

**SCIENTIFIC BASIS  
FOR  
THE MARTIAL ARTS**

**GMAU PRESS**



**BY VARIOUS AUTHORS**

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**THE SCIENTIFIC BASIS FOR THE MARTIAL ARTS**

**FUNDAMENTALS OF FLEXIBILITY**

**GMAU PRESS**

BY  
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## I. INTRODUCTION AND EXPLANATION

Most people who have been involved in any athletic endeavor for a prolonged period of time are aware of what flexibility is and the benefits derived from it. Flexibility is just as crucial to an athlete as is strength, endurance or agility. Why? Because just as with the other mentioned physical attributes, flexibility enables an athlete to function more economically in his or her chosen activity.

While the development of a high level of flexibility is a plus in any athletic activity, some require a maximal range of motion just to execute the basic techniques. The martial arts comprise one of those activities. Consider the basic side kick: With the exception of a physical disability, a black belt martial artist should be capable of delivering this technique at least his or her own waist level, preferably at head level. The latter in specific cannot be accomplished without proper flexibility in both the kicking and supporting leg. The lower back, leg abductors (groin muscles), biceps femoris (hamstrings) and gastrocnemius (calf muscle) play a limiting factor in the execution of the side kick.

Apart from the ability to actually execute the technique, flexibility has other benefits desired by the martial artist. Whether one is enjoying a friendly sparring match or defending one's life, hundredths of a second can often make the difference between winning and losing. Reflex and reaction time are crucial to the martial artist. It has been deduced that a person's reflex ability is maximal when asleep. The explanation given for this is that the muscles are in a relaxed state when at rest. If a relaxed muscle is more reflexive while a person is asleep, this principle must apply also when one is awake. This is where flexibility comes into play. The more flexible a particular muscle group is, the less tension is found in that muscle group. A flexible muscle is a relaxed muscle, and a relaxed muscle is a fast muscle.

Flexibility has also been shown to enhance the aerobic capacity of an athlete. The sharpest, most powerful technique is of little value to the martial artist who is too exhausted to perform it. Through consistent flexibility training, the muscle groups stretched display an increase in circulation. Eventually, the particular muscle group allows more blood to pass through in less time. This blood, rich in oxygen, not only aids the endurance of the muscle itself, but also enables the heart to work more efficiently because it does not have to work as hard to pump blood to the working muscles.

Another physical attribute aided by increased flexibility is power. Without power, a particular technique may look good, but in reality is rendered ineffective. Just how does flexibility affect power? A simple analogy will illustrate this. Have you ever watched a baseball player's movement just prior to hitting the ball? He instinctively makes a movement in the opposite direction, aware that it will increase the force of the bat. A muscle is similar in its action. It functions optimally only if it can contract from a maximal stretch. In his book, *Stretching Scientifically*, Thomas Kurz explains:

"The ability of a muscle to contract is proportional to the length of its fibers. A longer muscle can exert force on the object (foot, in the case of a side kick) on the longer trajectory, accelerating it more. The longer your muscles, the more you can get out of them." (Parentheses mine.)

One final case in the argument for consistent stretching in the training of a martial artist centers upon injury prevention and post-workout recovery. A martial artist cannot progress apart from consistent practice and that practice is only possible when one is healthy. A pulled groin muscle, for example, would prohibit one from performing any kick (and most stances for that matter). Another limiting factor in one's practice involves overtraining. Remember the first time you practiced that new kick and the next day your legs were too stiff to spar? Or have you ever wondered why one day your kicks feel effortless and another your feet feel like lead weights? A person can only perform at optimal level in a completely recovered state. Regular stretching facilitates recovery by relieving any muscle spasms and regulating muscular tension. It also improves blood flow that carries away chemical byproducts produced by exercise and replaces them with nutrient-rich blood.

As we have seen, flexibility is not only desirable in the martial arts, but is mandatory for more than one reason. With this being established, we will now look at what occurs physiologically to bring about these desired results.

## **II. THE SCIENCE OF STRETCHING**

Every conceivable martial arts technique is limited by certain principles of biomechanics. These limitations are specifically related to the flexibility of those areas involved in the technique. Flexibility at a given joint is limited by two body components: 1) bone and 2) soft tissue. Soft tissue refers to muscle and connective tissue related to it.

Consider this illustration. From a fighting back stance, extend the lead hand out in a circular motion executing a backfist. You will notice that when the elbow remains stationary, the technique has a limited range of motion. That is because the bone structure will not allow the elbow any further extension once the arm is completely straight. Through this illustration, we can see that nothing can be done to reeducate the bone structure thus increasing a joint's range of motion. For this reason, we must turn our attention to the soft body tissue components when embarking upon a flexibility program.

The body organ most crucial to flexibility training is obviously the skeletal muscle. The many fibers packaged in equilateral bundles give muscle tissue some very unique characteristics. Muscle tissue has the ability to contract and, in a relaxed state, expand. Muscle can increase in both length and diameter. Just how much can muscle tissue vary from its normal resting state? Kurz (Scientific Stretching) gives us an idea:

"In the body, a muscle can be contracted to seventy percent or stretched to one hundred and thirty percent of its normal resting length. Normal resting length is the length that the muscle takes up in the body in a typical resting attitude. Outside of the body, the muscle can be contracted to fifty percent of its length and stretched more than one hundred and thirty percent."

As you can see, regardless of what your body seems to be telling you when you throw that high round kick, muscle has the potential to be very elastic. Before we move on, let it be said that the elasticity of the muscle tissue is directly related to its blood flow. Flexibility improves with increased blood flow while it decreases as the blood flow is cut off.

As a muscle reaches its maximum stretch potential, the tension is increasingly passed along to the fibers of the connective tissues. The two major types of connective tissue we will investigate here are 1) tendons and 2) ligaments.

Unlike the large degree of change possible in muscle tissue, a tendon can only extend beyond four percent of its length before irreversible damage is done. This is due in part to the collagen fibers that compose a tendon. Collagen fibers tend to have a great deal of strength, but are lacking in the ability to stretch or contract. Because the tendons are extensions of the muscle attached to a bone, they can only allow motion until their "slack" is taken up. Attempting to force a tendon beyond this "slack" is highly discouraged.

A tendon holds a muscle to a bone, but a ligament holds a bone to a bone. These ligaments responsible for holding your joints together are also composed of collagen, but are more flexible than tendons due to their possession of elastin. This flexibility is still well behind that of muscle tissue, however. A ligament will tear once it has been stretched beyond six percent of its normal length. While we are discussing the issue of ligaments, this important point must be made: **YOU SHOULD NOT ENGAGE IN ANY FLEXIBILITY PROGRAM AIMED AT STRETCHING THE LIGAMENTS!** Ligaments are much like a spring. They can be stretched to a certain point and still return to their original state. However, upon stretching them to a maximum state, **LIGAMENTS WILL REMAIN STRETCHED.** Because these ligaments hold the joints together, any joint supported by stretched ligaments is a weak joint! There is no need to stretch ligaments to perform even the most spectacular martial arts technique. The natural range of motion proves adequate.

There are many other factors determining the flexibility of a given muscle group. However, due to limited space and the complexity of these factors, I have chosen two of the most important factors and will attempt to state each in an easily understood manner. These two factors are often overlooked when considering a stretching program, but may be the most important to its success. These two factors are the involvement of the nervous system, and more specifically the Golgi Organs.

The same nervous system activity that allows us to simply move can also have a positive effect on flexibility. As stated earlier, the length of a muscle is determined by its tension and this tension is regulated by the nervous system. Nerve cells receiving signals from the brain (neurons) are the contacts to nerve centers in the muscle itself (motoneurons). Some neurons stimulate motoneurons causing a contraction of muscle fibers. Other neurons block the signals to motoneurons causing a relaxation of muscle fibers. When one set of muscles are stimulated, the opposing set is blocked (relaxed). For example, when you contract the quadriceps muscle in performing a front kick, the biceps femoris (hamstring) must relax. This is what allows us to move. The importance of this relaxation when stretching will be alluded to later.

Another factor influencing this relaxation is the involvement of the Golgi organs, which are located in the tendons where they join with the muscle. We stated earlier that when the tension is increased in the muscle, it is transferred to the tendon. When this occurs, the Golgi organ fires impulses in proportion to the tension in the muscle. This inhibits the passing of impulses from the motoneurons to the muscles itself. Remember when the impulses are blocked, the muscle relaxes. And remember that when a muscle is relaxed, it is more flexible. Thus the amount of possible stretch can be increased by taking advantage of the inhibiting function of the Golgi organs. This will be discussed in depth in the 'Methods Of Stretching' section.

### **III. METHODS OF STRETCHING**

Numerous methods for improving flexibility exist. Eight different methods will be mentioned here and then evaluated for their safety and effectiveness.

#### **A. Ballistic**

Of all the stretching methods mentioned in this writing, ballistic stretching is probably the least desirable. Ballistic stretching is accomplished by using momentum to forcibly increase the stretch. An example of this type of stretching would be bouncing up and down in a side split position using the weight of the trunk to force the legs lower.

#### **B. Dynamic**

Dynamic stretching must not be confused with ballistic stretching. Although dynamic stretches involve swinging the leg to gradually increase the height, no bouncing or jerky movements are employed. There is also no excess weight forcing the muscles to extend beyond their range of motion. Dynamic stretches are highly recommended for martial artists because they mimic the action involved in kicking techniques. By understanding the Law of Specificity of Training, we realize that floor stretches alone do not prepare one for kicking techniques at the full height and speed. Dynamic stretching offers a relatively safe method of preparing for this. Dynamic stretches useful for the martial artist include straight-legged rising kicks to the front and to the side. Begin by swinging the leg up comfortably, increasing the height and speed with each successive swing. Sets of twelve with each leg are standard. Dynamic stretching should be employed as a warm-up

prior to a martial arts class as they prepare the muscular and nervous systems for the dynamic actions to follow.

### **C. Synergistic**

The theory surrounding synergistic stretching states that a specific pre-arranged order of exercises yields the best results. For example, because some exercises like a front split involve many smaller muscle groups, the smaller muscle group must be isolated first to achieve maximum flexibility in the split. Stretches would begin working on the lower back, progress to the calves, then the hamstrings and then the groin and hip flexors. No stretch is employed which uses a previously unstretched muscle group. This method may be particularly useful for those with limited flexibility or those just beginning a stretching program.

### **D. Static Passive**

Static passive stretching is an excellent method to employ in any flexibility program. These stretches can be done every day, several times a day if desired, because they do not cause fatigue. It is the safest method of stretching and is useful for relieving muscle spasms and facilitating recovery. The only drawback to these stretches is that they do not increase flexibility as rapidly as isometric stretches. When performing static passive stretches, one should assume a position in which all the muscles can be relaxed. Relax the body into the stretch and hold the position for approximately thirty to sixty seconds.

### **E. Static Active**

Static active stretching is difficult to cultivate to the level of your static passive level. The reason is that static active stretches require the simultaneous display of strength and flexibility in a difficult position. It involves moving the body into a position in which the stretch is held by the contraction of the opposing muscles. An example of this would be holding one leg in a front kick position as high as possible. The contraction of the quadriceps muscle accounts for the stretch in the hamstrings. The leg should be extended fully for at least six seconds. Although this method does not produce the level of flexibility produced by other methods, it is especially beneficial for martial artists. Performing slow-motion front, round and side kicks and holding them for prolonged periods of time will vastly improve full speed kicking techniques.

### **F. Proprioceptive**

Proprioceptive neuromuscular facilitation is a complex word for isometric stretching. Isometric stretching brings about the most dramatic improvements in flexibility in the shortest amount of time. The reason for this is that isometric stretching takes full advantage of the nervous system and Golgi organs as previously mentioned. Isometric stretching is done using the same stretches one utilizes in relaxed stretching. The difference is the use of a contraction without the limb moving; thus the term 'isometric'. A strong tension of the stretched muscles causes the Golgi organs to fire resulting in

reflexive relaxations, and conversely, an increased stretch. By alternating these contractions with relaxations a further stretch is realized. Once the maximum stretch at that current level is achieved, a final contraction is held for thirty seconds. This is especially helpful for injury prevention because it not only increases flexibility, but strength as well. Because this exercise is more intense than standard stretching exercises, it should be treated as other strength workouts, spaced between adequate days of rest. Four days per week appears to be the maximum number of isometric stretching routines from which the body can recover.

There are various methods of doing isometric stretching although all are quite similar. The method meeting the most success will be detailed here. The prescription as given in the book *Stretching Scientifically* is as follows:

"Stretch the muscles nearly to the maximum, then tense for three to five seconds. Stretch further and further until the stretch cannot be increased. Then hold this last tension for up to thirty seconds. After a minute of rest, repeat the same stretch. Do three to five repetitions of a whole stretch per workout. Use isometric stretched three or four times per week. Gradually increase the time of the last tension to about thirty seconds."

It should be noted that with isometric stretches the strength gains should be stressed in each position. When the stretch will no longer increase, tense the muscle harder and longer and it will eventually result in an increase in flexibility.

### **G. Partner Stretching**

Much has been written about the use of partners in stretching. Some advocate the use of partners to gently increase the stretch for a more effective workout. It is this author's opinion that partner stretching should be left to advanced trainers only. If you need someone's help to achieve a certain position, then you are probably not ready for that position yet. Another drawback is that a partner does not feel what you feel. Tension continued for a split second when a minor injury occurs could translate into a major muscle pull. While you would react immediately to a pull, your partner can only react when he or she knows something is wrong - which may be too late. It should also be mentioned that partner stretching is uneconomical because one of the partners is wasting his or her time.

### **H. Machines**

Many different devices exist for increasing flexibility, from simply pulley contraptions to complex hydraulic mechanisms. Many of these machines do not offer any advantage over conventional floor exercises. I have seen two primary benefits in the seated hydraulic machines developed recently, however. The first advantage is seen in the specially designed leg decks. A machine with ergonomically correct thigh pads eliminates the dangerous torque on the knees found in conventional groin stretching exercises. The other benefit is the ability to consistently and accurately monitor your progress on a reference scale. This scale typically reads the degree of the stretch up to one hundred and



eighty degrees, and is excellent for those who keep a training diary because it offers objective data.

This same type of machine is also excellent for performing isometric stretches on because it provides perfectly aligned resistance to push against during contractions.

#### **IV. APPLICATIONS OF STRETCHING**

Prior to developing a personalized stretching program, you must examine the requirements of your activity to determine your needs. Why? Is not all stretching the same?

To a certain degree, yes. However, every routine should begin with the basics and proceed to specifics. For example, a swimmer may begin with general stretches used by a hurdler, but each will then choose exercises and methods specific to their sport. The question, then, is what level of flexibility is needed by the martial artist, and in what muscle groups? This must be determined by your particular art. A soft style, such as jujitsu, for example, has demands that are different from that of a hard style, such as taekwon do. In my personal arsenal of techniques, I prefer kicking. Many of the kicks I utilize are head level and multiple kicks. This means that I have a large demand for flexibility in my lower backs, hips, groin, hamstrings, and calves. How much of a demand? This is determined by the particular needs. In my case, I need to be able to kick the head effectively. In order to do this, I must be able to the kicks higher than head level if I am to maximize head level kicks. The reason for this is that it is impossible to achieve maximum speed at your extreme ranges of motion. This means that to kick head level with sufficient speed, I must be able to kick beyond head level. This is what is known as "flexibility reserve". The flexibility reserve is the difference between my flexibility and the needs of my sport. To determine your level of flexibility, clearly define the needs of your art. Then aspire to supersede that level to assure that you exceed the maximal range of motion needed to be your fastest.

Many people believe that their body structure will not allow them to kick to the head effectively despite the amount of stretching that they do. Many of them are wrong. There is a simple test that can be conducted to determine whether or not you have the potential to achieve a full side split.

To test the side split potential, just rest one foot on the back of a chair in the position it would assume in a side split. If you are able to do this, you are able to achieve a full side split. The reason for this is that no muscle runs from leg to leg. If you can do one half of the split, only the intramuscular tension prohibits you from achieving the same position with the other foot.

Now that you have determined the level of flexibility you need and are convinced that you can achieve it, it is time to choose a method. When choosing a method, you must first answer a few preliminary questions. The first question is 'Which methods produce the best results with the least amount of risk to injury?' The second question, then, is 'Which

method or methods produce the best results in the shortest amount of time?' One final question is 'What resources do I have at my disposal?' In actuality, a combination of the previous methods mentioned works best. The question regarding safety, in my opinion, eliminates the ballistic and partner stretches. The quickest results question eliminates the static active (this is very effective in developing strength in the muscles involved in kicking and should be used in technique practice). The safest and quickest results are obtained by a combination of dynamic, isometric, and static passive stretches. A stretching machine can be utilized in isometric and static passive stretches if you have one at your disposal.

The task at hand now is to construct a program using these three methods. Any stretching program should begin with some type of activity that raises the body temperature and increases the blood flow to the muscles to be stretched. This can be accomplished by approximately five minutes of some type of aerobic work (i.e. stationary bike, jogging in place, skipping rope, etc.) Next specific exercises must be selected.

The exercise selection depends upon two primary concerns: (1) which muscle groups require the most work and (2) safety. Because I rely heavily upon my kicking ability, I always choose an exercise for the following muscle groups: lower back, hips, quadriceps, groin, hamstrings and calves. Which exercises are chosen for these particular muscle groups is based upon effectiveness and safety. Due to limited space and the inability to demonstrate, I will be unable to assess every stretching exercise. I highly recommend those constructing a stretching program to consult a recent (1990 or newer) book by a reputable physiologist or doctor. I will mention here that any exercise which places an unnatural torque on the knee should be avoided (i.e. hurdler stretch). Exercises should typically move from a vertical to a horizontal position, evolving from the previous exercise (synergistic method).

Now that methods and exercises have been chosen, they must be integrated into the overall training regime. Because dynamic flexibility is decreased with fatigue, it should follow the aerobic warm-up (unless your training goal is endurance, not flexibility). This should be followed by the technical workout (sparring, bag work, martial arts class), and the workout should conclude with static passive stretches to cool down and facilitate recovery. On days in which the isometric stretches will be included (two or four days per week), they should be placed after the technical workout and before the static passive stretches. The reason they are placed here is twofold. Isometric stretches produce fatigue that would hinder the workout; also, isometric stretches are most productive when the body is thoroughly warmed up. Static passive stretching can be performed every day, but at least one complete day of rest is ideal.

Now that the program is ready for institution, some method must be incurred to determine whether or not success is being met. First of all, success must be defined. Is success a full split? If so, if I achieve a full split in eighteen months, is it a success? Ultimately it is, but in reality it is not. Maximum flexibility is achievable in about two months. If it takes much longer than this, then the wrong methods, exercises or both are being employed. Look for consistent improvement each week, then each month. Keep a

record of your progress (this is where a machine with a reference scale is useful). If progress is not being made, then reevaluate the situation. Are you allowing sufficient recovering time between isometric stretching sessions? Are you performing the isometric sessions at least two days per week? Upon re-evaluation, make the necessary changes.

By following sound training principles, flexibility can be developed to a high level by any martial artist, at any time in his or her training. The principles contained in this writing can be used with a great deal of success by healthy trainers at any age and at any skill level. The tools have been provided - the builder must simply use them.

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# **The Scientific Basis for the Martial Arts**

Doug Haralson 1-27-91

## The Scientific Basis of the Martial Arts

### I. Introduction

All motion has mathematical laws involved in the movement and motion. This includes the human body. Karate, which many people would like to include in sideshows and arenas for amusement, has very solid scientific and physical principles upon which it is based. These principles form the roots for the physical foundation of karate. Whether or not people realize that they are being taught these principles, they are still learning them to increase their skill in the martial arts.

Three of the basic principles of motion are Newton's three laws of motion. These provide a good grounding in elementary karate and understanding the why and not just the how.

### II. NEWTON'S LAWS OF MOTION

**Newton's First Law of Motion:** A body at rest or in uniform motion in a straight line will remain at rest or in the same uniform motion unless acted upon by an external force. This law is also known as the law of inertia. In basics, every time a move is done we are acting against Newton's first law. A fist is put into motion and stopped. A kick is thrown into the kicking bag and the bag stops the blow. These are example of this law in action. Just like when a ball is thrown through the air, it eventually slows and hits the earth. This is not because the ball got heavier, but rather because the outside forces were applied to the ball to slow it down. Gravity and friction acted upon the ball to slow its inertia to zero. The same can happen in class; kicks would be easy to do all night if it wasn't for the fact that our bodies produce resistance to the output of energy.

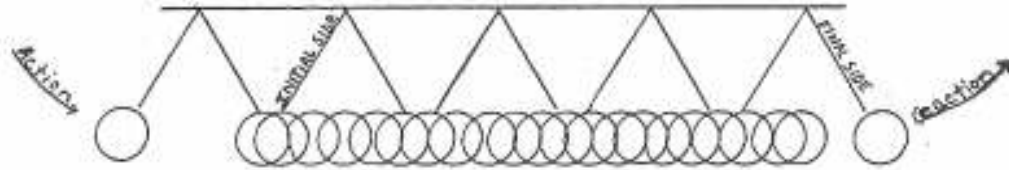
**Newton's Second Law of Motion:** The acceleration of a body is directly proportional to the net force exerted on the body, is inversely proportional to the mass of the body, and has the same direction as the net force. As we punch, we can vary the power of our punches by the speed and force that we apply to them. A simple equation that fits this is:  $F=ma$ , or Force = Mass x Acceleration.

The more force you put into a punch, the more acceleration you have and proportionally, the more inertia you have to transfer to the target. By looking more closely at this equation we can also see that if a person has a smaller mass, they can make up for that loss of mass by more speed. Thereby a smaller person could theoretically hit much harder than a big person if he/she worked on developing speed to make up for the smaller body size.

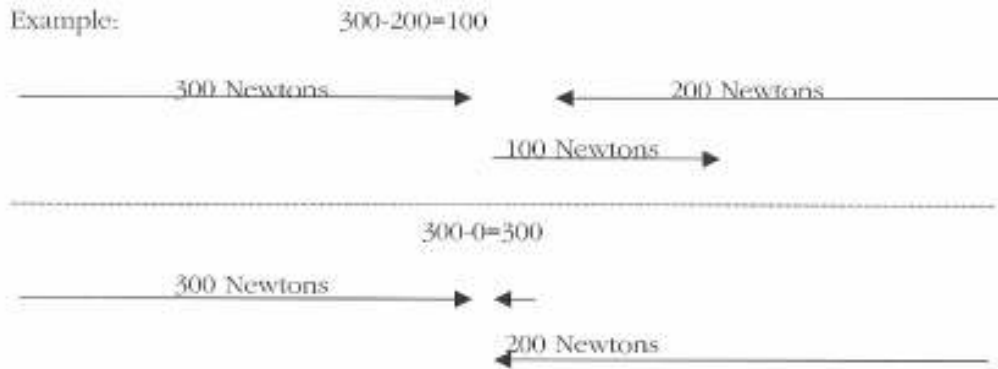
**Newton's Third Law of Motion:** If one body exerts a force on a second body, then the second body exerts a force equal in magnitude and opposite in direction on the first body. The laws of elasticity and perfect elastic collisions are used in this area of motion. According to theory, the only particles of matter that have perfect elastic collisions are subatomic particles, but we can still have fairly balanced reaction on the human level.

### III. ILLUSTRATIONS

Action=Reaction. This can be shown by throwing a punch without pulling back the previous punch; there is a lot less power and balance than if as you throw the punch out, you retract the other hand. Doing it this way can give a lot more power and stability. This law can be shown by numerous examples: push on a door, it opens; jump into the air, fall back to the ground; the point is made.

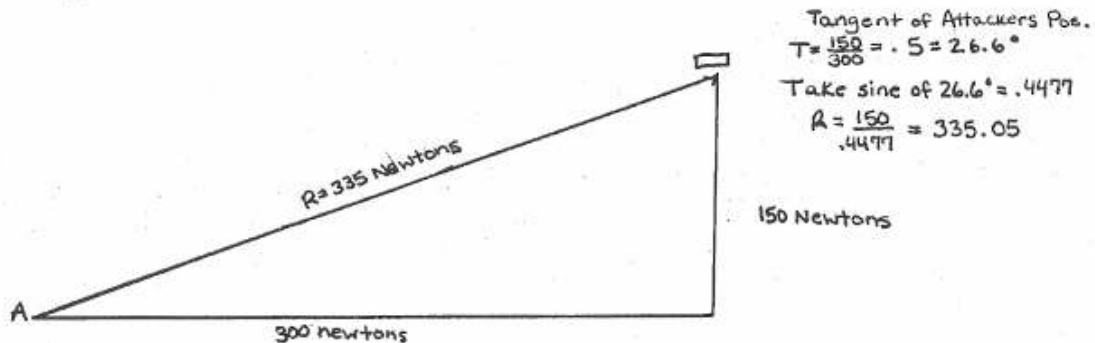


Concurrent forces can make a big difference in karate and self-defense. Concurrent forces are forces that act as the same point at the same time and they form resultant forces. These can help by combining your opponent's inertia and your force to more seriously affect your opponent.

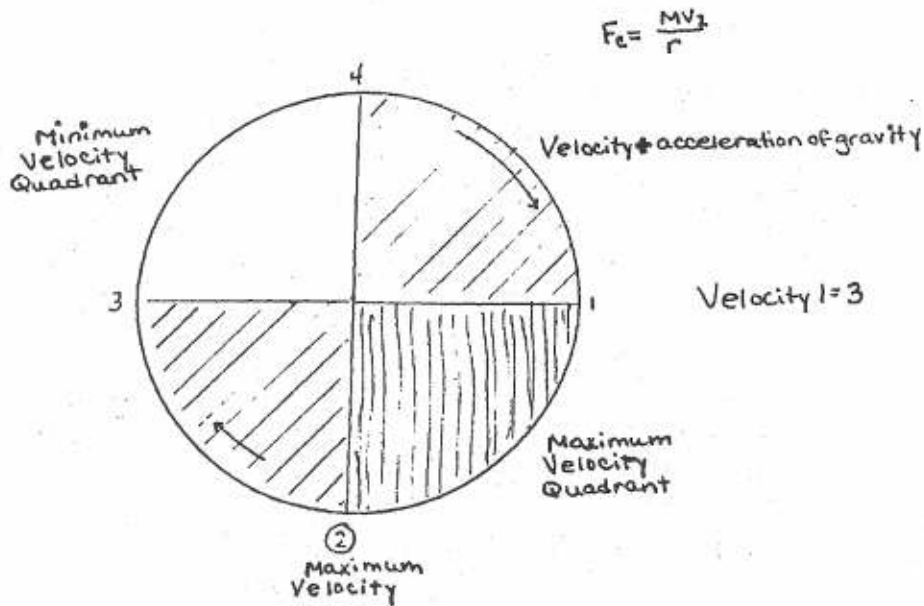


As you can see, hitting an opponent before his forward motion is stopped causes him to absorb more of the blow, instead of rebounding off the blow. This can also be shown for an attack to the side of an opponent by using resolution of forces.

Example:



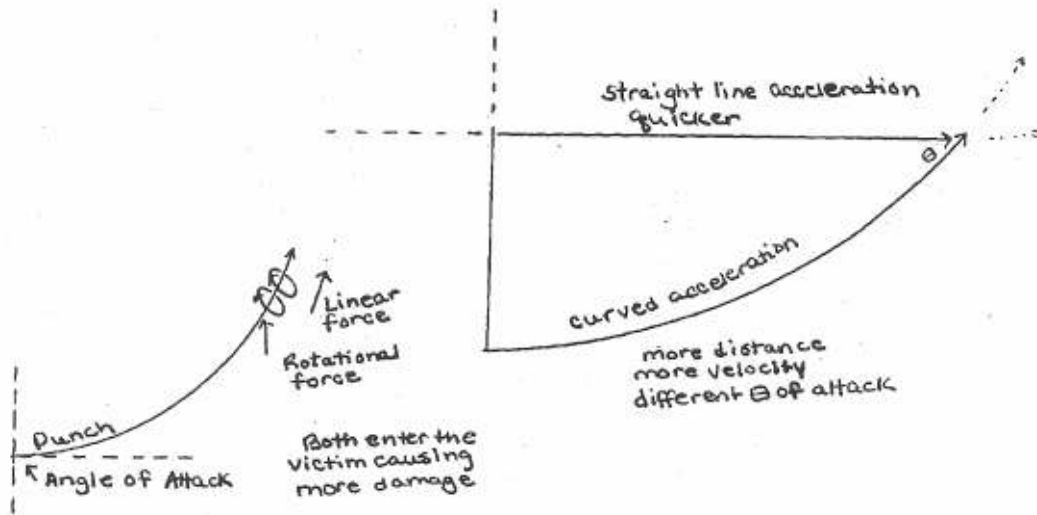
Gravity has a lot to do with power, speed, and mass in karate. A kick or punch coming down can get more force behind it if it uses gravity as a companion, instead of working against it. The equation of centripetal force in a circular motion is shown below:



The first law of Thermodynamics also gives us an important principle to remember: Energy cannot be created or destroyed, but only transferred or converted to other forms of energy. When attacking an opponent, any attack you land on him is absorbed according to the angle of attack and the solidness or force behind the attack. Earlier, we saw how the angle of attack varied the force of the attack.

Rotary motion and torque play a role in developing attacking and defensive strategies. When blocking or using an attack, circular motion can be used very effectively to gain much force and multiply the force with minimum effort. Rotary motion used in blocking is very effective; when defending against an opponent, an outside block or inside block are examples of rotary motion. A few attacks that use circular motion include the spinning kicks and twisting punches.

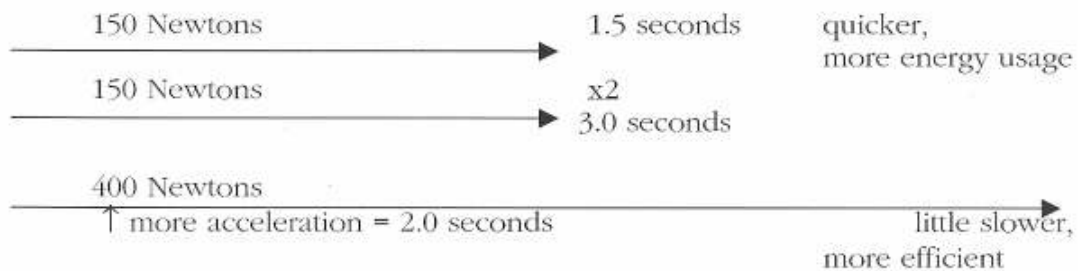
Let's use an example to illustrate the point:



Efficiency is an important issue to address in karate. The amount of output in a fight is tremendous and any edge that you can gain by conserving energy and making attacks and blocks as effective without a waste of energy is beneficial. The equation for energy is **work input divided by work out put**.

Since no device can be one hundred percent efficient, we thus cannot expect perfection; however, we can increase our efficiency to the best of our potential. Case in point - when attacking, the fastest way to get from point A to point B is a straight line; sometimes, however, a straight line will get you to the point of impact but will not have the necessary force to get the job done. This then requires a second attack. But if the first time the attack had taken more energy but did not require two hits, less time and energy was expended, and then more is in reserve for other attackers - or to call an ambulance.

Example:



$F=ma$



Power is another point to consider in the awesome art of karate. Power depends on force involved and the distance traveled in a certain amount of time. When choosing techniques, they should be chosen according to the need. Power requires force and force requires energy, so a technique should use the maximum amount of power with the minimum amount of energy.

Example:

$P = F \Delta D$	
$\Delta t$	
$P = \frac{150 \times 1.5}{1.5}$	$P = \frac{300 \times 3}{2.5}$
$P = 150j$	$P = 360j$
<hr style="width: 80%; margin: auto;"/> 150 Newtons 1.5 meters 1.5 seconds <b>maximum energy</b>	<hr style="width: 80%; margin: auto;"/> 300 Newtons 3 meters 2.5 seconds <b>minimum energy</b>

#### IV. BREATHING AND KI

The principle of ki also has its foundation in scientific principles. Ki is the basic building block in the realm of karate and life, because it has to do with breathing, the force we gain from that freedom, and the fullness of breath we receive.

The definition of ki is "a natural life force flowing from all creatures". Ki is not some supernatural force, but rather something that most people do not make use of in their daily life. We have all heard stories of mothers lifting cars to save their children, and yet they couldn't do it right now if their own lives depended on it.

In those instances they used an extension of their ki to help them to do the "supernatural". Karate and ki involve breathing from your diaphragm and focusing or controlling your body to accomplish a task. Just like a singer breathes from their diaphragm to gain more volume and air control, that is one of the reasons ki is used in the martial arts.

These are four principles that a person must keep in mind to be able to control your ki and your body:

1. FOCUS ON ONE POINT. Set your mind to staying on one thought.
2. RELAX COMPLETELY. Let all the muscles in your body relax.
3. KEEP YOUR WEIGHT ON THE BOTTOM SIDE. This is achieved by thinking that all your weight has sunk to the lower half of your body.
4. EXTEND YOUR KI. This is done by thinking that you are extending your ki; by combining the first three and driving your power, or ki, out with your breathing.

Ki is something that everyone has in him/her, but something that few people learn to use.

## V. STRIKING POINTS

Striking points are another one of the areas where scientific truths are used. In karate we have different blocks and attacks that we use in different places because they fit the job and we can accomplish our goal best by using them. For example, if I am accosted by two muggers, and they have me up against a wall, I do not want to use a flying side kick to disable them. Rather, I would attack using a hands combination with an elbow or fist combo. But there is also a level of attacks and blocks below the actual move. We have sets of striking points that can be used with different moves to get different jobs done. The following is a list of different hand techniques and their uses:

1. **Fist** - to attack an aggressor; fairly generic
2. **Flat fist** - to attack to solar plexus or under the chin, a smaller target.
3. **Extended knuckle** - used to attack the solar plexus, ribs, or temples.
4. **Hammer fist** - especially useful in attacking to the side of the head.
5. **Upright fist** - more stable of an attack, not as much torque applied when hitting an attacker.
6. **Back fist** - used in counter-attacks or when attacking to the face.
7. **Extended thumb** - applied when hitting the temples or ribs.
8. **Fingers** - good when attacking a soft area of the body such as the groin or eyes.
9. **Eagle beak** - better to use than fingers when more force is needed in the attack.
10. **Bear claw** - good for ripping action against the ears or neck.
11. **Circle ridge** - very useful for take downs and throat attackers.
12. **Open palm** - used when a driving, powerful head on attack is needed.
13. **Open hand** - excellent for attacking the eardrums or to get someone's attention
14. **Knife edge** - good for attacks to the neck or to the limbs.
15. **Back knife edge** - good follow up for knife edge as well as a stretching attack.
16. **Back of wrist** - useful for close in attack or if hand is hurt.
17. **Front of wrist** - good follow up for inverse attack.
18. **Elbow** - excellent close in attack that can be driven in strongly.
19. **Back Elbow** - very good for follow up attacks and close in fighting.

Many of these techniques were devised to be beneficial for blocking and attacking because of the applied force and power needed to make the attack effective. This is proven by the relationship between force and the area applied. The less area to absorb or attack the force, the more damage occurs. That is why these attacks were formulated to get the greatest result.

## **VI. CONCLUSION**

There are many scientific principles that apply to the human body because the human body is part of the physical world. Karate makes use of these laws by applying them to the body just as a car maker applies the laws of aerodynamics to a car body. As Christian martial artists we just make use of the orderly world with which God has blessed us.

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**A Scientific Basis for the Martial Arts:**  
Physiological Components of Skill Development

Sara Lawson  
10/18/96

## **INTRODUCTION**

The purpose of this paper is to outline for the reader the basic physiological mechanisms at work in the development of physical skills. I will begin this discussion with an overview of the neuromuscular system, which carries the primary responsibility for physical movement. An understanding of the neuromuscular system will provide the reader with the framework and terminology needed to understand the biological processes at work.

Following this overview of the neuromuscular system, a general model for skill acquisition will be explained. Two characteristics of the neuromuscular system prevent detailed understanding of the mechanisms at work as skills develop. The first is the molecular nature of the neural processes. In addition, the vast interconnections of the neuromuscular system make identification of specific pathways difficult. However, scientists have observed mature adults, children developing their first motor skills, and those persons with neuronal conditions that hinder controlled physical movement such as cerebral palsy and Parkinson's disease, and have proposed a working model of how coordination of motor skills develops.

This model has many implications for martial arts practitioners and instructors. If we better understand how it is that our bodies learn to make efficient and precise movements, we will better understand what methods best lead to mastery of technique. This paper will close with a discussion of how to best develop physical skills in ourselves and in our students.

## **THE NEUROMUSCULAR SYSTEM**

The neuromuscular system is composed of muscle fibers, the neurological regions of the brain that control them, and the neurons that connect these components. This system is responsible for the contraction of our skeletal muscles to produce movement as well as the isokinetic contractions that maintain balance and posture. The neuromuscular system is also responsible for reflex actions such as the simple knee-jerk reaction tested by physicians and more complex reactions such as picking up your foot when accidentally stepping on a tack. The neuromuscular system is closely linked to the sensory system as it constantly requires input from the environment. A detailed description of the neuromuscular system is beyond the scope of this paper; fortunately, an understanding of the basic functional components at work is all that is necessary to understand how motor skills are developed and perfected.

Motion is achieved through contraction of muscles. However, if our bodies were only capable of contracting whole muscles, only fast movements of maximal force could be produced. To precisely control speed and force, muscles are organized into many motor units. Each motor unit is in turn composed of one motor neuron and several individual muscle fibers. When the electrical signal from the brain travels through the motor neuron and reaches the muscle fibers in that motor unit, they contract. The brain also sends

inhibitory signals; they prevent the motor neuron from stimulating its muscle fibers. The sum of the stimulating and inhibiting signals to a motor neuron determine contraction.

The size of a motor unit varies in different areas of the body. In the eye, the size of a motor unit is very small; one neuron may innervate as few as three muscle fibers, allowing the very precise control. In contrast, one motor neuron in the back or thigh may control hundreds, or even thousands of fibers.

To further control force, muscle fibers themselves vary in size and composition. The force produced by a muscle fiber is directly proportional to the diameter of the fiber. Large fibers are able to produce large amounts of force quickly (hence the name "fast twitch"), but pay for their strength in a loss of endurance. Slow twitch muscles, which are smaller, produce less force per fiber, but are able to contract repeatedly without fatigue to do a different metabolic process.

The orchestration of motor unit coordination is called recruitment. Recruitment allows movements to be smooth and controlled. In general, the smaller fibers are activated first, followed by increasingly large fibers. When a forceful movement is desired, recruitment occurs quickly. The process is slower when precision is desired.

As mentioned previously, the contractions of these muscle fibers are dependent on a signal brought to them through the motor neuron. This signal may arise from some physical stimulation, as in a reflex, or it may originate in the higher centers of the brain as an intentional action. In the latter case, the brain transmits this intent to the muscles as a motor program. A motor program is "the pattern of neural activity required to perform the desired movement" (Vander 351). The areas of the neuronal system that create these motor programs and transmit them to the motor neurons are organized into a three-tiered functional hierarchy.

The highest level is that which we think of as the conscious self. It involves those parts of the brain which are involved with our emotions, memories and desires. These parts of the brain do not act independently, but receive constant information from other areas. It is in this area that complex motor plans are constructed "according to a person's intention" (Laizzo, 11).

As we move to the middle level of this hierarchy, we descend from the conscious levels of the brain to lower centers. These functions convert complex motor plans to a number of smaller motor programs that determine the actual pattern of neural activation required to accomplish the movement. The smaller motor programs are again broken down to subprograms that focus on each joint involved. At the same time, information regarding details such as the starting position of the body are integrated by these neurons before transmission.

After this breakdown of the desired task, the subprograms are transmitted to the lowest levels of motor control consisting of the brain stem and spinal cord. It is at this level that the tension of specific muscles and the necessary angles of the joints are communicated in the form of electrical potentials in the neurons to the motor neurons that synapse on the muscle.

The following scenario illustrates these concepts. Suppose my mother sees a sock on the floor. Being a woman who maintains a very tidy home, she decides to pick up the sock and put it away. This decision to act arises in the highest centers of the brain. Before she begins this action, the middle level of the brain transforms this desire into a plan of motion involving the movement of her trunk to lean over, the extension of her arm, and the closure of her fingers around the sock. The middle levels also note where the sock appears to be located and her present body position. (The motor program would be different if she were cleaning dust bunnies out from under the couch, when she begins, than if she were standing upright.) This program then moves down her spinal cord where it is divided into small tasks such as "triceps extend to 180 degrees" or "right middle finger close with .3 pounds of force."

What would happen if motor commands were controlled by only conscious thought? Every movement would proceed very slowly. It is difficult to even think of all the muscle contractions necessary for a simple movement such as picking up a sock. The task becomes more complex when one considers the control necessary to prevent falling over as the center of gravity moves and that for every muscle contraction there must be an accompanying relaxation in the opposing muscle. It has been shown that "we can attend to only one muscle at a time, and that only when the demanded activity is slow, isolated, and nonforceful" (Kottke 568). Fortunately we do not have to think about all this with every motion, or every motion would be performed very slowly.

## **SKILL ACQUISITION**

From the prior discussion it is apparent that motor function is not fully controlled by the conscious mind. Rather, a person's conscious desires to move are transmitted to unconscious centers of the brain for processing and then motor programs are sent through the spinal cord to the muscles. Although we do not notice it in most activities, this processing does take time. There are some situations when we do realize the lag time between decision to move and our body's response of motion, especially in the martial arts. As I learned how to spar I would often think to kick my opponent or take advantage of an opening, but my body would not move fast enough. (To be honest, this still occurs frequently during sparring.) As measured by reaction time, the quickest and most efficient movements of the body are reflex movements that require only local neural activity. The slowest movements are those that we perceive as awkward, such as a movement sequence attempted for the first time.

The fastest intentional movements are those which have been practiced many times. As we repeat motions again and again, the lower centers of our brain actually learn the motor program of that motion. As the motor program becomes better learned, the role of the higher centers diminishes until, with enough repetition, the conscious mind needs only to initiate the motor program, maintain the activity, and discontinue the program rather than continually monitor the movement. When motor programs achieve this level where they no longer require constant conscious input, they are called engrams.

If the neuromuscular system is likened to a computer, an engram would be a computer program. Once this computer program is started one no longer needs to tell the computer what to do. It runs through the program until termination, either by completion of the program or by discontinuation by the programmer.

A motor function performed by an engram is called a skill. Skill involves several important traits (Iazzo 23):

- A skilled activity activates the right muscles at the right time.
- Skills are efficient
- Increased skill reduced the activity of unnecessary muscles, while activity in the prime movers remains constant.
- Skill develops through practice.

A mature motor program, or engram, displays all of these traits. The spatial and temporal control to activate the right muscles occurs through an appropriate recruitment pattern. The best order for contracting the needed motor units is determined in practice and "programmed" into the engram. This gives rise to smooth, coordinated motion with the desired speed and force. Efficiency of the skill is developed and included in the engram through trial, error, and repetition. With each repetition the energy input is evaluated and the engram modified to minimize metabolic demands.

As skill increases, the overall muscular activity decreases. When we learn a movement we are not learning which muscles to use, but which muscles not to use. With skill the engram includes more inhibitory and fewer stimulating signals.

The explanation lies in the fact that our bodies tend to tense more muscles than is required for motion. This tendency is termed overflow. Not only are the muscles necessary for the desired movement contracted, but the surrounding muscles as well. In newly learned motions, many muscles are actually contracted in opposition to the motion. This makes the movement inefficient, slow, and choppy.

For an illustration of skill development, picture a room full of martial arts students learning a front kick for the first time. First note that each portion of the kick must be consciously controlled. Each student must think to himself something like, "chamber, extend, pull back toes, flex, relax", in order to execute the kick. As they begin to chamber, many are actually contracting muscles in both their quadriceps and hamstring,



as well as surrounding leg muscles. Because the movement changes their center of gravity, alterations must be made in posture. Again, opposing muscles in the torso contract. If they are really concentrating, overflow increases and the shoulders tense and move toward the ears. It is no wonder that students are tired and sore after their first lesson! Many are getting a full body workout from a single kick.

With practice, though, the body learns exactly which muscles need to contract to execute a front kick and which to relax. Opposing muscles are inhibited from contracting. This increases speed, force, and efficiency.

It is important to note that engrams develop only through practice (Kottke 569). No other way of developing the automatic programs for skilled movement has been discovered. Only through practice does the body assemble engrams and increase skill.

Very little research has been performed to determine just how much practice is needed to perfect a skill. One study published in 1959 investigated the manual dexterity of women working in a cigar factory. The number of cigars rolled by each woman functioned as a measure for skill level. When novice workers were compared with skilled workers, a three-fold difference in rate was found. For the new workers to reach comparable dexterity with the more experienced women required approximately three million repetitions (cited in Kottke 569). This figure is on the same order as estimations from other activities. Clearly, there is no substitute for practice!

It is also important to note that engram refinement does not occur solely within the confines of intentional practice sessions. Whenever motions are performed, they are added to our repertoire of programs. Bits and pieces may be spliced into existing engrams. In this fashion maximum efficiency is developed sooner.

This phenomenon explains the changes in side kick execution by my karate students who play baseball all summer. Instead of performing a side kick chamber, the knee is lifted in the baseball pitching motion. The engram they develop in the ball field replaces the engram for the kick. This also explains an unfortunate and painful fall taken by one of my students when a flying side kick was attempted. Although the approach and kick had been practiced without a target, this did not override the more mature engram for a bowling approach. When the student diverted attention from the approach to fully concentrate on reaching the target, the bowling engram took over, leading to improper body posture at the start of the kick and a quick loss of balance. Luckily she was not seriously injured and has since developed a more mature flying side kick engram.

## **IMPLICATIONS FOR MARTIAL ARTS TRAINING**

Now that the model of skill acquisition is understood, which training methods are most appropriate for maximizing skill? Martial artists can easily adapt the training techniques recommended by professional physical therapists to develop coordination. In his paper on the subject, Kottke breaks down the program for coordination training as follows (569):

1. Perception
2. Precision
3. Perpetual Practice
4. Peak Performance
5. Progression

Further discussion of each of the elements and application to the martial arts will equip the reader for more successful training.

**Perception:** To improve performance, every practice must be somehow be evaluated. Following evaluation, modifications, to the engram can be made. To some extent this perception is automatically done by proprioception mechanisms in the body that relay information regarding body position back to the brain. Certainly in the case of my flying side kick student, pain receptors reinforced the message that some part of the motor program performed was not correct.

Conscious thoughts also impact engram modification, so although a motion "feels wrong" (like walking in a classical front stance for the first time), we can still reinforce the correctness of the motion if we know that it is right.

It is important, then, for students to know whether techniques are thrown correctly or incorrectly. Practicing kicks in front of a mirror gives immediate feedback. Practicing restraint techniques with an honest partner also allows us to know if we are executing it effectively. Martial arts students can also benefit from critique and correction by the instructor. This will help them to learn faster than unsupervised practice and may prevent incorrect execution from forming into an engram that may later be difficult to change.

**Precision:** Someone once told me, "Practice makes permanent. Perfect practice makes perfect." To develop the best skill, practice must be precise. Complex movements or sequences must be broken down to a level that can be correctly performed. As these simple movements are mastered, assemblage of the piece results in the complete motion. If an attempt is made to perform a movement that is too complex, learning will be very slow. This is not only inefficient, but also tends to demoralize students.

When teaching students, the best method is to partition skills into simpler movements the student can perform more easily. Once the initial segment is mastered, the next segment can be added. Overloading students with a task they cannot successfully perform does not lead to successful learning. Instead instructors should challenge them with accomplishable goals. A dojo atmosphere that respects hard work over hard kicks will deter students from throwing fast, sloppy techniques and encourage precise practice.

**Perpetual Practice:** Recall that millions of repetitions are required for successful engram formation. Obviously this does not occur in one single session. A movement or martial arts technique must be learned, repeated and frequently worked on to build up repetitions. Through this repetition the necessary motor units for the motion are identified and the unnecessary units are inhibited. If engrams are not practiced regularly, they begin to fade.

Unlike a computer program, engrams will be forgotten when not used. Therefore, perpetual practice is necessary to maintain skill.

Endless repetition can unfortunately be boring. Rotating through different exercises instead of long sessions with one technique will make practice more enjoyable while reducing fatigue by working different muscle groups. Making slight alterations in the environment can also help; throwing kicks with and without targets, at moving targets, blindfolded, etc., reduced monotony.

Instructors and students should not expect to master a new kick in a few weeks or even months. Only many years of consistent training will perfect technique. Rather than being daunted by the idea of throwing three million front kicks, we can be encouraged that if we continue to work at it, the kick will continue to Improve.

**Peak performance:** Improvement can only happen when a skill is performed to the best ability of the performer. Kottke recommends that to establish the level of peak performance, the effort, speed, and complexity should be increased until failure occurs; that is, until the technique is no longer properly executed. Practice level should then be just below the peak. Consistent success at a challenging level leads to learning and improvement.

As we practice the martial arts, then, we should not expect to improve without performing at our best. We must push ourselves and encourage our students to give full effort in every technique thrown, understanding that a student's "best effort" may vary from day to day. Note that this does not mean full power kicks on every count. This means precisely correct kicks on every count. Details of the technique should be added as the basics are mastered.

**Progression:** Since practice needs to occur at a peak level, the intensity of practice should increase as skills improve. Again, we need to give our best effort to every practice. We cannot be satisfied with the execution of techniques the way we did them yesterday. Instead we should focus on how we want to perform tomorrow. To be content to practice at a level of "yesterday's best" will solidify that engram and not lead to improvement.

## CONCLUSION

The moral of the neuromuscular story for the martial artist is "practice, practice, practice." There is no substitute. Practice cannot be lackadaisical or half-hearted; this will only lead to bad habits that are difficult to break. Skill perfection is no small task, but takes years to develop. "Let us not grown weary in doing good, for in due time we will reap if we do not lose heart" (Galatians 6:9).

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**THE SCIENTIFIC PRINCIPLES OF STUDYING  
THE MARTIAL ARTS**

By Sheryl Rainfrette  
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History provides records of mankind's attempts to advance so that through the social structure and technology the individual's needs would be met. These social advancements, however, have not culminated in a culture that is harmonious but rather has led to a self-oriented, autonomous people. God provided the equipment in the body to live a harmonious life that would bring honor to Him and enable the people to live with one another, which would glorify Him. However, mankind has evolved into a body filled with undisciplined and uncontrolled desires to gratify the self. Thus man has created more obstacles for himself.

We as Christians possess the earth through a body composed of human beings that seem to be more often than not out of tune with God's script. We form God's presence in the world through the indwelling of His Spirit (I Cor. 3:16). In Ephesians 2:22 it states, "In Him you too are living built together to become a dwelling in which God lives by His Spirit." Christ has no hands but our hands to be the player of the script. So despite the world's bombardments, we as individuals in the body of Christ have been provided a means by which we can fulfill our needs and still maintain character traits that glorify God. We can optimize the whole body through daily devotions and maintaining a disciplined lifestyle. By ardent training through the Christian martial arts we can develop ourselves to become a person who can successfully pursue God's intended way of life and influence our society to that which will bring glory to God. Only through discipline can we achieve lifestyles that honor God. Martial arts offer the individual the ways and means by which each can become a learned person, a disciple for Christ and obtain the capability to pursue his or her life's goals. The study of the martial arts is a relevant scientific approach to advancing the individual health, character and to achieve success through a healthy, positive and optimally functioning body, mind, and spirit. Through this training the martial artist can become the catalyst for creating behavior standards for those people found within their circle of life.

The first aspect of development that has a scientific and medical basis is **health**. Health is not just the absence of illness but a way of life. The individual requires the balancing of health between the soul, the mind, and the body. These three parts of the body are inherent to the martial arts as each of their functions is utilized in performing techniques in any style. To understand health of the body it is necessary to break down the body into systems. Each is unique but none operated independently from the others.

Physical activity relates primarily to the musculo-skeletal, digestive, respiratory, circulatory, and nervous systems. There are still other systems of the body that are required for life and indirectly affect the physical activity. These are: immune, endocrine, and excretory. But those initially mentioned are more closely related to physical activity. Physical output requires attention to the digestive system. A well-balanced diet is necessary to create the fuel for any activity; one low in fat, high in carbohydrates and protein should be considered. A physician should be contacted should there be any existing health considerations for the exercising individual.

The activity performed, such as kata, if done on a routine basis, will provide the exercise necessary for a well-functioning body. When the stretching and contracting of the muscles occurs in exercising it demands an energy source that would enable the activity to take place. This energy source is stored in the form of glycogen in the muscles, with reserves being held in the fat cells for future use. As activity increases, fat reserves decrease. And with the increased activity comes improved muscle tone and less mass for the heart to circulate the blood through. Thus, improvement in circulation is created. This is a necessity, as the blood carries the nutrients and oxygen need for healthy cells.

Circulation also carries away the cell waste in the blood to the excretory channels (lungs, kidneys, and bowels). The individual cell life relies upon this circulation as its main lifeline for regeneration and for specific functions that create the specialized tissues that make up the different organs and tissues. Since cells are the basic units of all the specialized tissues, it stands to reason that healthy, functioning cells result in healthy tissues. Cell regeneration, specialized functioning of organs (such as digestion), disease/injury fighting processes and brain activity, are some of the benefits of physical activity. Other benefits include lower blood pressure, weight loss, lower pulse rate, improved heart function, and better use of lung capacity. The full use of the lung provides the required oxygen for cells as well as the avenue for expelling the carbon dioxide resulting from the chemical processing in the body.

These physical actions of the body are in direct relation to the individual's mental activity. The mind controls the body and because of this, it mandates the need for a disciplined way of life. This creates a continuum of health. In 1 Cor. 6:15-16 & 19-20 the bible relates, "You are not your own, you were bought with a price. Therefore honor God with your body." The requirements for abstinence from chemical usage (drugs, alcohol, tobacco) is mandatory for the human body to remain healthy, allowing all the systems to function at their fullest, promoting the health of a body in which God dwells. The martial arts provide the necessary reinforcements for a disciplined lifestyle, one that encourages a "total-way-of-Life" concept, keeping the body in optimal form. However, spiritual health is at the core, allowing the mental and physical parts of the body to develop and grow. The study of the arts must be Christ-centered, focusing and filling our minds and lives with the Holy Spirit. By practicing and maintaining contact with the Holy Spirit, we can be directed by God, be filled by His Grace, and thereby live more God-inspired lives as He intended. Through the martial arts, our lives can be an example for those who do not know Christ. Remember, our loyalty to Christ determines the body's health.

The second area that has a scientific basis for studying the arts is the **development of mind and body harmony**, which adjuncts health. 1 Peter 1: 13 tells us to be sober or self-controlled and prepare the mind for action. The mind is where learning takes place and is the function of the brain cortex. The cortex also holds the ambitions, expectations, imaginations, and all the thoughts that make up the mind. The mind memorizes the stimuli received from the outside, and because of their consequences, it forms an association between the two. A response is then received and the stimuli sent to the body to perform it. These stimulus-response reactions can be voluntary (chosen by the self to

enact), semi-voluntary (is automatic but can be brought under control, or automatic (no control over the reaction of the body). So the mind and its nerve pathways function to allow the actualization of the mind's directives. So the interactions of the mind and body's stimuli and response patterns show that they are not separate entities. They react together to the different stresses of our society, to the wonders of the world and to the experiences that occur in our lives.

Emotion is one such reaction that occurs on a daily basis. The human being responds with happiness and laughter to something funny, while anger is the emotion to aggression and a multitude of them are caused by stress. For example, the mind feels anger toward a particular situation. The body reacts with a reddened face, a rise in pulse rate, and increased blood pressure and muscle tone, which prepares the body for action. This demonstrates the closely connected interactions of the mind and body. Why the mind reacts so differently to situations and the uniqueness of the individuals has prompted the study of psychology. Many, however, still relate the mysteries of the mind with the occult. This is seen frequently in the martial arts. However, the mysteries of the mind are created by God and since they are not understood, we must rely upon faith and seek God for direction. There still remain connections between mind and body that can be physically understood. And if understood, it can also be studied and be trained to be controlled by will. This development of the mind is also known as CHI.

Chi is the study of controlling the mind and body. This paper's purpose is to relate the basis for martial study. While this connects to chi, it would require a study solely unto itself, and so is only mentioned here. The studying of the arts utilizes situational exercises that enable a person to learn to control the automatic responses by producing quicker reactions and producing intentional responses with purposeful intent. As in the previously cited situation of anger following stress, the semi-voluntary response of the emotion and its impact on the body can be altered through training. Specific psychological effects can be acquired and utilized through the arts, and turn a hindrance into a benefit for the overall well being of the person. Some of these benefits are ambition, imagination, confidence, motivation, and relaxation.

**Ambition** is the first benefit. Ambition is derived from the Latin word meaning "canvassing for promotion". It is the goal setting for the future. Whether reasonable or unreasonable, the expectations are usually high and it must be remembered if failure occurs, so the level of distress is high. A sensei's responsibilities include recognizing their own students' ambitions and guiding each of the students to ensure that their expectations are not too high so that ambition is not hindered. The advancement of these students to the next test level should be commensurate with their abilities and capabilities.

**Imagination**, the second benefit, is seeing and feeling events and situations that haven't occurred. It is an inbred psychological entity and can only be had by that particular individual. Training to reduce or enhance the imagination is obtained through the martial arts. Some people are unable to express their imagination through their feelings but through the performance of techniques, their feelings become easier to express. In our Christian walk we need to comprehend the enormity of our debt to Christ. Christ's



compassion for the lost is what we should strive to inherit and through our use of imagination this compassion can be stimulated. Abraham Lincoln once said, "I am sorry for the man who can't feel the whip when it is laid on another man's back." Only by imagination can a person see and feel this event. All martial arts require some degree of imagination and it is an ingredient in the developmental growth.

The third benefit is **confidence**. This is the knowledge that a task can be performed and that it will be performed correctly. In the martial arts, confidence is that the technique chosen for a situation will be effective and that it will be performed correctly. In the martial arts, confidence is that the technique chosen for a situation will be effective and that it will be performed properly. Confidence is abandoning voluntary control in the mind while relying on the automatic responses developed in the body and mind to occur. Remember, through training the body develops these automatic responses to the stimuli their brain receives. Lack of confidence makes a person rely upon voluntary control of their actions that are usually performed at a slower rate. Confidence is a prerequisite to motivation, goal setting, and success.

The fourth benefit is **motivation**. Motivation is what drives a man forward to fulfill a desire. It usually is associated with need satisfaction as well as fulfilling wants. Our physical body is motivated to perform necessary responses to ensure health and survival. It leads us to seek solutions thereby meeting higher needs as well as wants. It is therefore the desire to do well, which leads to improvement in self-esteem. Esteem is placing a high value on something. Then self-esteem is not being dependent on the whims of social judgment or cultic aspects of our culture. Teenagers and older elementary children are highly susceptible to inferiority views of themselves. Those people who have developed self-esteem can easily handle the bombardments of peer groups with continued guidance and development as seen in a martial arts program conducted with Christian principles. The martial arts can even inspire these psychological effects of motivation and self-esteem. Martial arts are the study of self-improvement with no preset limitations. The student can individualize which will reinforce confidence and instill the motivation to promote self-esteem.

The fifth benefit to be mentioned, which regards the psyche, is **relaxation**. Relaxation of the mind is very useful as it removes worry, the enemy of confidence and is restful for the body (Matt. 6:25-34). If you relax your mind for ten minutes it provides the body the rest, as in a whole night's sleep. Here relaxation for the Christian martial artist must be used differently than the secular dojo participants. Rather than emptying the mind or producing a self-hypnotic state, the meditative time is with the Lord and it accomplishes the effect of calm while freeing the body of stress as you contemplate on the Lord. A far better result than the zazen, where only a void is found and where there is no "rock" to stand on. Re-centering the mind upon the Lord is what releases stress and worries and allows problem solving to take place. Relaxation reduces blood pressure and pulse rates and improves breathing, which reduces the demands on the body, enabling it to continue with whatever situation presents itself. By practicing relaxation it can be reproduced upon demand. It can become an automatic response to stimuli received. The exercises in the dojo are perfect practice sessions for this particular benefit of mind & body harmony.

Once it can occur on demand it can be utilized in all areas of a person's life and the benefit is quite dramatic.

The third basis for studying the martial arts is the **development of character**. D.L. Moody stated, "Character is what you are in the dark". The Webster's II Dictionary defines it as. "The group of ethical and mental characteristics that mark a person or group", also stating it as a "moral integrity". Here a direct correlation can be made with the older civilizations and cultures of the Orient. Bushido of Japan and the Hurang-do of Korea can be paralleled as they both center on character. The basis of their society was the individual's character traits, which, along with courage and honor, included compassion, duty, self-control, truthfulness, and loyalty. Our culture on the other hand is self-centered. The moral decay seen today has resulted from individual selfishness and the decline of social mores that has once held the same traits as the fundamental basis. Character is a developmental process and requires a continual lesson plan as each person is molded and guided. Emerson in Social Aims says, "Don't say things. What you are stands over you the while, and thunders so that I cannot hear what you say to the contrary." In this character of man lay his compassion, duty, self-control, truthfulness and loyalty. Some of these provide acknowledgment of the worth in each other, while others prove the self or give identity. Our society and culture exalts self-fulfillment, self-discovery, individualism, and autonomy. While some of these are perhaps positive to some degree, the Christian must strive to remain loyal to Christ and not independent of Him. Loyalty to Christ is the reason for being. Through Christ all is possible (Phil 4:13). When a commitment to Christ is made and kept it will lead to healthy, relaxing, and wholly good life. The study of Christian martial arts centers on Christ, developing the spirituality of the individual, while reinforcing the mental and the physical. These in turn create and develop the character that marks the person as the strong and trustworthy individual who anyone could rely on and one who also commands respect. Dojo etiquette instills standards that teach just this.

**Compassion** is the first character trait and standard to be discussed. Compassion acknowledges another's worth. Christ is the world's best authority on compassion. By His example we should make compassion our trademark as well. A servant attitude lessens the self-orientation as seen in people today. Encouraging the urgency to meet an upper belt's need or assisting any neighbor or fellow student with their loads carries importance while it also fulfills the loyalty to Christ by loving your neighbor as thyself (Matt. 28:19-20). A Christian is to spread the gospel and have compassion on the lost. Showing loyalty and obedience is commanded by God and also relates to the Japanese Bushido as a human duty. This is required if the other character traits and basic elements of our existence are to maintain any resemblance of God's order.

**Duty** is the second trait. Duty to serve others goes hand in hand with compassion. These traits are taught with positive reinforcements so that the behavior is learned and automatic responses take place. Duty involves all persons in the dojo. A sensei has a responsibility or duty to the students to teach while the student has a responsibility or duty to learn.

Another trait is **self-control**, which is not readily seen in our present culture and is not encouraged by our society's institutions. However, through the regimented practices, which is a part of the expected behavior in a dojo's etiquette, and through the standards of conduct that are required, one's self-control is continually reinforced. It becomes an automatic response by the martial artist whether in the dojo or whether outside the dojo (Prov. 26:28). A martial artist learns to be in full control of the self. Only after many years does a person know all the weaknesses and strengths. The personal desires are not to be placed before the principles of the martial arts to which he/she is joined. Through integrating the Christian martial arts into a day-to-day lifestyle, self-restraint becomes a given.

**Truthfulness**, the fourth trait, is synonymous with honesty and is a trait that creates an allegiance to Christ. Shakespeare wrote, "To thy own self be true". If a person is to become trustworthy and respectable, then honesty must begin within each man's heart. And God is the "discerner of the thoughts and intents of the heart" (Heb. 4:12). For the bushi, lying was cowardly. For the Christian, they reserve a seat of judgment (Rev. 21:8). In Eph. 4:14-15 it speaks of growing and learning. "Then we will no longer be infants, tossed back and forth by the waves and blown here and there by every wind of teaching and by the cunning and craftiness of men in their deceitful scheming. Instead, speaking the truth in love, we will in all things grow up into him who is the Head, that is Christ." A martial artist's program should incorporate veracity into its standards of conduct as well as in training precepts. It will then succeed in developing a person who has courage to stand for the truth, is trustworthy and is one who commands the respect from others because of his/her demeanor.

As previously mentioned, **loyalty** is paramount to achieving all a person wants to be. Sacrificing the self is something near forgotten in our country. Much of our chivalrous etiquette has vanished. Loyalty to God, country, and family has been marred due to the attitudes of the people. Loyalty rides with obligation - these are virtues acquired through a martial arts dojo, specifically one with classical principles and rooted in biblical doctrine.

Thus far, this paper has presented three sound reasonings for studying the martial arts. All three aspects - health, mind/body harmony, and character - complement each other to enable the individual to be successful in all avenues of life. This is the fourth reason for pursuing the martial art way of life. Success is satisfactorily completing something. To complete something is to have met all requirements. It is developing the principle of compliance. This is defined as "conforming to fit a given situation". While this concept is normally related to the engineering field, it is applicable to a martial artist who must learn to develop adaptability and conform to fit a given situation. The arts train a person to bring the automatic responses under voluntary control so that the necessary performance of mind and body is appropriately and successfully accomplished. Since the martial arts should be conducted as a way of life, the opportunities to utilize the achievements of training are near endless. The arena can be in your home, church, job, school, or recreational activity. People who succeed learn to face up to a no-win situation - and win anyway. It's also the person who gets up one more time than he falls down. Christian

martial arts teach students to continue to work hard with the support of the Lord and the Sensei, who gives positive feedback furthering the growth in character, confidence, ambition, and motivation to succeed. These essential ingredients to success allow God to say "well done" (2Tim 2:15). A life pattern that has been honed through a three-sphere developmental training program develops a strategy which allows the compliance principle to be applicable to the life performance. Success not only deals with the performance of the interactions with the physical environment, but with the internal as well. To be able to be successful in any given situation, a person must be able to deal with his/her being. A person's greatest challenge is his own self, not circumstances. A martial artist's greatest challenge is therefore the self-with all the attached psychological elements, some of which are known, some of which are hidden in the subconscious. So the opponent is not the actual challenge. The emerging emotions and fears of the martial artist is what he learns to accept as the challenge. Earlier in this paper this author stated that an artist learns to know his/her weaknesses and strengths, as then he/she will know him or herself. To reach such a point, the training must be ongoing. It is never restricted to just a certain time or place, such as when the dojo doors are open, but it is instead a 24-hour-a-day process. The disciplined lifestyle is mandatory and the pursuit of knowledge and understanding goes far beyond the physical realm and on to a philosophical one. Here is the beginning point to obtain the reasoning necessary to successfully deal with one's own inner being. Knowing the weaknesses and strengths and using these to obtain success is the beginning of real understanding of the martial arts. And since the martial arts are a "way of life", the student then obtains some wisdom and understanding as well (Prov. 4:7).

The last component of scientific principles for martial study is **life performance**. This paper thus far has presented the associations and application of the psychological and physical elements of the body, which can be developed through the arts. To bring these concepts to the fullest understanding, one must be able to see the great lesson in the simple. As daily tasks flood our lives we many times fail to see the profound lessons that are available for us to learn, and apply them to better understand where our place in this great universe is. The practice of kata, one-steps, and other dojo routines can be only a boring redundancy, or can be avenues that lead toward a whole new road to wisdom. This is the point where all the training of the martial arts brings the karateka: a never-ending path of new heights and goals to be encountered and met, only to see new replacements of the old ones. Life performance is the complete transition of application of thought to the physical, and success in the daily tasks and routines of life. To provide for the many, one must be dealt with first. "One day at a time" is a Christian saying. To achieve Christ-like behavior through the entire day is most difficult. Christ gives us an escape and enables us to succeed because of who He is. But we should strive to conduct ourselves in a "blameless" manner. Sin is the great defeatist, and is our great challenge as it sits within our own nature and self-will. Our mind and personality traits make the selfish tendencies easy to master while making self-control and denial difficult. Discipline is then required to keep the self in check so that the expectations of Christ and man can be met. The best avenue for this is the study of the martial arts. The arts allow the individual to grasp the self and bring it into subjection (1 Cor. 9:27). Our life performance is built by the day-to-day tasks and acts we perform, all of which culminate in the sum total of who we are.

Each step of growth and development in the martial arts brings you to a point where all aspects of one's life are in balance. The techniques chosen, the attitude and the outward demonstrations through physical acts carried out smoothly and successfully are all part of transferring the lessons learned into one's daily life. Physically the body can remain calm despite the circumstances. The systems of the body are improved and function more optimally. As the body runs more smoothly, so does the mind. The mind develops the focusing powers, giving improved concentration abilities. Focus and concentration allow for the relaxation previously stated to occur while also being the thrust for the mind and body harmony necessary for improved speed, strength, and power. These elements are not only held for the fighting or take down of an opponent. The opponent can be the self, a test, a disease, or any conflict that raises the inner stresses and/or weaknesses. Bringing all the fundamentals of martial arts teaching (spiritual, mental, & physical into one focused energy is the goal, so that whatever the task, it is done sufficiently and done to the glory of God.

It is hoped that the purpose of studying is not lost to the flashy American cinema. A classical and Christian foundation brings a student to challenges necessary for their development as they slowly begin to see the values that are there beyond the kick and punch. To develop and learn to coordinate the mental with the physical, keeping a mind and body harmony, is basic to successfully achieving the block of a punch or reaching a personal goal found in life outside the dojo. Learning to make automatic responses voluntary and voluntary responses automatic makes getting through a tough day easier. One day at a time leads to a year, then to a decade. So to understand and comply in the one makes the many easier. Our mental and physical performance is directly related to the level of our spiritual strength. If we are securely grounded in Christ there is no need to flounder on any premise, and the day is sufficient unto itself. Our relationship with Christ must be secure to have access to the power that is offered to us as children of God (John 1: 12). A Christian dojo offers instruction on a foundation of biblical doctrine, allows the student to grow in Christ and to utilize the Holy Spirit as God intended. It also provides the training and equipment to make the body physically fit and encourages the individual student to maximize the body's potential and performance, enabling them to accomplish feats that previously were beyond their range. As the body grows in strength and endurance, the mind learns to expand its realm, controlling the internal responses to external stimuli. This allows the student to develop the will to overcome weakness, the effort to gain control, and to achieve the final victory over the self and the environment. Sang Kyu Shim once stated, "By reforming the man you can reform society". This can be achieved through the martial arts creating fit members of society who impact their family, friends, and neighbors because of who they have become.

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All scripture quotations taken from the New International Version of the Bible.

# **A Scientific Basis for the Martial Arts**

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## **An Introduction**

### **Scientific Basis Defined**

Scientific is defined as: "1. Pertinent to science. 2. Systemic and accurate." Science is defined for our purposes as: "a branch of knowledge; what is known concerning a subject." (New American Webster Handy College Dictionary, New American Library, Inc. New York, New York.) For the purposes of this paper, a "Scientific Basis" is defined as: "A logical basis for action or technique based on a systematic study of what is known concerning the basic elements of the action or technique." As a result, every action or technique with a scientific basis has a scientific justification.

### **Why Study It?**

Is there in fact a scientific basis for the martial arts, and if so, why study it? As with other arts, such as music, painting, poetry, or speech, the martial arts do have a scientific basis. The respective musician, painter, poet, and orator all require an in-depth understanding of the scientific bases for their arts. To truly master their arts, they must also be able to apply these principles to their arts.

We, as martial artists, in order to properly practice and pass on our art, owe it to ourselves and to our students to fully understand and strive to refine the scientific basis for the martial arts. With this understanding, we can then apply what we learn directly. As a result, our art will continue to be refined and strengthened, becoming a more potent tool for sharing the gospel and building stronger Christians.

In nearly all of the other arts, numerous texts exist which define, explain, and teach the practical uses of their scientific bases. The martial arts, while easily as ancient and widespread as any other art, has comparatively little resource dealing with the scientific roots of its customs and procedures. Although its founders and early practitioners no doubt had a scientific basis for their art, much of it has been lost to us. The reasons for this are varied: "A master might keep a secret for any of several reasons. He might do it because it was the traditional way of doing things. In this way his teacher had taught him, parceling out small increments of knowledge over several years. Or he might feel that this method was effective; perhaps the student appreciated knowledge more if it was given reluctantly over long periods. The established principle 'never tells too plainly' was a fixture in Ch'an (Zen) as well as in boxing. On the other hand, the teacher might hide his inadequacy behind this cloak of secrecy, or he might simply be ill-natured and unwilling to help a struggling student. Whatever the reason, many systems died with the demise of a master." (Donn F. Draeger and Robert W. Smith, *Comprehensive Asian Fighting Arts* [Kodansha International/USA Ltd., 1987], 21). It is therefore up to us to begin to observe, analyze, and catalogue the basis for why we believe, practice, and teach what we do.



## **How Do We Study It?**

For a scientific study of the martial arts to be successful, it must be done methodically. The Scientific Method, developed in 1854 as a systematic method for obtaining knowledge, is still used in modern scientific study. The Scientific Method has 3 steps:

1. Recognition and formulation of a problem
2. Collection of data through observation and experiment
3. Formulation and testing of hypothesis.

Steps 2 and 3 may be repeated numerous times until a satisfactory working hypothesis is formed. Scientific study of the martial arts should be no different. In fact, most martial artists unknowingly use the 3 steps of the Scientific Method every time they strive to improve a technique.

Since it is impossible for anyone paper or study to examine all of the relevant areas of the martial arts, it is important that the data obtained be easily transferred and applied to other studies. For this to be achieved, it is necessary to achieve an understanding of how one concept or element of the martial arts affects another. The interrelation of these various elements within the martial arts needs to be carefully isolated to aid in analyzing cause and effect type relationships.

Not only should the martial arts be analyzed methodically, but from the appropriate fields of scientific discipline as well. For example, of the three major areas of martial arts development, spiritual, mental, and physical can each be legitimately studied from a scientific viewpoint. It would be foolish, however, to study both from the same point of view. The physical aspect of the martial arts needs to be studied from a physics and physiology point of view, while the mental aspect should be examined from a psychological and chemical viewpoint. They obviously cannot be totally divorced from each other, just as the spiritual element cannot be ignored when looking at the martial arts as a whole. As a result, certain mental and physical elements are closely related, and should be studied together.

As with any study, it is wise to begin with the basics and then build a level of understanding based on those basics. There are many basic physical elements within the martial arts, and almost all of them make use of sound, scientific principles. The majority of this paper deals with those basics. When the basics are understood and mastered, it is much easier to see where they lead, and why they exist in the first place.

### **EXAMPLES OF PHYSICAL SCIENTIFIC PRINCIPLES-**

#### **Physics 101**

Anyone can see through observing that a martial artist uses his feet or hands as missiles, driving them into their targets with great speed and strength. It seems obvious that one must hit hard and fast, but it is essential that the martial artist understands the physics

behind this requirement. From a physics point of view, a striking martial artist seeks to achieve three objectives:

1. Overcome the forces of inertia.
2. Generate maximum momentum towards the target.
3. Transfer most or all of the generated momentum to the target.

Before a martial artist can fully attain these objectives, it is necessary to understand the physical laws governing mass, motion, and the transfer of momentum. The more complete a martial artist's understanding of these physical laws, the more efficient his or her technique will become.

Dynamics is the study of how forces affect the motion of bodies. Sir Isaac Newton, in the second half of the 17th century, composed a coherent theory of forces and formulated a set of equations by which the motions of a body under the influence of a force or forces could be calculated. His theory and formulas have become the basis for Newtonian physics and are known as Newton's Laws.

Newton's 3 laws are:

1. A body at rest remains at rest, and a body in motion continues to move at constant velocity unless acted upon by an external force. (Also known as the Law of Inertia.)
2. A force (F) acting on a body gives it an acceleration which is in the direction of the force and has a magnitude inversely proportional to the mass (m) of the body. ( $F=ma$ )
3. Whenever a body exerts a force on another body, the latter exerts a force of equal magnitude and opposite direction on the former.

The momentum (p) of a body is defined as the product of its mass and velocity ( $p=mv$ ). Newton's laws can be efficiently expressed in terms of momentum.

1. The momentum (p) of a body remains constant. ( $p= [\text{constant}]$ )
2. The rate of change ( $\sim$ ) of momentum (p) is equal to the force (F) exerted.

$$\frac{\Delta p}{\Delta t} = F$$

3. Whenever a body exerts a force on another body, the resulting changes in momentum for each body are equal and opposite.

Conservation of momentum is a direct consequence of Newton's third law. This can be shown thus:

If the force exerted by body 2 on body 1 is F, then by Newton's Third Law, the force exerted by body 1 on body 2 is -F. The equation for each body's motion is:

$$\frac{\Delta p_1}{\Delta t} = F$$

$$\frac{\Delta p_2}{\Delta t} = -F$$

By adding these two equations, the following is obtained:

$$\frac{\Delta p_1}{\Delta t} + \frac{\Delta p_2}{\Delta t} = F + -F$$

or

$$\frac{\Delta (p_1 + p_2)}{\Delta t} = 0$$

This shows that the total momentum (P) of a two body system is a constant ( $\{=p_1 + p_2 =$  [constant]).

It is Newton's Third Law, or the Law of Conservation of Momentum that allows a martial artist to break a board, brick, or when necessary, a bone. This is accomplished by transferal of momentum into the target through a small actual striking object (fist or foot).

### **Achieving the 3 Physical Objectives**

For the martial artist to achieve the first objective, overcoming the forces of inertia, it is necessary for him or her to apply an external force to his or her body, which changes its velocity in a positive direction, thereby increasing its momentum. The energy necessary to overcome the inertia at work on a body varies greatly with the technique being executed.

"The concept of inertia can be readily understood in body language by performing the following exercise. Assume a front stance; keep arms outstretched with underarms tensed so that the arms move rigidly with the hips. First rotate the hips and arms with maximum torque across the hips to cause the hips to rotate. Practice rotating the hips several times. Second, bend the arms at the elbow, and do the same hip motion. Then do the movement a third time, clasping your elbows with your hands." (Lester Ingber, PhD., Physics, Karate Kinematics and Dynamics [Unique Publications, Inc., 1981], 36).

Try this exercise. You can easily see that with the arms outstretched it takes much more effort to accelerate your body to the same velocity, than with them hugged to your sides. For this reason, most techniques begin in, close to the body, with the body beginning the move with some type of torque or rotation that the striking object (hand or foot) then follows. In this way, the inertia on the body is overcome in stages. By beginning the technique close to the body, inertia is low. As inertia is overcome, the striking hand or foot then begins to project out towards the target, beginning to pick up momentum that is transferred to it by the rotating body.

An excellent example of a technique beginning close to the body to overcome inertia would be the tae kwon do combination of sudo (knife hand)-yok sudo (reverse knife hand). The arms cross close to the body as the body begins to twist. As the first sudo is thrown outward, inertia already overcome by the twisting body, the body's momentum is used to throw the second yok sudo after it. It follows that with the ability of a twisting technique to transfer the body's mass to the momentum equation of the striking hand or foot, they can carry more power.

The second objective, obtaining the greatest possible momentum in the shortest possible time, is highly dependent on how quickly inertia was overcome. It is desirable to accelerate the body to impact speed as quickly as possible since inertia is much lower at the beginning of the technique. Another important aspect of achieving momentum is that of "lock-out". For swinging techniques, discussed earlier, it is the motion of the body that contributes its mass to that of the hand or foot. With a linearly applied attack such as the jirugi (punch), it is necessary to lock the elbow at the time of impact. This in effect "fuses" the arm with the rest of the body, adding the body's mass to that of the arm and fist, and increasing the momentum of the hand at impact.

When the first two objectives are achieved, and the body part possessing great momentum strikes a relatively non-moving target, incredible destructive pressure is applied to it. This pressure can be found by dividing the total force applied by the surface area of the target.

With the general principles of Newtonian physics under our belt, we can begin to apply them to more specific techniques and aspects of the martial arts.

## **Stance**

It is the stance that ties the martial artist to the earth and provides a foundation for the torso, the launching pad for the arms and legs.

There are many torques (two or more forces acting in opposite directions on either end of a lever) in action when a martial artist moves. The stance helps provide these torques. There are two basic types of stances, inside and outside force stances. Inside force stances allow for powerful torques directed toward the inside of the body, while outside force

stances provide for torques directed outward, away from it. The following is a categorized list of most hard-style stances:

<b>Inside Force</b>	<b>Outside Force</b>
Hourglass Stance	Horse Stance
Cat Stance	Back Stance
Half Moon Stance	Front Stance

By anchoring a martial artist firmly to the earth, a good stance can, in effect, add the mass of the earth to that of the martial artist, giving him or her incredible momentum ( $p=mv$ ). This momentum is needed for both blocking and striking techniques. For a stance to provide this type of solid foundation, the martial artists must have good balance. This is done by keeping one's center of gravity low to the ground. It is, however, important to remember that if the stance is too low to the ground, inertia will be too high and overcoming it too difficult to allow a quick technique.

### **Breathing and the Kiai**

Breathing is perhaps one of the most often neglected areas of the martial arts. Breathing is, in fact, one of the most important, yet simple aspects of martial arts training.

Simply put, force moves through a medium with strong elastic bonds between its building blocks (Ibid, 20). When the martial artist moves, he is attempting to transfer force through his body to the striking hand or foot. To do this effectively, the body needs to be strong, but elastic. When inhaling, the stomach muscles retract, and are relaxed. When exhaling, however, they are rigid, and the body is an ideal conduit for force. When exhaling is terminated with a loud Kiai, further tension is created throughout the torso allowing for more effective transfer of energy.

### **Shoulder Rolls and Falls**

The concept of transfer of momentum can also be used to great effect in defensive movements such as shoulder rolls and falls. When one is thrown or swept, unwanted momentum and velocity are applied to the body in a disadvantageous direction. By smoothly curving the spine, and tucking the body into a ball, linear momentum can be harmlessly converted into rotational momentum and dissipated.

### **Anatomy**

Most of the soft-style arts such as judo or jujitsu make heavy use of wrist bends, throws, and other lock and restraint/release techniques. For those to be effective, a base understanding of muscular structure and control must be had. A brief glossary of terms is in order:

**Bone** - Specialized hardened connective tissue formed of collagen fibers and calcium. Provides a skeletal foundation for the muscles.

**Joint** - The joining point of two adjacent bones. Most allow for a specific range of motion.

**Ligament** - Fibrous tissue bands which connect bones to bones at the joints.

**Muscle** (skeletal, not smooth or cardiac) - Fibrous tissue that produces body movement when contracted.

**Tendon** - Fibrous tissue bands that connect muscles to bones near the joints.

**Nerves** - Filaments of tissue that transmit sensations to the brain and connect the nervous system to other organs.

Knowing that joints provide for movement in a specific range of motion allows us to apply pressure to the joint outside of this range, thus causing pain or immobility. Knowing that at the joints, bones are connected with ligaments, and muscles to bones with tendons, the joints then become likely targets for a strike of pressure point attack.

Knowing how the muscles work in conjunction with the bones and ligaments can help also: "Muscles cannot exercise a high level of control over more than one joint. Therefore multi-joint muscles will normally work with other muscles or sometimes ligamentous structures to control one or more joints in the chain, thus limiting the number of joints over which they are acting at that particular time. The fingers cannot work effectively through the long flexors unless the wrist and mid-carpal joints are fixed by other muscles ... For maximal power the long digital flexors must work on a fixed wrist and preferably with some degree of extension. If, however, the wrist is flexed, the power of flexion on the digits is weakened. This fact can be used practically in removing the knife from an assailant. The forearm is grabbed and the wrist forced into full flexion when it becomes virtually impossible to maintain a hold on the knife" (Kenneth M. Backhouse and Ralph T. Hutchings, *Color Atlas of Surface Anatomy* [Wolfe Medical Publications, Ltd., 1986], 16 & 19).

Most martial arts have a series of target areas centered around what are known generically as "nerve centers." In Gichin Funakoshi's *Karate Do Kyohan*, he not only identifies and names 40 nerve centers (jintai kyusho), but also isolates the causes and effects of a strike to each. This distinction is important, for if the uneducated karateka strikes a blow to a target he has memorized from a wall chart without knowledge of the effects that such a blow might have, he may unintentionally cause grievous harm. This is one area in which a substantial amount of research and resources are available, so further discussion will not be given but to say that it should be the responsibility of every practitioner to know the effects of his or her blows.

## The Ki to it all

### Definition

Most martial arts have an equivalent to ki (Japanese) or chi (Chinese). It is perhaps what makes the true martial arts as powerful as they are. It is also probably the last place that the world would try to apply scientific principles. Often looked upon as the source of karate's "super-powers", it is important that we as Christian martial artists fully understand it from a physical, mental, and spiritual standpoint.

The Overlook Martial Arts Dictionary defines ki as: " 'spirit', ideally, the mental and spiritual power summoned through concentration and breathing that can be applied to accomplish physical feats. This centralized energy, possessed by every person, can be manifested through the practice of just about any martial discipline, particularly those subscribing to a sophisticated study of physiology." Chi is defined as: "'Spirit', 'air', 'breath', or 'vital energy', a biophysical energy generated through breathing techniques studied in kung-fu. Ideally, chi can infuse a person with tremendous vitality and make him or her extremely powerful in action, much more so than the power developed purely through the muscular system alone. The methods of developing and controlling this force are numerous, but all of them include, in addition to meditation and concentration, the fundamental exercise of abdominal breathing. Known also in Japanese as ki."

### The 4 elements of ki

There are 4 elements to ki:

1. Focus your mind on one point.
2. Keep your weight bottom side.
3. Stay relaxed and calm.
4. Extend your ki through breathing, lockout, and kiai.

**Element 1** is both mental and physical. Mentally, the karateka's mind has to be focused on the task at hand, specifically the technique(s) he or she is currently executing. This is more of a subconscious focus since the speed of a properly executed technique can be faster than the eye can follow. Physically, focus is related to making sure your entire body is devoted toward hitting the target. The more focused your technique, the more momentum will be transferred to the target.

**Element 2** is all physical. Related to stance, if your weight is bottom side, your center of gravity is low, giving you greater mass to increase momentum towards your target.

**Element 3** is physical and mental. In both regards, the mind and body need to be relaxed with the exception of lock-out. In this way, the mind is like a calm pool, able to reflect the attacks of the adversary.

**Element 4** is the coming together of the first 3 elements and all other elements of karate. When one has everything down, and techniques are executed reflexively, then ki will be projected. It is this projection of ki that every martial artist strives for, without which the martial arts would simply be another sport.

Gichin Funakoshi said: "The essence of combat lies between the sei (the regular) and the ki (irregular), and without attaining the ability of changing sei into ki and ki into sei how can one obtain victory?" The concept of ki is the "irregular" that makes the "regular" of scientific principles truly add power to the martial arts. The yin and yang, the science and supernatural come together. Until we have an understanding of the scientific, we cannot hope to begin to understand the spiritual basis of the martial arts.

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