't be used concentrically to rapidly produce force.

Up to this point, I have singled out individual muscles to explain the neural and physiological mechanisms of dynamic movements, explaining why they are important and how they must be trained. Now, in talking about the concentric phase, we must think in terms of whole neuromuscular systems. The true importance of training the concentric phase is the synchronization of the entire triphasic muscle action—maximizing the energy transfer from the preceding eccentric and isometric phases into a unified, explosive, dynamic movement. For the purpose of simplicity, we are going to package all these mechanisms into one of two categories—intramuscular and intermuscular coordination.

**1) Intramuscular coordination** (*within the fibers of the same muscle group)*

I. Motor unit recruitment: The maximum number of motor units are recruited.

II. Rate coding: The discharge frequency of motor neurons is at the highest possible level.

III. Rate coupling: The myosin heads attach, pull, and detach.

This list should look very familiar. It is the same list used explaining the importance of developing intramuscular tension during the isometric phase. For all intents and purposes, it is exactly the same, the only difference being that, once again, it is a different neural pathway than that of the eccentric and isometric phases. When I say pathway, I don't mean that it's a completely different set of neurons. This is a hotly debated topic in physiology. However, it appears that the differentiation takes place in the motor cortex of the brain.[22] There, different rate coding and frequency patterns, sent through the same neural pathway to the muscle, appear to innervate the same motor units differently, resulting in the differentiation seen in eccentric, isometric, and concentric contractions. For athletes to generate high levels of concentric force, they must train the specific mechanism that signals a highly efficient concentric contraction, specifically the alpha motor neurons and muscle fibers to fire at high levels.

**2) Intermuscular coordination** *(between different muscle groups)*

I. Inhibition/disinhibition

II. Synchronization

Let's take a moment to describe these components more thoroughly.

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[22] Kidgell D, Pearce A (2011) What has transcranial magnetic stimulation taught us about neural adaptation to strength training? *Journal of Strength and Conditioning Research* 25(11):3208–17.

## INHIBITION/DISINHIBITION

In every muscular action, there is an agonist and an antagonist, an inhibitor and a disinhibitor. For our purposes here, all you have to understand is that while the agonist is concentrically contracting to produce force, the antagonist is eccentrically contracting. The purpose of this eccentric contraction is to try to decelerate the speed and force of the concentric contraction to protect the joint and ensure that the antagonist muscle doesn't tear from rapid stretching. Like most defense mechanisms of the body (e.g., GTO), this one is overprotective and must be detrained. Training the concentric phase to perform explosive dynamic movements improves intermuscular coordination, allowing for the inhibition of the antagonist muscle and resulting in maximal RFD. Put another way, by training the concentric phase, the athlete is also training the inhibition of the antagonist. Looking forward, this concept is what I have come to term "antagonistically facilitated specialized methods of training" (AFSM). Because this falls outside the parameters of the triphasic model, I won't take time here to outline it in depth. However, you can find a full explanation of both the physiology and methods in section five.

## SYNCHRONIZATION

Clearly there is more to training the concentric phase than just improving the contractile mechanism and subsequent RFD, although that is a very important part. There isn't any question that the athlete who can generate more explosive force in less time has a decisive advantage. This, however, is only advantageous to an athlete if he can unleash that power in a manner that gives him a performance edge, a step up on his opponent. Nolan Ryan could touch 100 mph on the radar gun consistently, but that isn't what made him a Hall of Fame pitcher. Being able to place that 100 mph fastball wherever the catcher put his glove from sixty feet and six inches away is what made him the most feared pitcher of his era.

As a generalization, the concentric phase of dynamic movements is a much more complicated motor task than the eccentric or isometric phases. As explained above, this is due to the fact that dynamic concentric actions require a significant amount of coordination and synchronization between numerous neuromuscular systems to produce a high level of force output. A dynamic concentric contraction is the culmination of every neuromuscular mechanism we have talked about up to this point:

- Golgi tendon organ reflex
- Stretch reflex
- Stretch shortening cycle (SSC)
- Rate coupling
- Motor unit recruitment
- Rate coding
- Reactive ability

As an example, compare the hang clean to a Romainian deadlift and shrug. A novice athlete can quickly learn and perform a proper Romanian deadlift and shrug. For the most part, it is a slow, controlled movement that allows more time for the athlete's neuromuscular system to interpret, process, and execute instructions from his entire neuromusculature of the posterior chain (calves, hamstrings, glutes, and back). On the other hand, teaching the hang clean, though a very similar movement pattern to that of an Romanian deadlift and shrug, can be a long, arduous process. Decreasing the weight and increasing the speed of the exercise, the athlete's neuromuscular system gets overloaded.

The take home point from this example is that just like the eccentric and isometric phases of dynamic movement, the concentric phase is a learned, trainable skill. Not every concentric dynamic action is as hard to learn as the hang clean. I can teach an athlete to concentrically perform a back squat in a few minutes. It's intuitive—once he squats down I simply tell him to stand up. It is a neuromuscular action that he has likely performed hundreds, if not thousands, of times in his life. Every time he has sat down and stood up, he has performed at least a partial rep. But to teach that athlete to fire all his hip extensors, drive his feet through the floor, and activate his high threshold motor units through afferent neural pathways that are likely underdeveloped all while trying to move the bar like it was just shot out of a cannon—that takes time and lots of training.

During the concentric phase, the actual concentric contraction takes place sandwiched between the stretch reflex and SSC. For maximal explosive strength in dynamic movements, all three components must fire in rapid succession—stretch reflex, then concentric contraction, and then SSC. This sequence has been termed *reactive ability,* or the ability to rapidly generate explosive force resulting from a preliminary dynamic stretch followed instantly by a subsequent concentric contraction. An athlete's reactive ability (which is, in essence, their RFD) is determined by the efficiency and speed with which the concentric contraction follows the preliminary force output from the stretch reflex and, in turn, determines the amount of stored kinetic energy used from the SSC to improve overall force output.

Try to think of reactive ability in terms of an athlete performing a back squat with 85 percent of his 1RM. The athlete eccentrically squats the load, dropping quickly to maximize the absorbed potential energy in the muscles and connective tissue, and stopping the load with a strong, instant isometric contraction. This strong isometric acts like a concrete floor, giving the resulting stretch reflex something hard to push off of, signaling the start of the concentric phase by reaccelerating the load in a vertical direction. From this point, there are two scenarios that can play out in the subsequent concentric phase—a well-trained athlete can accelerate the load with a high RFD through the entire range of motion, maximizing energy transfer, or a poorly trained athlete will lose RFD due to lost energy from an uncoordinated concentric mechanism. Let's take a look at what both of these scenarios would look like.

**1) Well-trained concentric/high energy transfer/high RFD**

In this scenario, the athlete's concentric mechanism quickly builds intramuscular tension greater than that of the load imposed on the muscle structure. The force produced by the concentric contraction is added immediately to the force generated by the stretch reflex, having an additive effect and accelerating the load at a constant high rate. The total force acting on the load is further increased by the energy, now transferred from the connective tissue of the muscle structure through the SSC. Due to the speed with which the stretch reflex and concentric contraction began to move the load, a high percentage of the total stored energy from the SSC is transferred, as little of the energy had time to dissipate from the muscle as heat. For this example, let's say that 95 percent of the SSC energy is transferred. This is represented in Figure 3.14 by the steep sloping, smooth force curve. The first part of the graph shows the isometric tension (force) building within the muscle until it reaches a level of force greater than that being imposed on the muscle, signaling the beginning of the concentric phase as the bar begins to move. The second part of the graph depicts the force produced during the concentric phase, its continued acceleration, and its deceleration as the athlete completes the movement. A well-trained concentric muscle action will show up as a seamless transition between the isometric and concentric point on the graph, keeping a constant slope or rate of acceleration. When you watch this athlete perform the squat, the bar moves fluidly, accelerating through the entire range of motion.

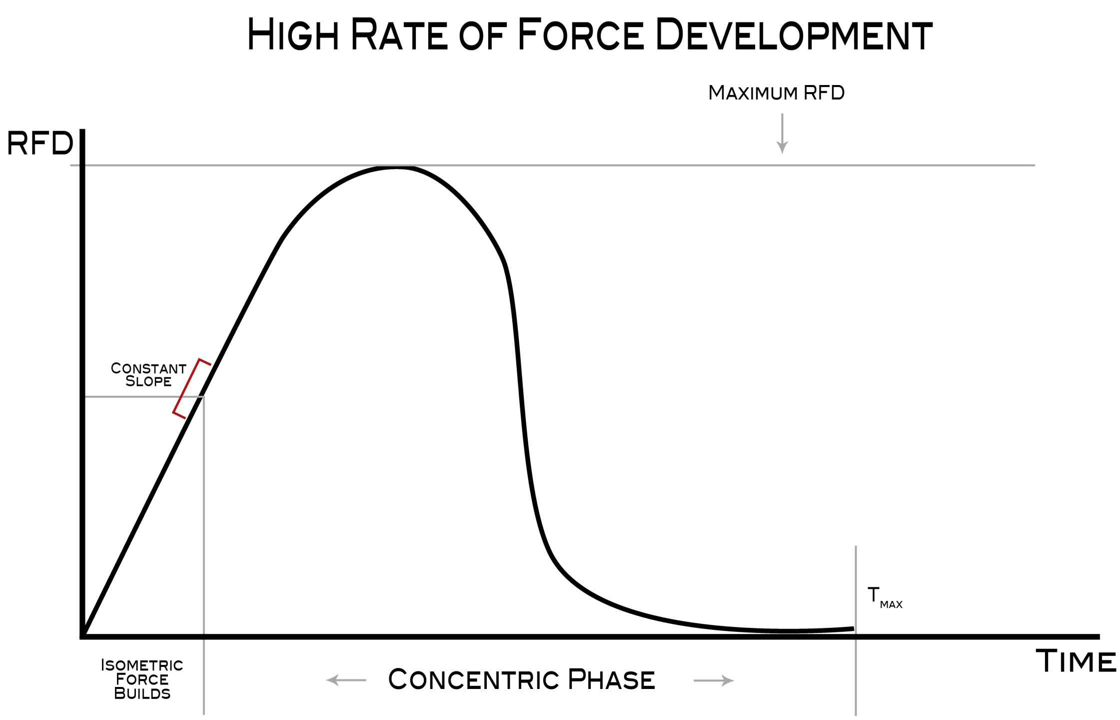


**Figure 3.14:** Graph depicting a fluid transition between the isometric and concentric phases of a dynamic contraction. Adapted from *Supertraining* 6th edition by Y. Verkhoshansky and M. Siff (Ultimate Athlete Concepts, 2009).

**2) Poorly trained concentric/low energy transfer/decreased RFD**

In this scenario, the athlete's concentric mechanism takes longer to build intramuscular tension to a level greater than that of the load imposed on the muscle structure. Due to this increased lag time, there isn't any additive effect between the stretch reflex and the concentric contraction.

You can see this in Figure 3.15 in the dip in the force production line. This is shown by a change in the slope of the force line at the transition point between the isometric and concentric phases. At this point, the force produced by the stretch reflex has peaked, but the concentric contraction hasn't reached a level of intramuscular force to continue accelerating the load at the same rate. As a result, the rate of the concentric shortening of the muscle slows, effectively negating the contribution of the stretch reflex. This has further negative effects on RFD because the extra time that it takes for the concentric contraction to build sufficient force to move the load allows energy, stored within the connective tissue, to dissipate as heat, resulting in decreased force production from the SSC. In this example, let's say that 60 percent of the SSC energy is transferred. This can be seen in the graph by noticing that the decreased slope of the concentric portion now makes it impossible to reach the same maximum RFD as in the previous graph.

When you watch this athlete squat, the bar will slow immediately after coming out of the hole—think of it as a mini-sticking point. The bar will then begin to reaccelerate through the remaining range of motion, never reaching the velocity of the bar squatted by the athlete in the first scenario.

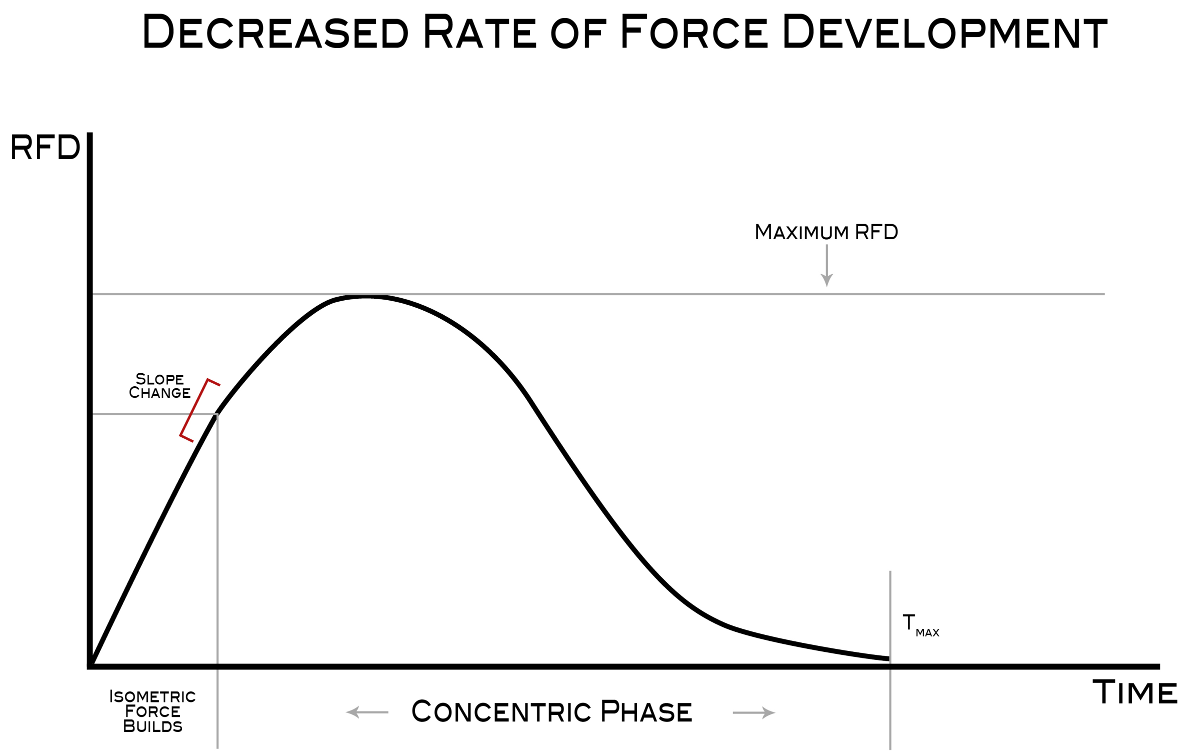


**Figure 3.15:** Graph depicting a inefficient transition between the isometric and concentric phases of a dynamic contraction. Notice that the slope of the line changes, signaling a decrease in the rate of force developed (RFD) for the remainder of the contraction. This results in lower power output.

A well-trained concentric phase is the organization of chaos into a deliberate, focused application of force. Athletes may be able to absorb great amounts of kinetic energy during the eccentric and isometric phases, but it won't do them any good if they don't have a trained concentric system to release it. In order to reap the benefits of the stretch reflex and the SSC, athletes must train the neurological and physiological systems of the concentric phase to improve the rate of both intramuscular and intermuscular coordination—motor unit recruitment, rate coding, rate coupling, synchronization, inhibition, and disinhibition. Below, you will see the RFD graph from before, but this time, the lines from both graphs are overlaid. Both athletes develop isometric force at the same rate. However, when the isometric phase transfers to the concentric phase, the underdeveloped athlete's RFD drops off considerably (slope of the line decreases). The blue athlete has a better trained concentric muscle action, allowing him to coordinate and use the energy from the stretch reflex and SSC to build force rapidly.

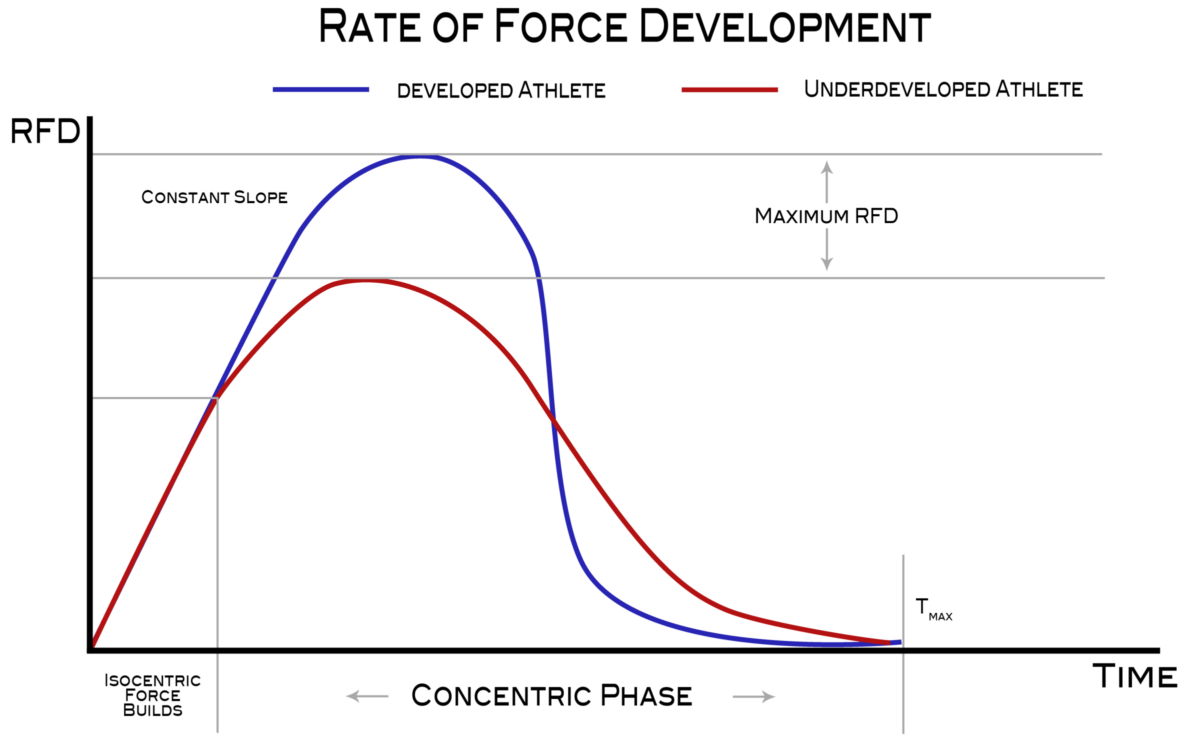


**Figure 3.16:** A side by side comparison showing the resulting disparity in RFD between a developed (fluid transition) and underdeveloped (inefficient transition) athlete.

A coach can't take the concentric phase for granted. While it is always the most coached and most trained aspect of the three triphasic components, it rarely, if ever, is taught and trained in a way that maximizes the use of the kinetic energy absorbed by an athlete. As a result, the concentric phase can often be the most important. Athletes can spend weeks learning how to eccentrically and isometrically absorb energy, but if they fail to teach their body how to unleash that power, it is all for nothing.

## How to Apply Concentric Means

This is fairly straightforward and simple—train fast!! The goal of concentric training is to maximize intermuscular coordination, increase motor unit recruitment, and maximize force production. This is where every rep should start to resemble a red rubber ball slamming off a concrete floor. Concentric means will look very familiar to most strength coaches because they are the predominant form of stress used in training. I should say, however, that it will only look similar on paper, as an athlete training concentrically after first building a solid foundation of eccentric and isometric strength will be able to move loads at much higher velocities.

Table 3.10 is a breakdown of the loading parameters for an athletic model of training. Remember, athletes aren't bodybuilders. The percentages and reps correlate to ensure that each rep is high quality, neurological work aimed at producing high levels of force. In addition, the loading variables are allocated by color, showing the parameters for each mesocycle:

## TERMINOLOGY

***"Reactive"*** *is defined as the ability to switch instantly from the eccentric to concentric phase of a dynamic movement. The goal of a reactive movement is to lose as little force as possible from the stretch shortening cycle accumulated during the eccentric and isometric phases. When an athlete is told to be reactive, it means that all three phases of the movement should be completed as fast as possible. Be explosive.*

| Table 3.10: Concentric Loading Parameters and their Respective mesocycle | | | | |
|---|---|---|---|---|
| Load | Total Time of Concentric | Rep Range | Sets | Mesocycle |
| 97.5% | Reactive | 1 | 1–2 | Above 80% |
| 95% | Reactive | 1 | 2–3 | |
| 90% | Reactive | 1–2 | 3–4 | |
| 85% | Reactive | 1–2 | 3–4 | |
| 80% | Reactive | 1–3 | 4–5 | |
| 75% | Reactive | 1–3 | 4–5 | 55–80% |
| 70% | Reactive | 2–3 | 4–6 | |
| 65% | Reactive | 3 | 4–6 | |
| 60% | Reactive | 3 | 4–6 | |
| 55% | Reactive | 3 | 4–6 | Below 55% |
| 50% | Reactive | 3 | 4–6 | |
| 45% | Reactive | 3 | 4–6 | |
| 40% | Reactive | 4 | 4–6 | |
| 35% | Reactive | 4 | 4–6 | |
| 30% | Reactive | 4 | 4–6 | |

The most important thing to remember when performing dynamic, concentric focused work is to push against the bar as hard as possible, driving the bar all the way through its entire range of motion. Again, the focus should always be on developing a synchronized, powerful concentric contraction.

| Table 3.11: Example Exercises With Reactive Concentric Means | |
|---|---|
| **Exercise** | **Coaching Points** |
| Back Squat - Reactive | 1. Set up with the bar on the back of the shoulders.<br>2. Keeping the chest up and the back flat, pull yourself down into the bottom of the squat.<br>3. Once in the bottom, explosively fire out as fast as possible.<br>4. Repeat for the desired number of repetitions. |
| Single Leg DB Front Squat - Reactive | 1. Holding a pair of dumbbells on the shoulders, keep the chest up and the back flat.<br>2. One leg should be elevated to the rear.<br>3. Using the front leg, pull rapidly into the bottom of the squat.<br>4. Once in the bottom, explosively fire out and repeat for the desired repetitions. |
| RDL - Reactive | 1. Grab the bar just outside of the thighs with the feet shoulder width apart.<br>2. Keeping the chest up and the back flat, lower the bar along the thighs rapidly.<br>3. Once the bar hits the bottom position, explosively fire up and return to the start.<br>4. Repeat for the prescribed repetitions. |
| Bench Press - Reactive | 1. While laying on your back, grab the bar one thumb length away from the knurling.<br>2. Using the upper back, pull the bar rapidly into the chest.<br>3. Once the bar touches the chest, explosively throw it as hard as possible.<br>4. Repeat for the prescribed repetitions. |

# 3.5: SUMMARY AND REVIEW

I often find that strength and conditioning coaches fall into the trap of focusing solely on the concentric phase of dynamic movement. All they are concerned about is the load on the bar and that the load is constantly increasing for each athlete year to year, workout to workout. To some extent, this is understandable because most every performance measure we take of an athlete is concentrically tainted. The deadlift, back squat, and bench press—all are measures of concentric force production at low velocities. At the end of the day, strength coaches have to prove to their employer that their methods are somehow resulting in improved performance of the athletes they work with or they will lose their jobs. It's very simple to show that progression by giving the coach a printout of the athletes' 1RM for the bench press and back squat from the start of the off-season as compared to the end of it. "See, coach, every guy increased his back squat by 30 pounds. I did a great job and your athletes are better." I will admit that they are stronger, but are they "better" athletes? That remains to be seen.

Strength is not what sport is about. Sport is about force production at high velocities and high rates of speed. Sport is about being powerful. Every dynamic movement in sport is a skilled act requiring the coordination of dozens of muscle groups, hundreds of motor neurons, and thousands of muscle fibers. The emphasis placed on concentric loading has limited the potential of many athletes by failing to also address the eccentric and isometric phases.

I am a firm believer that the best way to learn new concepts and ideas is to apply them to real life situations. The material then becomes relatable and real to the learner. To get a better idea of the results you can expect from programming triphasic methods of training into your athletes' workouts, I want to tell you a story about a team of baseball players I worked with back in 2004.

Every fall when the baseball players first get to campus, we put them through testing so that we have baseline numbers to compare to when they're done with winter workouts before the start of the season. One of the tests that I have them run is the pro-agility or pro-shuttle drill. This is a great drill for testing an athlete's lateral power, acceleration, and overall state of their triphasic muscle response. Why? Because the pro-shuttle drill forces an athlete to decelerate (eccentric) at high speeds, stop (isometric), and then reaccelerate (concentric) in the opposite direction. A deficiency in any of the three phases will become instantly apparent both in the time it takes the athlete to complete the drill and in the form exhibited by the athlete during the drill's execution (more on that in a second).

In the drill, the cones are spaced five yards apart. The athlete starts at the center cone (Figure 3.17) facing straight ahead so that one cone is to the athlete's right and the other is to the athlete's left. Once the athlete is set, the clock will start on the athlete's first movement. The athlete will choose which direction he wants to go first and then take off. The athlete will sprint five yards, touch the cone, turn, sprint ten yards back to the furthest cone, touch it, turn, and sprint five yards, finishing at the cone from which he started.

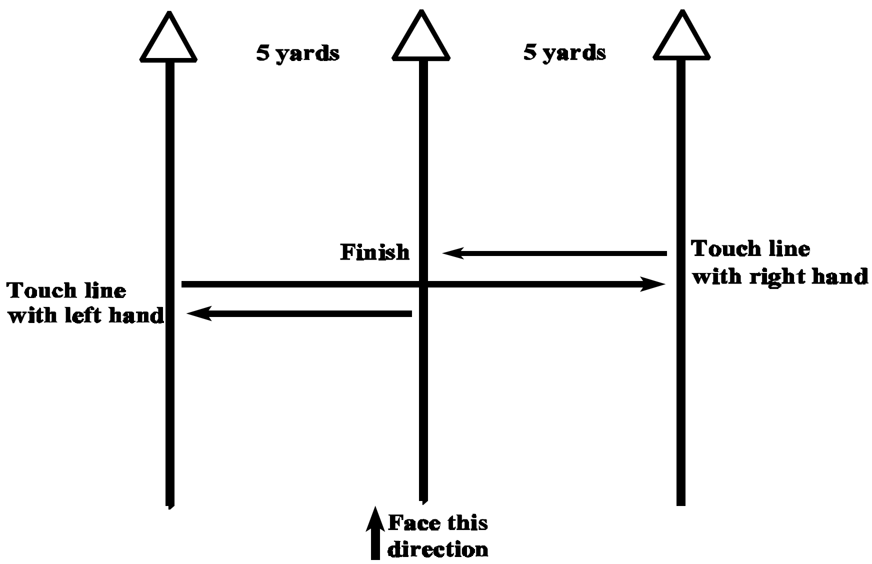


**Figure 3.17:** Pro-agility drill (20-yard shuttle).

When the baseball team ran the drill that fall...well, let's just say that I was less than impressed. Their times were terrible and their technique was horrendous! As I watched them run through the drill, I realized that they were bending over at the waist to touch each cone instead of sinking their hips at the turns. The key to a good shuttle time is to stay as low as possible and explode with the hips out of each turn. I realized that the guys' hip extensors were so eccentrically and isometrically weak that they couldn't absorb the force going into the turn at full speed. As a result, they had to start decelerating much earlier, using their quads as the eccentric decelerator to decrease the total amount of force they had to isometrically absorb in order to bring themselves to a stop. This forced them to stay high through the entire drill, slowing their times.

From what I saw in testing, I decided to carry out a little experiment with the baseball team. I had yet to implement any of my triphasic methods into their training program, so the group posed a great opportunity for me to test performance improvements resulting from the implementation of triphasic means in training.

To do this, I performed a longitudinal study lasting four weeks and consisting of two groups—standard method (SM) and triphasic method (TM). I randomly split the baseball team into two equal groups. SM worked out in the morning session at 9 a.m. while TM worked out later in the afternoon at 2 p.m. The SM workout program didn't have anything programmed to specifically work eccentric or isometric strength. They performed an off-season program that would look very similar to any done by a Division I baseball program across the country—lots of medicine ball throws, explosive squatting, and proprioceptive work. To try to improve their shuttle times, they also followed a protocol that many baseball strength coaches would employ—they practiced the drill. Every week they ran the drill three times before their normal lift and every time they were coached on form and technique, trying to make them as proficient at the drill as they could possibly be.

Meanwhile, the TM group had triphasic elements added to their normal workouts, specifically drills to emphasize eccentric deceleration and isometric absorption. Using exercises and means that I outlined in the previous section such as slow tempo eccentric squats and single leg isometric deadlifts, I tried to make their hip extensors as strong as possible, eccentrically and isometrically, to be able to absorb force at high velocities going into the turns of the pro-agility drill. In sharp contrast to the SM group, the TM group did not perform any repetitions of the pro-agility drill nor were they coached on technique.

Both groups went through the above protocol for four weeks. At the conclusion, I ran them through the test a second time. Remember:

**Standard method (SM):** Normal lifting, no eccentric training, practiced drill three times a week

**Triphasic method (TM):** Eccentric/isometric training, no practice with drill

**TABLE 3.12: Pro-Shuttle Results**

| Group | Pre-Test Times | Post-Test Times | Difference |
|---|---|---|---|
| Standard method | 4.8 sec | 4.7 sec | -0.1 |
| Triphasic method | 4.8 sec | 4.4 sec | -0.3 |

I don't think I can give you a better example that shows the importance of triphasic training with your athletes. During this experiment, the athletes who trained with the triphasic method improved their time by eight percent compared to a two percent improvement for those who used a traditional training program—a fourfold difference! Instead of focusing on trying to improve dynamic performance through concentric only methods, you need to use a program that physiologically improves the weak links in dynamic human movement. In this case, you need to specifically train the eccentric and isometric portions of the triphasic muscle action. The hyperlinks in table 3.13 show the drastic difference triphasic strength can make in an athletes performance performance.

**TABLE 3.13: Pro-Shuttle Comparison**

| | | |
|---|---|---|
| Incorrect form (Poor triphasic action) | 1) High hips<br>2) Reaching for cone<br>3) Slow turns | 1. Bad Pro-shuttle<br>2. Bad Pro-shuttle End View |
| Correct form (Optimal triphasic action) | 1) Low to the ground<br>2) Hips sink to cone<br>3) Explode out of turn | 1. Good Pro-shuttle<br>2. Good Pro-shuttle End View |

The question I get asked most often when I talk to people about stress and triphasic training is the "how" question. How do I implement these within my own system? People see the importance of stress. They see the need of applying specific stress to each phase of dynamic movement. They understand the means that can be used to apply it, but they don't have a firm grasp on how to implement it within their own training programs. After reading the first two sections, you, too, should have a good understanding of stress, triphasic training, and the role they play in developing your athletes. Right now, however, these concepts are very fluid. They aren't singularly focused or contained within the confines of an organized system.

In the next section, I will show you how to take these fluid concepts and solidify them by using two different periodization models—a weekly undulating model and a monthly block system. Together, these methods form a framework within which you will be able to manipulate and implement the stress placed on your athletes. So take a deep breath and bear with me. What now seems to be a complicated, insurmountable mountain of information will be by the end of this book a logical and intuitive reference that you will be able to use time and again in helping your athletes reach their athletic potential.

Below are hyperlinks to a video series where I elaborate and explain further the triphasic training principles, methods, and periodization schedule outlined in this section. The videos will serve as a great review, as well as give some additional insights into how to apply triphasic principles with your current programs.

TRIPHASIC TRAINING METHODS: PART I

TRIPHASIC TRAINING METHODS: PART II

TRIPHASIC TRAINING METHODS: PART III