

# Stretch-shortening cycle

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## Introduction

The stretch shortening cycle is an integral part of Taekwon-Do, as it is in any martial art. Nearly every movement, if performed quickly and with proper technique, will be utilising the stretch shortening cycle. This mechanism within the muscle can be harnessed to increase the speed and power of techniques dramatically. Taekwon-Do is an exacting martial, having a focus on the fitness of the practitioners. So it is important to be able to produce the maximum force with the least energy expenditure.

In this essay, I explain a basic concept of the types of muscle contraction and the contraction at a cellular level, outlining how the stretch shortening cycle works, what roles the stretch shortening cycle plays in aspects of Taekwon-Do, and how having an understanding of the stretch shortening cycle is beneficial to practitioners of Taekwon-Do. I will give examples of Taekwon-Do and show how the stretch shortening cycle is utilised and necessary to gain the most force that our body can generate.

## Muscle contraction

Most definitions of muscle contraction are limited to the shortening and thickening of the functioning muscle or muscle fibre. But this is simplistic as contraction can occur while the muscle is shortening (concentric contraction), lengthening (eccentric contraction), or remaining the same length (isometric contraction). An example of eccentric contraction is when you lower your body in preparation to perform a flying technique. Specifically, your gluteal and quadriceps muscles are controlling the descent caused by gravity, producing force while lengthening. An example of concentric contraction is when you launch from a stance to perform a technique or the muscles action while the technique is being performed. Moving forward from a walking stance, the quadriceps muscle group produce a concentric contraction to propel our body forward. The quadriceps muscle group also produce a concentric contraction producing the force, while shortening, to extend or flex a joint irrespective of gravity when executing a turning kick (extending the knee joint) or a reverse hooking kick ( flexing the knee joint). An example of isometric contraction is when you remain static in a stance such as the sitting stance. Here the muscle is producing force but neither shortening nor lengthening.

At the cellular level, contraction within the muscle is produced by the chemical reaction of intracellular calcium binding to troponin (a major protein in actin filaments which are the thin filaments in the muscle fibre). In response to a signal from the nervous system, the calcium activated troponin causes tropomyosin (a rod shaped protein that coils around thus stiffening and strengthening actin) to shift aside and expose the actin's active binding sites. Myosin (the thick filaments in the muscle fibre) binds to the active site on the actin filament and the result is a muscle contraction. The strength of contraction is proportional to the number of motor units (the muscle fibres that one motor neuron enervates) which are activated.

## The Stretch –Shortening cycle

The stretch shortening cycle is a mechanism which occurs within the muscle greatly increasing the strength of contraction produced by the muscle. The stretch shortening begins with an eccentric contraction; this causes the muscle-tendon complex to increase its stiffness or resistance to stretching. The result is the storage of elastic energy in the muscles and tendons (the connective tissues) which is restored in the subsequent concentric contraction.

Timing is an important component of the stretch-shortening cycle. If the transition from eccentric to concentric contraction is slow, the potential energy within the elastic components (muscle-tendon complex) may be lost as heat and cannot be utilised in a later contraction.

The stretch reflex can also play a part in the stretch shortening cycle. As the muscle is being rapidly stretched through eccentric contractions the muscle spindle receptors, located within the muscles, are activated. The muscle spindle receptors send an action potential, through a sensory neuron, to the integrating centre within the spinal cord which then sends the action potential, through a motor neuron, to cause the muscle being stretched to contract. This reflex can contribute to the increase in contractile power of the muscle.

The stretch shortening cycle can be improved with plyometric (speed and agility) training. An example of this is continuous tuck jumps trying to minimise the time that feet are on the floor between jumps, or clapping press ups. Training in plyometrics also improves motor skill, brain signal efficiency, reaction force and reaction time. Plyometric training can also stimulate various neurological mechanisms to help increase muscle recruitment over a shorter period of time. It is suggested that plyometric training increases neuromuscular coordination and improves neural efficiency.

The stretch shortening cycle is extremely important in Taekwon-Do and we need to utilise it while performing techniques. As we lift our leg into the loading position for our kicks, and as long as this loading is performed rapidly, we utilise the stretch shortening cycle to produce the explosive speed needed to perform our techniques with power. An example of the utilisation of the stretch shortening cycle during a kick is the delivery of 'apcha busigi'. As the knee is raised and flexed the quadriceps muscle group is lengthened and must contract eccentrically (the muscle produces force as it lengthens) to slow the lower leg in order to extend the kick. This phase is very rapid storing the elastic energy we need into the muscle-tendon complex. We then utilise this stored energy in the subsequent concentric contraction (the muscle produces force while shortening), extending the kick.

The stretch shortening cycle is extremely important for the amount of height we are able to attain when jumping. If we stood in parallel stance then moved about a foot lower and held it for 5 seconds, if we were to jump as high as we could, the height gained would not be as much as the height gained if we were to stand in parallel stance then rapidly drop a foot lower in height and then as quickly as possible, launch into the air. When remaining in a stance, to get the most height for the required technique to be performed properly, we drop slightly in our stance. Dropping in our stance allows us to enhance the height we jump by exploiting the stretch shortening cycle.

Another example is demonstrated in running starts. When performing a technique from a dynamic start, in the take off step, we use the 'take off' leg like a pole vaulter uses the pole. As the pole gets stuck in its mount, it starts to bend and build up energy because its natural state is straight. The pole then straightens which dramatically increases the height of the pole vaulter's jump. Our muscles do not like to be stretched too much either. As we launch into a flying technique, our muscles have to produce the eccentric contraction. This produces the stretch in the muscle and stores the elastic energy created. Then, as the cycle is completed by the rapid subsequent concentric contraction the elastic energy is added to the contractile strength of the muscle. The result is a muscular contraction with greater force, which in turn increases our take off power.

Hip twist takes advantage of the stretch-shortening cycle to increase the power of our techniques. This is because it is utilising the dominant muscle groups at the core of our body as a foundation for subsequent muscular contractions. Specifically, when these muscle groups contract at the start of the movement, the next muscle in the muscular sequence lags behind slightly - producing a slight stretch of the muscle. That muscle then has the elastic potential energy stored within the muscle-tendon complex to increase the power of its contraction. Once started, this creates a domino effect throughout the sequence of contraction throughout the body until the movement is completed and results in a net effect of greater force delivered.

"All movements must begin with a backwards motion with very few exceptions. However, once the movement is in motion it should not be stopped before reaching the target"

Training secrets of Taekwon-Do

Black Belt Techniques Handbook, Page 30

The last part of the backwards motion in the loading phase just before executing a hand attack, jump or a kick, is the first part of the stretch shortening cycle. When a fore fist front punch is executed it goes through the relaxation phase then through the loading phase and finally to the execution phase. In the relaxation phase, the fist is moved forward from the hip three inches. In the loading phase, the fist is drawn back to the hip then as it enters the execution phase the fist is accelerated from the hip to its target. At the end of the loading phase is where the stretch shortening cycle is activated. As the fist is just about to be accelerated away from the hip the muscles in the shoulder produce the eccentric contraction, storing elastic energy. As the movement enters the execution phase, the muscles from in the shoulder use this elastic energy to increase the force of contraction. The result, is a faster and much more powerful punch

**A good understanding of the stretch shortening cycle is beneficial to Taekwon-Do practitioners.**

Understanding the stretch shortening cycle is useful when explaining and utilising hip twist. This knowledge is important when teaching movements and the reasons why each movement is delivered the way they are and the importance for the technique to be delivered properly. An explanation of how hip twist maximises the speed produced and thus how it increases the power and effectiveness of the attack or block help a student understand the importance of including it in the movement. Understanding the stretch shortening cycle is useful for explaining where and how the speed is produced, if a student does not understand the relevance of technique to the production of speed and power,

Having knowledge about the stretch shortening cycle is beneficial for one's own training as well. Knowing how the speed is produced helps us understand the need to practice these techniques properly and why we should not become sloppy with our approach to training. This enhances our own training because proper technique and application of the stretch shortening cycle gradually increase the speed in which our bodies can move and react. The faster we can react, the faster and more effective our movements become. This enables us to move more effectively and efficiently increasing power for the energy used within our body.

With the continual practice of movements, making sure to utilise the stretch shortening cycle, the addition of the stretch shortening cycle to techniques becomes instinctive. So if it is necessary for us to use these skills in a real life situation, we will instinctively utilise the stretch shortening cycle with each technique. This will help with the one necessary blow to achieve victory.

## Conclusion

It is important for an instructor to have a good understanding on how the body can efficiently produce more power through technique. Having knowledge about the stretch shortening cycle helps build our understanding about the performance of techniques. With this understanding we are able to enhance our techniques so the maximum potential power is reached and exploited. With this knowledge about how to exploit our muscles full potential, it is easy to understand the reasons behind the technique that we are suppose to use. In this essay I have outlined muscle contraction. I have also explained how the stretch shortening cycle can contribute to the increase in potential power of the techniques in Taekwon-Do and its role in hip twist. The usefulness of understand the stretch shortening cycle for explanations to students and the importance of utilising the stretch shortening cycle while training to install the instinctive ability produce more speed and power with every movement.

“To understand the purpose and method of each movement clearly”

Training secrets of Taekwon-Do

The stretch shortening cycle is a component in the method of effectively executing techniques with the most force available, with efficiently achieving the best possible effect.

## Reference

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