
The Art of Speed



Understanding The Biomechanics Of Speed!

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INTRODUCTION TO SPEED

This information is designed to teach the fundamental biomechanics of sprinting/generating speed. A tool once learned will provide great results in the future, regardless of what sport you participate in. These fundamentals are not always taught at the high school level, not to mention college. As most commonly stated, "As parents, we teach our children to WALK, but not to SPRINT!"

Throughout the ages, humans have been running at high speeds. Today we have narrowed it to the art of sprinting. But what is effective sprinting? Young athletes are not even taught the biomechanics of running, let alone developing it into what we now call sprinting.

Speed is one of the most important bio-motor abilities in sports performance. It is a contributing factor for success in individual and team sports. Speed can be defined as the skill of an athlete to move as fast as possible, while utilizing efficient movement patterns through the greatest range of motion without using flawed mechanics, resulting in the use of wasted energy, thereby hindering performance.

Throughout this manual, we will attempt to break this down, so everyone has the opportunity to learn the biomechanics of sprinting. Then most importantly, be able to effectively apply what has been learned.



Chapter One

THE BRAIN AND HOW WE LEARN

At birth, our brain is only equipped with basic survival skills. No one is born with the ability to immediately start walking, talking, and all the other function we take for granted. It is said that our brain is a muscle. A muscle in which we must exercise daily, in order for us to reach our full potential.

Why must we exercise our brain? Because we are creatures of habit. Habit is the way in which we learn. Through repetition, habit is created, increasing our muscle memory. Bringing us back to the fact that our brain is a muscle.

We need to understand when we teach a new skill, the brain does not have the capability to determine if the skill taught is right or wrong. It just copies that particular skill to be used at a later time. These newly learned skills will create movement patterns and with practice, the brain and the neuromuscular system becomes faster, fine-tuned, and will re-create these movement patterns in a competitive situation regardless of if they are right or wrong. It is extremely more difficult to erase and reprogram a faulty practiced movement pattern that is embedded into an athlete's motor program than it is to teach the correct skill for the first time.

Time and patience should be given in practice to ensure athletes are taught the proper mechanics. These mechanics should be reinforced daily in training. Just going to training, lining up your athletes to run sprints, yelling “get your knees up” is simply not going to improve their speed.

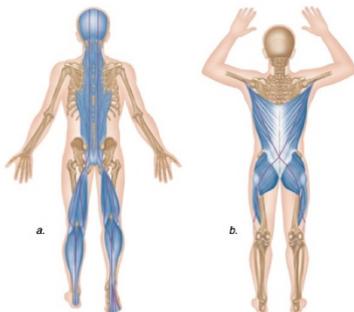
Force

An athlete must understand first and foremost how to create force. Understanding that every time their foot makes contact with the ground, three times the weight of that athlete is landing on that point of contact. Which brings us to Sir. Isaac Newton.

Newton’s 3rd Law of Motion states: that for every force exerted there is an equal force exerted in the opposite direction.

Studies have shown vertical forces on ground contact will improve stride length and stride frequency by applying Newton’s 3rd Law of Motion. For example, when the foot makes ground contact under the hip, applying vertical force while pushing against the ground with a down and backwards motion, an opposite reaction occurs, which gives a forward motion. This force generated from ground contact will transfer up to the athlete’s posterior chain, and propel him forward, which will increase stride length. This force and the ability to spend less time on the ground during ground contact and less time in the air during the flight phase will increase stride frequency.

Your next question may be, how do we apply Newton’s 3rd Law? This is done via repetition. Simple walking drills such as: step, dorsiflex, heel under the butt, knee up, then stepping straight down making contact with the ground with the ball of your foot.



Conditioning vs. Speed

Conditioning does not create speed; it can only maintain what you have created. Creating speed is a violent but controlled action. Once understood, this action can be used to your advantage. Until then, it’s just an action without a means. While knowing this, many believe that speed can be turned on during any time of a race or an event. This is not true.

Speed is a source of energy that has its own expiration date. Once at the top level, immediately the body begins to decelerate, causing the body to look for ways to comprehend the effect of Newton's 3rd Law of Motion.

This is when most problems occur. We begin to over think and rely solely on conditioning. Which is great, but when misunderstood it can become our greatest problem. Why? Because conditioning is there to aid in our ability to maintain form and the speed we have already created. Allowing us the ability to decrease the speed at a slower rate than our opponent.

Myth Regarding Speed

There is a myth that sprinters are born and not made. However, this statement seems to be nothing more than a myth. There is always going to be a genetic component related to athletic performance, but learning to run fast, using proper sprinting mechanics is a complex skill, that any athlete if taught properly, can learn to master.

Speed is a function of the product of stride length and stride frequency. One of the oldest training philosophies, still used by coaches today, is that in order to increase speed, one must increase stride length and stride frequency. Coaches and athletes are under the impression that to improve speed, one must increase one's stride length by over striding during forward leg swing and to increase stride frequency, one has to move one's legs as fast as possible. This training philosophy is misunderstood: if you increase stride length, you are decreasing stride frequency, and if you increase stride frequency, you are decreasing stride length.



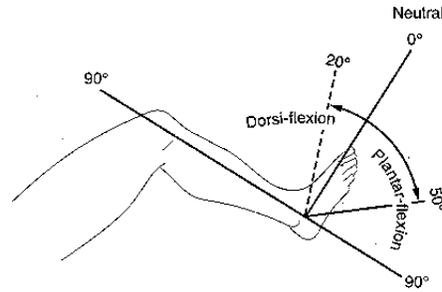
Chapter Two

SKILLSETS

1st Skillset:

Dorsiflex

The ankle should be stabilized. The foot should be in a dorsiflexed position with the toes up. The lead leg is raised and the lower leg extends at the knee-joint to start upward swing mechanics. Ankle remains in a dorsiflexed position to prepare for ground contact.

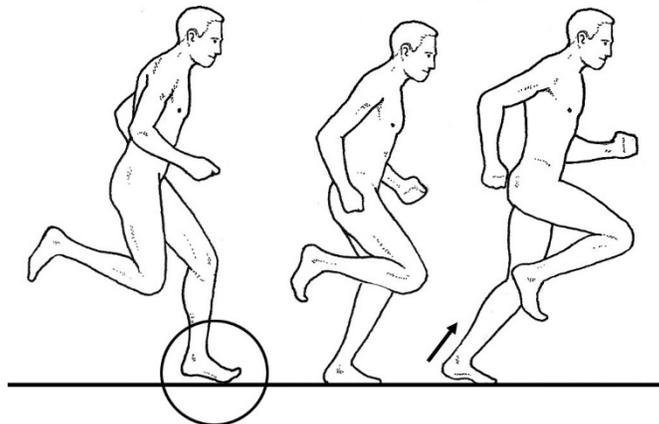


Front Side Mechanics

The foot must land in the proper force producing position, which would be a flat normal position with toe up, not in a pronated (outward) or supinated (inward) position. Landing in these two positions will not produce force and could cause severe ankle injuries. Therefore, at ground contact the ball of the foot should make contact first.

There should not be a clawing action by the foot; this will cause serious hamstring injuries. The foot of the forward swing leg should accelerate 2-5 inches in front of the hip into the ground to apply force on contact. If the foot lands too far in front of the center of gravity, it will produce braking forces that will decelerate the athlete. This is very important because this is where the rate of force development takes place by increasing the stride length and frequency. If the foot lands too far under the hip, the athlete could lose stability.

While making contact with the ground, force is then pushed downward into the ground creating a forward motion of 45 degrees, thus creating a triple extension with the ankle, knee, and hip.



Backside Mechanics

It is very important that the recovery leg be even at the knee with the support leg on ground contact before starting backside mechanics.

The hips should remain in a tall position, keeping the foot dorsiflexed, or in a cocked position. The athlete should push-off with the toes, when the toe comes off the ground, the athlete is utilizing backside mechanics.

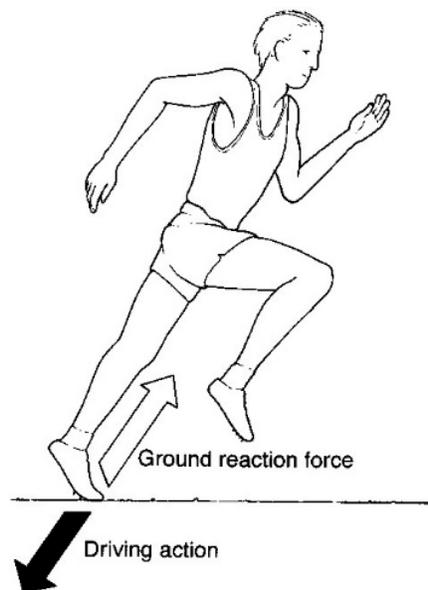
The support leg should remain in a triple extension position, on the balls of the feet with the heel slightly raised. The athlete should have a high heel position, tucking the heel under the gluteus with the toes up. This is not a butt kick.

The recovery leg will shorten as it goes up and over the knee of the drive leg (support leg). The thigh should be raised to a flexed locked position.

Sprinting mechanics are a cyclical motion just like riding a bike, one leg is putting pressure on the pedal to turn, bringing the heel (ankle dorsiflexed) as high as possible, up and over the knee of the support leg, which is a repetitive motion in sprinting.

Maintain “triple extension” with your support leg, keeping your ankle, knee, and hip extended. Stand on the balls of your feet with your heel slightly raised.

Shorten your recovery leg as it goes up and over the knee of your support leg and rises to a locked position. Think of the cyclical motion of pedaling a bike, bring your heel as high as possible, up and over your support leg knee.



Ground Support

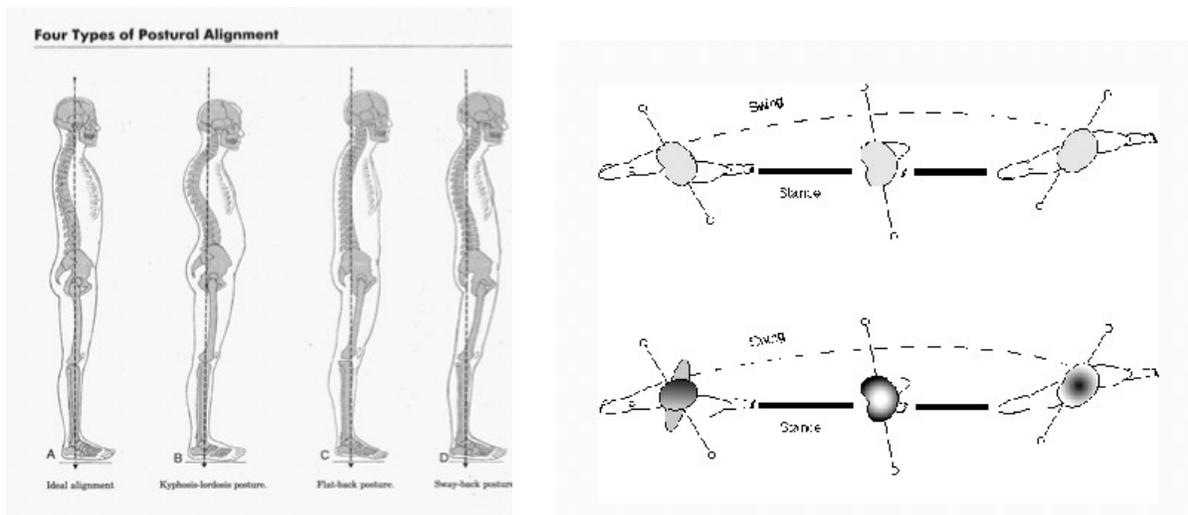
The opposite leg will become the support leg, there should be an extension in the hip, knee, and ankle. The athlete should be up on the balls of the feet with a slight heel raise - creating lift off!

2nd Skillset:

Posture

One of the most important factors of sprinting is proper posture. The athlete should not be in an anterior pelvic or posterior pelvic tilt position. Poor posture in the pelvic region will decrease the range of motion in the hips, which adds enormous pressure on the hamstrings, potentially resulting in serious injury.

The pelvis should be in a neutral position in line with the spine. This places the hips in the proper position to be utilized. The pelvis should rotate in all three planes.



Head Position

The head should be in a natural position, in line with the spine. The head should not move forward and backward or laterally turning left to right while sprinting. The jaw and muscles of the neck should be relaxed. Any movement of the head during a sprint will cause disturbances in this sprinting technique.

Eye Position

The eyes should be looking straight down the track, not down or side-to-side.

Shoulders

The shoulders should be in a natural position - down and relaxed.

Shoulders should never be in a shrugged position in hopes of increasing speed. Shrugging the shoulders will cause the direct opposite result of locking the hips, which hinders sprint performance.

Arms/Hands

Some coaches believe using the arms is important to increasing speed because it controls turnover and stride length. Others say the arms are used to balance the athlete and bringing the arms to far forward or to far backward results in wasted motion and, therefore, is wasted energy.

The motion of the arms should come from the arm and shoulder joint, not the shoulders.

Wrists should be straight and not bent. Arms should never cross the body; they should have a smooth forward closed, and backward open motion. The arm on the side of the lead leg (knee up) should be back the opposite arm in a forward position.

Fingers should not be in a fist position; they should be extended, and open to increase the lever. A sprinter should never shorten the lever of the arms, by clenching the fists and moving them as fast as he can. This disrupts the pattern of the arm swing.

Arm movement could be different in the acceleration phase of sprinting.

Elbows

Elbows should be bent at 90 degrees and moved to a closed position in the front of the body to 45 degrees, and into an open position in the back of the body.

One of the great coaching myths about sprinting is that the elbow joint should remain locked at 90 degrees, fixed throughout the movement. Carefully observing most great sprinters will reveal this is not the case. The elbow angle changes during the arm stroke.

Viewed from the side, at the top of the up-stroke, the elbow joint on most of the world's fastest sprinters bends to around 40 degrees. Some like Usain Bolt and Michael Johnson can be observed to close the angle even further. At the top of the upswing, the forearm and bicep/humerus are nearly touching with the hand close to the chest.

On the down stroke, the elbow should open up to almost straight – 45 degrees. This down stroke will produce a movement where the wrist passes below the hip socket as it moves back.

Finally, at the back end of the movement, where the arm goes behind the runner, the elbow joint closes again. This back-side elbow angle is around 90 to 120 degrees and occurs just as the backswing hits its conclusion. The arm then swings forward, and the elbow joint begins to close again in front of the body. The front and back strokes also finish simultaneously to impart forces.

These movements are necessary and correlate to knee joint movement that also undergoes changes in angles as well - opening on the way down and flexing on the way up/forward.

For example, one wouldn't see an efficient sprinter's knee rise forward with an open angle of the knee joint.

On the contrary, the leg folds at the knee joint on the way up such that the ankle passes close under the pelvis and steps over the knee of the support leg on the other side. The knee joint then opens up during front-side mechanics. Hence, the leg is lengthened out again before touchdown, where it is in a stronger alignment to push off the ground.

These changes occur during each arm and leg cycle respectively because short levers are quick, and long levers produce force. Elbows open on the downstroke to create a long arm that aids in force production. The same actions happen for the leg on the opposite side. The arms and legs then close up at the elbow and knee joints on the way forward to quickly recover in time to set up for the next down stroke. This is a constant process during sprinting.

For coaching purposes, the forward movement of the arms and legs are often elastically reflexive in nature. A result of the backstroke of the arm, the frontal deltoid is put on a stretch reflex, which rebounds the arm forward again. The same with the legs. As the hip, knee, and ankle triple extend at push off, the hip flexor muscles are put on stretch, followed by a shortening reflex which aids in bringing the leg forward - with the angle of the knee joint closing to increase angular speed.

3rd Skillset:

The Drill

This is a very simple drill, but must be mastered first, in order to move forward. Start by taking a 36" step forward, with either leg. Leaving the opposite leg back. Then with the back leg, bring the heel directly under that corresponding butt cheek. Once there, lift the knee up, while dorsiflexing the foot. This will put the leg in a right angle. Then drive the ball of that foot straight down to make contact with the ground. Remember while doing this, the upper body and arms are in their correct positions. This drill should be repeated often until it is mastered.

SPRINT TECHNIQUE DRILLS

Practice makes perfect but only if practiced perfectly! To practice sprint technique drills incorrectly is to rehearse them perfectly wrong and get very good at it. Below are the basic sprint drills that are used as a warm-up for any speed sessions.

All drills are performed with head held up and the hips high and forward (clench the bum cheeks together) and on the balls of the feet. Each drill should be completed twice over at least 15m with no distractions from music, phones or chatting to fellow athletes.

Arm Drill

Arms are bent at approximately 90 degrees and the hand is brought down and back to the hipbone. The opposite hand is brought up to approximately eye level.

Shoulders are not hunched up and are kept relaxed. Thumbs point upward and the palm of the hand faces inwards. Hands are loose and relaxed.

Ankle Drill

This drill aims to educate the athlete to dorsiflex the toes and has been nicknamed the 'Penguin Walk'. Legs are kept straight and are activated by bouncing alternatively on the ball of each foot with the toes pulled up towards the shin after contact with the track. Arms are moved through the full range of motion. A cue to the athletes would be toe-up toe-down.

Step-Overs

Support leg should be straight with the heel off the ground. The active foot should be dorsiflexed. The foot should come up underneath the buttocks to step over the opposite knee and then driven to the ground. Arms are again moved through a full range of motion. A cue to the athletes would be step over drive down.

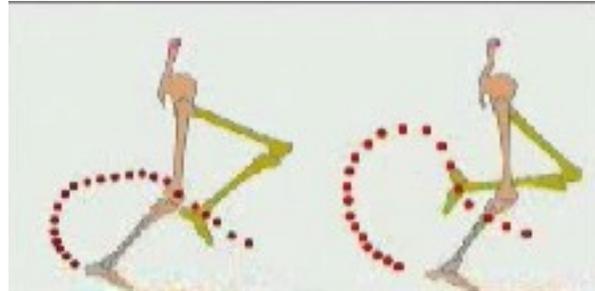
Fast High Knees

Same action as step-overs, but with speed to suit the athlete's development. Emphasis is on fast foot contact.

Recovery Action

In the recovery action, the foot should be lifted quickly from the track with the heel coming under the buttocks. Simultaneously the knee and hip should be swung forward. The calf muscle should be "smashed into the hamstring". This is probably the most poorly coached drill as coaches still insist on the thigh being vertical, which is a slower recovery action and is counterproductive. A cue to the athletes would be heel up, knee up, toe up. The image below on the left shows the correct recovery action.

Bending of the knee and hip at the same time. Knee bent followed by the hip.



Heel Up Drill

This drill is designed to improve recovery mechanics. The heel up drill teaches proper backside mechanics, allowing you to run faster by bringing your heel up in recovery, stepping over the opposite knee and driving the leg down into the ground with proper shin angle to apply force.

To better understand the drill, envision your leg movement when you're running or sprinting. It's like a bicycle pedaling action; your support leg is on the ground and your free recovery leg goes into backside mechanics. After the free foot touches the ground, it goes into recovery using backside mechanics by coming up underneath the glute, over the opposite knee and back down into the ground.

The heel up drill can be performed every day as part of your speed development program. When you first perform it, take your time until you master the technique. Go for 10 yards, then rest. Repeat three times. Once you can perform it correctly every time, increase the distance to 15 yards, and then to 20 yards.

Please understand the typical butt kick drill used in most athletic programs is not the proper way to run and is totally different from the heel up drill. Coaches who are still using the butt kick drill should replace this drill with the heel up drill to ingrain proper recovery mechanics.



4th Skillset:

Breathing Techniques

Athletes vary their workouts by changing exercises, intensity and volume to continue making improvements in strength, speed, and flexibility. However, a training program is most effective if you have the ability to recover from and adapt to the stress placed on your body from a workout. Lots of techniques are used to aid recovery, such as

recovery baths, contrast showers, proper nutrition, stretching, and massage/foam rolling. A method very useful, but seldom employed, is deep breathing.

Research shows that slow, deep breathing induces a calming effect on the body, decreasing everything from blood pressure, to stress, and calming down the nervous system activity.

1. What does this mean for athletes? It means faster recovery, starting the digestive process sooner, and creating stronger, faster bodies that respond better to future stress.

The nervous systems response to training is well documented as an excitatory effect in response to stress from exercise. The key to recovery, therefore, is the ability to switch as soon as possible from the catabolic state brought on by training (the breakdown of energy sources, including muscle) to a more anabolic state (building muscle).

2. The faster you can go from an excited state to a calm one, the more capable you will be of recovering from your workouts.

So, what exactly is good belly breathing? It's basically as simple as it sounds: deep breathing into the navel. Take a deep breath into your belly through your nose and exhale slowly through your mouth. Try taking longer to exhale than to inhale. An example of a good, deep breath might be a four-second inhale held for seven seconds and followed by an eight-second exhale.

3. Repeat this process three to four times - letting your body calm itself, relax, and adjust to the new breathing pattern.

The last piece of the breathing puzzle is programming it into your workout. Most athletes and coaches agree that the focus of the workout must be the training itself. But I would contend that taking five to 10 minutes at the end of a session for something as simple as deep belly breathing can have a huge impact on future training and performance.

One could also combine this type of breathing with stretching (think yoga). Try a simple bar hang with slow, relaxing, and rhythmic breaths. Or try a glute ham hang: lie face down on a glute ham machine, hang over the edge, and let your body completely relax. This will not only realign your breathing pattern but help to decompress your spine. Every exhale should make your body relax more, elongating your spine and freeing your mind of tension.



Chapter Three

Coaching

Developing Speed

In the fundamental/developing stages, coaching is about patience. Patience and the full understanding that an athlete is likely learning these techniques for the first time. Or the athlete may have to relearn and break bad habits. The athlete's excitement is high and you can sense the motivation to begin training. This is the point in which the coach must capture the attention of the athlete. Discuss with them the WHY? Why are they here? Why do I teach in the manner I teach? Why an athlete should never just reply with the answer of YES, without knowing the WHY! At each point in introducing the concepts of The Art of Speed, the Coach should be explaining in a way that the athlete understands the why.

Coaches should remember, the brain does not know if it's learning a skill right or wrong. The only way it can confirm what has been taught, is by the results of its action. Humans are creatures of habit, which we rely on repetition to increase muscle memory, therefore learning a new skillset. One is not born, stands up, and begins to walk and or talk. There are a series of repetitions accomplished first prior to even taking our first step. If your training session are designed to enforce habit via repetition, you will find that your athletes learn faster and are able to accomplish said task. Through repetition we master.

Understanding force by teaching your athletes in the beginning about Newton's 3rd Law of Motion, is very important. It states that every action has an equal and opposite reaction. With this understanding one can begin the process of learning force.

$$\mathbf{F=ma}$$

Force equals mass times acceleration

When asking athletes what a dorsiflex is - don't be surprised if no one in your group knows. Many professionals don't know, because they were never properly taught. But in order to benefit from this newfound concept of force, your athletes must understand what a dorsiflex is and how to apply it. Note: Three times your body weight lands on your foot, every time it strikes the ground. Dorsiflexion involves bringing the top part of your foot, which is also known as the dorsum, up toward your shin. This exposes the ball of your foot. Providing the perfect landing base, when your foot makes contact with the ground.

The following drill should be conducted. Step, dorsiflex, heel butt, knee up and step directly down landing on the ball of the foot (Repeat). So, with the opposite foot step out about 36 inches. Then with the other foot left from the ground while dorsiflexing that foot, bring the heel of that foot directly under the butt. Next, while that foot is in the dorsiflexed position and under the butt, bring the knee up so that the thigh is

perpendicular to the ground. Then drive the foot straight down landing on the ball of that foot. Note: Do not kick out so that the heel of that foot makes contact first.

Commands and keywords from the coach should be as follows: step, dorsiflex, heel butt, knee up and drive down (while landing on the ball of the foot). Once the ball of the foot makes contact, say PUSH. Remember, that the pawing action on contact is NOT what we are looking for.

This drill should be conducted 10 to 20 times, from 10 to 20 yards daily.

Coaching is the art of seeing, then delivering the tools to complete an athlete's goal or task. Which is why tools such as Coach's Eye come in handy. It allows the coach to video the athlete, then review in slow motion with the athlete. Once the athlete can see what corrections are needed, it becomes a lot easier for them to master the technique.

Communications

Communication (from Latin *commūnicāre*, meaning "to share") is the act of conveying intended meanings from one entity or group to another through the use of mutually understood signs and semiotic rules.

In order for one to learn, the information that you are trying to pass must be shared. Shared in a way that, the athlete can respond with their interpretation of what they think you are trying to explain. This shared meaning brings the understanding of what is trying to be learned closer to becoming mastered.

The Listening Effect

One of the most important skillsets available, but hardly used is listening. True listening is an art that is learned over time. One must be comfortable with themselves and have the knowledge-base to support their actions. Listening is not just hearing the vocal vibrations of the words of someone but having the ability to read the physical expressions of the person speaking. This is very important when training youth athletes. Oftentimes the youth will speak out prior to even forming a clear thought about what they are trying to express. Which most of the time leads to confusion.

By being able to read the emotional expression of your athlete you can lead them to greater success in their training. We must remember that when training the youth, their response is just a reaction to your opposing question. But the physical reaction is what they are trying to express.

Many times young athletes express their feelings and expression in confident language, but then at the same time come to tears moments later. Why? This is because their brain hasn't yet linked together the verbal and the physical expression of what they are trying to get across.

During this exchange, many times you will get the normal youth reaction like “okay, I understand”, but when they go to perform the action, they are not be able to do so correctly. At this time the coach or instructor should ask the athlete to repeat what has been stated. Repetition helps to ensure and confirm the athletes confidence and lets you know that they truly understand.

As a coach one must know, as previously stated, that the brain doesn't understand if it's learning something right or learning something wrong. The answer only comes once the results are accomplished.

While coaching of an athlete, eye contact is very important. The eyes are the gateway to understanding. This contact can ensure that you as the coach has the full attention of your athlete.

Creating key-phrases to be repeated helps reinforce their ability to learn. Since we are creatures of habit the only way we learn is through repetition.

Human are emotional beings, regardless of their age. Once we understand that, then teaching and bringing forth new concepts become easier. By listening we enter into the soul and the true meaning of why and what that athlete is trying to achieve. Which in turns opens up a new avenue in which to communicate.

Coaches should take the time to coach their athletes during the initial warm-up; this is the most important part of the training program. It is an excellent opportunity to watch their front side and backside mechanics as they perform the different speed drills. You can only progress to more advanced speed drills when your athletes have mastered the basics. Your athletes will know how serious you are about their training if you are out there coaching them from start to end. You can find all types of speed drills and speed workouts, with promises to increase speed, but the first step to increasing speed comes from mastering the proper sprinting mechanics. Once mastered, you can incorporate the different speed drills and workouts to help your athletes reach the pinnacle of success.

Use your warm-ups to really focus on mechanics. The correct form may feel unnatural at first, but once it becomes second nature, you'll start seeing real results from your training.



Chapter Four

UNDERSTANDING THE YOU IN YOU

Most likely you are saying...What?! Well, that is a great question. Those questions are the thoughts that speak to you while you are alone and in a state of silence. In other

words, the conversation you have with yourself. Which is to do or not to do. That personal conversation is the muscle memory that is activated by your brain. As you have been taught by Generating Speed, you are a creature of habit and the brain doesn't know if it is being taught something right or wrong. The positive action that you take and those results, let you know that you are being taught correctly.

These days many young athletes play several sports, some within the same season. This has been taken to the extreme. Most great athletes play opposite end/season sports, such as football and track. While many kids play sports season after season, never taking a break. Then we wonder why they burn out by their senior year of high school or their sophomore year of college. Sports should be the decision of the athlete and not solely the parents.

Listening to the YOU within, is an art that should be mastered sooner rather than later. Understanding and taking in all input throughout your lifetime should be readily received, evaluated, and reviewed. While in this mental state of review, oftentimes confusion, misleading feelings, and doubt may be in control of your conversation. This is normal. It's a process of the brain validating its new muscle memory.

Make it a habit! To have a daily conversation with YOU! With the understanding that humans are creatures of habit, and our ability to learn is through repetition. Always continue increasing our muscle memory and developing our skill set. Out of this daily habit, one creates discipline. Discipline is the key element needed in order to form a habit that its end result is a new skill.

Understanding the you, while applying discipline, leads to the vision. The visual creation of your success within your brain. No, it is not daydreaming. Until you can create and see the image of your success in your mind, this skill-set or objective will not come to fruition. Remember, it is stated that our Creator made us in his/her own image, therefore he/she had to first see it in their mind before creating.



CONCLUSION

The information presented has taught you the fundamental biomechanics of sprinting/generating speed. Once this concept is learned, it is now yours to keep and most importantly master thru repetition.

Speed is defined as the skill of an athlete to move as fast as possible, while utilizing efficient movement patterns through the greatest range of motion without using flawed mechanics, resulting in the use of wasted energy, thereby hindering performance.

The Art of Speed is one of the most important bio-motor abilities in sports performance. It is a major contributing factor for success in all sports.

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