### Taijiquan's Enigma

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C.P. Ong, Ph.D., Independent Research, 11420 Beall Mountain Rd Potomac, MD, 20854, USA. Email: cpTaiji@gmail.com Taijiquan is a martial art of the highest order is culturally etched in the Chinese heritage and entrenched in wushu pulp fiction and kungfu movies. Therein lies the enigma. The gentle slow-motion practice cannot be more remote from the speed and power of combat. And adding to the mystique is the proposition that Taijiquan's kungfu prowess is not drawn from the physical strength of the musculature but from some "inner strength" or Neijin. This sacred belief was desecrated when a fighter thrashed a selfproclaimed Taijiquan grandmaster ignominiously in 10 seconds in an open match. Taijiquan was then derided as a bogus combat art. The incident shakes the foundation of Taijiquan and puts into questions many of its touted claims, which challenges the scientific quest of the art. The paper confronts the issue directly by studying the manifestation of Neijin in the framework of science to provide a scientific basis for the art. It transcribes the yin-yang metaphysics that regulates Taijiquan training in terms of the alignment of muscle actions to balance and to unify momentum, which develops the core strength of Neijin and the underlying life-force Qi energy. From this flows the kungfu marvels, which lie in the liveliness and agility of Neijin's response and in the force ensuing that is of the right vector values, all essential in the fluidity of combat application. The martial aspect of Taijiquan provides a concrete representation of Neijin, which gives an experiential insight into the multifaceted concept of Qi, and in turn a pathway to the exploration of Qi in physiology and thus in Qi energy medicine.

Keywords: Taijiquan; traditional Chinese medicine; Qi; Neijin

Scientific studies of Taijiquan usually consist of documenting the efficacy of its many health benefits in sample groups, governed by blind-study protocol, doing the exercise over a period of time but few if any relate the principle underlying the art in practice to physiology. What is Taijiquan?

Traditionally, Taijiquan, like any kungfu system, aims to produce martial skills for combat. Today, most people take up the practice for relaxation, health and wellbeing but Taijiquan does not regard itself just as an energytherapy for health. Given the increasing scientific interest in Taiji as an adjunct to health and medical science and the growing interest in energy medicine [1], research is going beyond the evidence gathering of treatment effects to understanding the role of the life-force Qi energy in physiology. Qi energy is nurtured in the practice of Taijiquan, as well as of other Qi-energetics exercises (generally referred to as Qigong).

Unfortunately, Qi as presented in the theory of traditional Chinese medicine (TCM) and yin-yang metaphysics cannot be deciphered in the framework of physics or biology. However, illusive as it is scientifically, Qi is picked up by our senses and the body relates to Qi readily. For this paper, Qi is assumed given as the foundational energy of TCM theory but it can also be thought of as a form of bioenergy, as in energy medicine.

Bypassing the yin-yang metaphysics, we look at the science of Taijiquan's training methodology to study the pragmatics of Qi in the traditional objective of producing a combat artist. Taijiquan's combat skills

and techniques are manifested in the body, thus demonstrable, and must reckon with speed, strength and energy, thus subject to physiological regulations. Therein lies Taijiquan's enigma — how to square the gentle slow-motion practice with the speed and power of combat. Incongruent as it may be, we are often regaled with stories of the incredible and physics-defying martial feats of the masters of old.

In April 2017, the issue was thrust onto the forefront more forcefully than ever before when an MMA (Mixed Martial Arts) fighter crushed a self-styled Taijiquan grandmaster in 10 seconds and harangued that Taijiquan combat was mostly fake. In effect, it was deriding that the sacrosanct concept of Neijin (inner strength), the stuff of Taijiquan's kungfu prowess, was bogus [2].

Suddenly, reciting the stupendous kungfu skills of Taijiquan to mesmerize is no longer good enough it has to contend with the real strikes to the face. The traditional theories in the classics that have served to inspire the art are ringing hollow. The incident shook the cultural heritage of Taijiquan at its core, and created such an uproar in the cyberspace that the internet portal had to be shut down.

The scientific interest is challenged, as the incident is raising doubts on the foundational basis of Taijiquan. It is thus imperative that we lay the framework of physics and physiology on the metaphysics of yin and yang to resolve and unravel the mystery of art that will lead to a scientific basis.

Inner strength (Neijin) that forms the basis of the kungfu art is so dubbed to distinguish it from the physical strength of the musculature and to imply that the real stuff is derived from the unfathomable "internal". The esoteric concept fits in with the mystique of "mind over matter", but has been misguided and has led to the claim of telekinesis of projecting force over space without contact, the so-called "empty force". Whatever "empty force" is, it has not withstood scrutiny. Nevertheless, claims of Neijin have grown more outlandish, but so have the doubts. And as many charlatans have been debunked, more have swelled the ranks. We avoid the "empty force" controversy.

Here we unpack Neijin by looking at its manifestation in application and grounding it on the musculoskeletal structure. While the yinyang metaphysics that guides Taijiquan training is esoteric, interestingly, the body relates to its principles readily in practice. At the heart of the training is the cultivation of inner balance, which develops Qi and the core strength of Neijin. The nurturing of Qi bestows health benefits by TCM theory and a sufficient buildup of Neijin delivers kungfu skills; both involve physiology and the regulation of muscle activations. That is, the same Taijiquan practice promises both, depending on one's kungfu — the time and effort invested. The upshot is that we gain an experiential comprehension of Qi and of its role in Neijin.

### Taijiquan rooted in martial arts

The very name of Taijiquan carries the aura of a combat art of the highest order by virtue of the imprimatur of the Taiji yin-yang theory. Indeed, the classical canons of Taijiquan tout the superiority of its martial skills as second to none, in uncharacteristic lack of humility. The classics critique that the other combat arts are mostly about the obvious advantages of strength and speed, of "the strong defeating the weak, the slow losing to the fast".

Taijiquan combat is based on the principle of the "soft" overcoming the "hard", not of absolute strength and speed. That is, by the principle, a person not physically endowed can defeat one who is stronger and faster. It gives rise to skills that can only be described as extraordinary, such as:

"Four ounces overcoming a thousand pounds,"

"Leading an opponent to emptiness,"

"Borrowing the opponent's force to strike."

These skills produce "heroes without peers", and the beguiling captivation for aficionados is that they remain good through old age. Thus, the classics talk of old masters prevailing over young thugs, as depicted often in wuxia stories (wushu pulp fiction) and the kungfu movies.

A Taijiquan practitioner, whether or not in quest of combat skills, is always exposed to its martial side. Taijiquan schools and instructors point to two credentials as proof of authenticity of their art: the lineage transmission and their martial prowess. They seldom tout their successes in providing health benefits and healing. In this culture, the indoctrination of Taiji's superior kungfu seeps in imperceptibly, notwithstanding the conundrum of the slow-motion and the speed and power of combat. Ironically, it is the slow-motion that nurtures the art of its martial DNA.

The slow-motion practice is often misunderstood as evolved and transformed from a martial origin. Quite to the contrary, the slow-motion is Taijiquan's modus operandi of training to develop the strength and precision of the art, namely, the strength of Neijin (more of which is discussed below). Thus, the slowmotion practice in no way diminishes the martial character of the art. To truly understand Taijiquan, one must investigate the science of its martial aspect in the process of training and in application, a study which is long overdue. But before that, we need to clear some air in the Chinese kungfu culture that tends to stunt such a discourse.

#### The close culture of Chinese kungfu

The Chinese kungfu culture is shrouded in secrecy and mystery, and the transmission of the art is traditionally guarded to trusted indoor disciples. This breeds an obsessiveness with the lineage of transmission and a culture of hubris to the detriment of the art. As a result, lineage purity becomes a more important arbiter of martial standards than the pragmatics of skills. In the close culture, open exchanges among the kungfu systems are discouraged. With little or no discourse, prejudices of each other's system abound.

Coupled with the Chinese reverence of the old masters, the culture breeds a deep relationship between master and disciple that is peculiar to the kungfu arts. As they are revered by their students, the present-day masters exalt their masters and their far superior skills that they can only dream of. It would be irreverent of them to think of surpassing their masters. This devotional respect had caused to skew and stymie the advancement of the arts, as Hao Tang (1887-1959), arguably the most notable martial arts historian, lamented. The kungfu arts are trapped in the martial ethos of their own making. The culture of mystique has resisted the onslaught of science.



Grandmaster Xiaowang Chen inspiring students in a U.S. Workshop.

Invoking a kungfu style to assert superiority in a winning technique may be fine and expected, but the style has no monopoly of or unique claim to the technique. It is not the kungfu style that wins the day, but the individual fighter knowing to launch the right attack in a timely manner. A knockout kick may be Muay Thai-inspired, but if it succeeds it is because it is faster than the opponent's retreat or block and it is on the mark. The armlock is a common technique, but it must find the joint weakness to force a submission, not by sheer force, but by leverage.

It is counterproductive to be mired in the old debate of which kungfu lineage is purer or engage in a new debate as to whether the modern Mixed Martial Arts (MMA) represents a superior genre in martial arts. Forging ahead by studying the combat manifestation of Neijin will break down the walls of secrecy and mystery, and foster a more open exchange to advance the research of the arts.

### The MMA platform

The MMA platform is a modern setup for a "noholds-barred" or "anything-goes" fight. Its rules are designed to make the fights as real-life as possible within the safety of entertainment sports. The MMA techniques, predominantly of striking and grappling, are mostly drawn from BJJ (Brazilian Jiu-Jitsu), Boxing, Wrestling, Judo, Kyokushin Karate, Muay Thai, among others. Fighters train in a hybrid system that is a fusion of these and other traditional systems. These fighting systems crank out fighters in the ring quite efficiently as the bulk of the training occurs in the ring itself.

Besides the nuances of ground fighting, the MMA techniques are by and large found in the hundreds of Chinese kungfu systems. The Shaolin kungfu system itself is a comprehensive system with an incomparable range of combat techniques. But unlike MMA training which is driven by the pragmatic considerations of producing a winner, kungfu training places emphasis on the mastery of the art.

While most of the kungfu calisthenics do convey martial characteristics, some of the flowery movements leave doubts as to whether they are effective. However, the Shaolin monks never fail to impress in their performances, where the martial skills are elegant and not only evident but formidable. Nevertheless, the combat skills have to be tested and interestingly, the MMA platform has become a laboratory to do that.

### The kungfu training system

The Chinese kungfu training is defined by its formal form routines called taolu, which also serve to distinguish the different kungfu systems. First and foremost, the kungfu training is to build the body's core strength (gong li). Without a prerequisite of foundational strength, a fighter would have been shoved off like a little kid. Without the necessary core strength supporting the technique, it would not be effective.

The core strength is developed by stationary horsestance and other posture standing and a gamut of taolu form routines, together with the basic drills of stretching, striking, kicking, rolling, somersaulting, jumping, and combinations thereof with hands, fists, elbows, knees and kicks.

The arduous process of form-routine training conditions and tempers the body as it builds the core strength so that the body responds naturally with the kungfu moves. This is the meaning of the word of kungfu (gongfu) itself, an investment of time and effort devoted to develop the martial skills in the process.

The taolu has evolved into an art form in its own right as the practice becomes one of self-cultivation, which develops the mind as well. The mind component of the practice is necessary to capture the spirit of the form to effect a unification of the mind and physical form. The Chinese kungfu systems have plenty to offer in techniques to fight in the ring, but the self-cultivation strives for an idealism of purity and spirituality and a culture of wude ("martial moral codes"), which extols righteousness and chivalry.

In other words, the kungfu training does deliver the necessary ingredients of a good fighter: courage, strength, and techniques. But however impressive and devastating a strike or kick may be in breaking bricks, the situation in real combat is fluid and ever-changing — the target is not only moving, but counterattacks as well. So traditional kungfu training incorporates combat sparring. Broken bones were quite common in the old days, and kungfu masters were often necessarily good bonesetters as well, and herbal lotion and medicines were always readily on hand to attend to injuries.

In modern wushu, which is a standardization of the traditional systems in 1958, the combat platform is called sanda, a "free-form fighting of kicks, strikes and throws", but the rules are quite restrictive, prohibiting strikes by headbutts, elbows, knees, and the use of joint-locks and ground-fighting, namely, a good portion of the MMA arsenals. Nevertheless, limited as they are, the sanda techniques are quite versatile, such as the tornado and somersault kicks, as demonstrated by the wushu-turned-sanda legend, Li Jianwen [3].

Sanda athletes may start out with taolu training, but rely primarily on sparring practice to fight in the ring. On the other hand, the practice of modern wushutaolu is driven by the difficulty elements of form competition, more for aesthetics than application. That is, elite wushu practitioners and sanda athletes belong to different camps.

The traditional kungfu systems are driven to refine, culture and spiritualize the art form, but have they come at the expense of combat application? True mastery of the art means that the core principles of the kungfu system are ingrained by the practice of its taolu. The body is instilled to respond with the right vector force in defense and offense, and can maneuver changes in movements under pressure with ease and liveliness to setup leverage in application.

Taijiquan is an outgrowth of this age-old kungfu culture and has developed into a martial system in its own right, with an array of weapons for real combat. The core training in the Taijiquan system is the development of Neijin.

### Taijiquan's training methodology and Neijin

Notwithstanding the apparent lack of physical vigor, Taijiquan training is very much about building the body's core strength. The strength development is regulated by the Taiji principles of yin and yang. However, the strength is not apparent, so is dubbed "inner strength" (Neijin) or simply jin, with the characterization of "inner" dropped as superfluous.

Couched in yin-yang metaphysics, the Neijin theory is elusive. There is no consensus among experts as to what Neijin is or how best to train for it. Indeed, the very practice of Taijiquan itself is cryptic, guided by the mantra of "using mind-intent and not force". This is often misinterpreted as "not using muscle force", which of course makes no sense. Nevertheless, the body relates readily to the manifestation of the yinyang theory and the practice dictum, and Neijin develops in the course of the slow-motion training.

However, the practice mantra has spawned a Taiji culture that disdains the musculature but exalts the roles of the mind (Yi) and Qi. The significance of the musculature is so discounted in Neijin application that any physical exertion of force is decried — the less the exertion of force, the more it is lauded as of Neijin. This over-characterization of Neijin by the non-exertion of physical force has led to many claims of kungfu feats, such as that of projecting force over space ("empty force") and tossing bodies about without contact. These physics-defying feats turn out to be the delusional beliefs of the masters of their own skills.

The unpacking of the yin-yang theory of practice in terms of physics and physiology has been discussed in the the author's paper, Scientific Perspective of Neijin [4]. We review the development of the strength of Neijin in terms of balance, momentum, and cognition of neural responses.

#### The Principle of Inner balance

Balance is a basic factor in bipedal functionality, without which there is no control. But underlying each physical function there are varying combinations of many muscles that can do the same task. In sports, picking the right combination is crucial, deciding between a win or loss, while in mundane activities, the combinations are less important as long as the job gets done. What are the preferred combinations of muscle actions? Taijiquan training picks a preferred combination of the muscle actions as that which corresponds to a state of better yin-yang balance, or simply that of better balance.

To illustrate, let us look at the balance of an arm outstretched to the side. The arm balance is supported by a wide ranging combinations of muscle actions of the shoulder and arm, with that of the deltoid tending to dominate. The arm would tire and tense up if it were held stationary for a duration, an indication that the muscle actions could be in a better state of balance.

In response to the discomfort of tenseness, the arm could relax and settle into a better state of balance —

a preferred combination of muscle actions with lesser tenseness. This describes the work of fangsong, "relaxing and letting go", at the most rudimentary level, which resolves the muscle actions that are too excessive, to get to a better state of balance.

We can elicit fangsong relaxation by the following simulation. Enlist someone to hold a finger and let the arm hang like a cable between the finger and the shoulder. This induces the arm to settle into a state of balance of overall lesser muscle actions. In the process of fangsong relaxation, the body gains perception of the elbow and the weight of the arm, a consequence of a state of a better balance. One can say that the sensation of discomfort is due to a change in the levels of bioenergy — an imbalance of local bioenergy, similar to pain receptors being triggered by a disruption of bioenergy caused by a damage to tissues. Another way to effect fangsong relaxation of the arm is to abide by the practice exhortation to "sink the shoulder and drop the elbow". This induces muscle activations to not over-exert in the arm support.

Associated with fangsong is an ease of tenseness, which in time, is sensed as an energy flow, a consequence of a better balance of bioenergy, which TCM attributes to as Qi. The body over time learns to associate the sensation of Qi energy with fangsong — the more the fangsong, the better the Qi flow. Applying fangsong relaxation to other parts of the body, one builds a sensation of motion of the segments and the associated flow of Qi energy and, significantly, one also gains awareness of the joints. These come from a better combination of muscle actions and better bioenergy balance, which manifests a better state of yin-yang balance in



The author in a push-hand and qinna (joint-lock capturing) play with Grandmaster Tiancai Zhu.

biomechanics. In other words, the Qi development of Taiji is grounded in the fangsong function to get to a better state of balance.

A state of inner balance is defined as one that conforms to yin-yang balance, which manifested in biomechanics, is a state where the muscle actions at the joints are neither excessive nor deficient. Inner balance encompasses the full comprehensiveness of functional balance under all situations between the forces of muscle actions themselves and with gravity. The art of Taijiquan finds its basis in the principle of inner balance.

However, more often than not, the body responds in action without regard to inner balance, which, inadvertently, makes balance worse. For instance, when you raise a hand high up to attract the attention of a dear friend afar, your ribcage is heaved up in the excitement, tensing the chest and making the body easy to topple, thus the functional balance worse.

The practice of Taijiquan is all about fangsong to cultivate inner balance to nurture Qi as a manifestation of yin-yang balance in the musculoskeletal framework. But Taijiquan cannot allocate so much muscle actions here and so much there as in a balance scale — we do not directly communicate with the muscles. Also, the postural configuration is ever-changing in motion and so are the fulcrum and arms of balance.

Taijiquan has a clever trick, which is to develop cognition of the excessiveness or the deficiency of muscle actions as too yang or too yin, respectively. In practice, one is exhorted not to be "too lax or too extensive" in the movements. Another constant reminder in practice is to "not go over but also not fall short", which also produces the effect of paring down movements that are too yang or too yin.

Here is the genius of the Taiji methodology. The practice does not seek inner balance directly, but the body learns to use the tool of fangsong to stay in the middle ground between the errors of too yang and too yin. This chips away at the errors, thereby reducing the errors of yin-yang imbalance and nurturing more Qi energy. As the practice advances with the maturity of Qi, the fangsong tool grows with sharper perceptiveness, the margin of errors tapers, and the practice-path converges to inner balance, in a realization of the classic Tao of "seeking without seeking".

The body's core strength grows in the fangsong process of cultivating inner balance. This is the core strength of Neijin, born of inner balance [5]. An immediate import is that, infused with inner balance, the body responds with balance intact, so one cannot be disadvantaged in combat. Also, with inner balance, the body responds with a natural ease of maneuver at the joints, so can undergo postural changes at will, which is in contrast to being locked and unable to move under pressure.

Next we look at the force that arises from Neijin in application. The principle of inner balance guides the harnessing of the full momentum of the body, thus tapping on its full potential to generate force. More significantly, instilled with inner balance, the body responds with a comprehension of force as a vector (to be explored more in a subsequent section on the "soft" and "hard" of Neijin).

### The force of Neijin

The body's comprehension of force is not based on calculation. While the speed of a punch is crucial in boxing, the force it produces depends on what is hit. If the punch is dodged, then there is no force to speak of. If it strikes the head squarely, the knockout bespeaks its force, which is a consequence of the collision between the fist and the head. That is, the force that inflicts damage is created when the body's motion, more precisely, momentum (mass times velocity), is resisted. This force is Newton's Second Law of Motion:

Average Force =	Change in momentum
	Time duration of the change

The contractile forces of muscles only produce body motion. The force that arises in application comes in only when the body's momentum is changed. The more the momentum of the body can be brought to bear, the greater the force potential in application.

Therein lies the problem, to get the body segments to move in unison to maximize momentum with respect to the action. The motion of each segment is independently innervated. The body is stubborn and does not always listen to us. We cannot just summon the muscle actions of the segments to unify

in momentum. Quite to the contrary, more often than not, the motor-neural circuits would activate muscles that would undermine sequential kinetics and degrade the force output.

For example, in the anxiety to throw a fast punch, the muscles closest to the punch action, namely, the arm and shoulder muscles, would dominate. This would cause the fist to jump ahead in the action, which would cut the muscle power and momentum of the chest and other parts of the body from contributing to the punch.

If the muscles activated are not in the right kinetic sequence, the segments of the body would not be moving in tandem relative to the functional action. The main culprit is the dominance of the primemover muscles in the actions, which would break the kinetic alignment of the muscle actions to unify in momentum. This is not an issue in mundane activities, but a key factor when you are trying to improve your golf drive.

Fangsong resolution tempers and reins in the muscle actions that are dominating or too yang and pumps up those that are under or too yin. To streamline the fangsong operation, the skeletal muscles are simplified according to their functional roles:

1. Outer or prime-mover muscles that move the body segments, such as the arms and legs, the torso, and so on, namely, that which power the physical movements.

2. Inner or core muscles that secure and stabilize the joints, which maintain the integrity of structure.

The muscles are not exclusive in the groupings. Also, the muscles are not dedicated and do compete and cross-over in their functional roles. Note that the agonist-antagonist roles of muscles are subsumed but are refined as well in the fangsong.

With this functional classification, we can describe fangsong as continually tempering the muscle actions to subdue the dominating tendency of the outer muscles to pull ahead and to allow the inner and deep muscles to activate in their support. In this way, the muscle actions are being worked to resettle in a better balance and alignment, thus for the segments to move in sync and unison of momentum.

This is where the cryptic mantra of yong yi bu yong li ("using mind-intent and not force") fits in. "Not to use force" means not to let any muscle group, especially the prime-movers, hijack the action. "Using mind-intent" has the effect of reining in the old habits of recruiting muscles, thus allowing the inner muscles to activate for a more balanced alignment of the muscle actions. Thus, adherence to the dictum has the effect of tempering the muscle actions in the slow-motion practice, to induce them to align and balance.

Importantly, the fangsong operation builds a reliance on Qi as well. The Qi sensation in the fangsong gives the body cognition of the motion of the segments. The motion of the segments jumping out of kinetic sequence is sensed as broken Qi, which can then be reined in by the feedback. In this way, Taijiquan uses Qi as a medium to balance and align the muscle actions of the segments, thus unifying momentum.

The force of neijin is consummate as it represents the full potential of the body by the alignment of momentum in application and with control in balance. More succinctly, inspired by inner balance, the body has cognition of the movements at the joints. This gives the body a comprehension of the force in application as "soft" and "hard", which represent the vector values of the force (to be revisited in a later section).

The key point is that the force that arises from Neijin in application is one of the right force vector and with balance intact. Hence, a body imbued with Neijin, enjoys an insurmountable advantage in combat, as the right force vector is imparted in response to the situation. And inspired by yin-yang balance, the force of Neijin is lively and agile — able to change spontaneously to the combat situations.

To fully appreciate the application of Neijin, we need to review the body's rotational motion and in the section after, the control by the mind-Yi and Qi.

### The body's rotational motion

Rotational motion is crucial in all the body's physical action. The body's main power source, waist power, comes from the rotation of the torso. The torso represents the largest mass as a component of the body. Yet, despite its critical role in generating strength, the muscle actions of the torso are not predisposed to producing the right torques at the waist for maximal power. Unless talented, our brains are not wired to produce long drives in golf.

A quick review of the anatomy of the torso shows that the large back muscles of the trapezius and the latissimus dorsi and the pectoralis of the chest, attach to the bones to provide the motion of the arms (for example, adduction and abduction). The muscle actions of the extensors and flexors are clear too from where they originate and insert. Less clear are the actions of the abdominal muscles, which are partly attached at the lower ribs and at the pelvic crest, but one can see that the corset of the oblique and transversus muscles, zipped on the front, provide some torque. One can also deduce that the horizontal components of the muscle forces of the right set of pairings also produce some torque. Given this lack of clarity of torque, it is thus not surprising that one is less familiar with rotational than with linear motion.

Another factor that affects training in generating torque is the spinal torsion in the trunk rotation. Besides the muscle-torque, spinal torsion is also introduced by the lateral motions of the vertebral column due to the spinal curvatures, which is the effect of Gracovetsky's Spinal Engine Theory [6]. The spinal engine creeps in all the time because the pelvic girdle supporting the vertebral column at the sacral-iliac joint (SIJ) is always tilting one way or another, which causes the column's lateral motions.

The discussion here is only to point out the musculoskeletal issues in generating waist power, not to be wrapped up with the details. Nevertheless, unless taken into account, the training cannot tap the full potential of waist-power. A more detailed discussion can be found in Spinal Engine & Waist Power from Taijiquan Viewpoint [7].

The good news is that the masters of old did not have to rely on anatomical details to develop the core strength of Neijin. These issues are addressed by the slow-motion methodology of yin-yang balance in the alignment of muscle actions and the development of Qi, which includes that of torques. In fact, Taijiquan's first order of business in training is the basic exercise of "silk-reeling", chansigong, which nurtures the body's comprehension of its series of rotations. Each segment has two modes of motion, that of its center mass and of its rotational motion. The chansigong exercise builds cognition of the series of rotations in body motion, thus inculcates the body with the tenet that silk-reeling energy forms the basis of all Taijiquan motion [8]. The biomechanics of fangsong to resolve muscle actions at the joints remains the same in the silkreeling training. Given the significance of the spinal torsion, the fangsong operation identifies the deep inner muscles that secure and maintain the integrity of the vertebral column and the SIJ, functionally as the core axial muscles. In practice then, the fangsong refinement tempers the outer and prime-mover muscles and gives the core axial muscles a chance to activate to better align and balance for the torso to rotate in maximal angular momentum. It is the breakdown of this balance, resulting in insufficient core axial muscle actions that is the major cause of chronic backache.

### The neural gap and the Qi medium

The voluntary control we have of our skeletal muscles is only at the top hierarchy, the command to execute an action, not of the activations of muscles. Between the command and the innervations of the muscles that result in the action is a huge gap of neural activities, which we have no cognizance of. We only know the result of the action-product, say of the finger touching the nose. When the shot is missed, it is too late. We are thus at the mercy of the neural activities to deliver the motion-product.

We give the best effort in the golf swing, but still fall far short in the range. We cannot recruit the muscles at will, even if we know which ones, to deliver a longer drive. While there is neural feedback of proprioception and balance as well as of muscle fiber tension — the speed and length of muscle stretch for smoothness, we have no feedback of postural structure. For example, we stubbornly keep the poor forward-leaning posture in lifting a box, by firing more back muscles to stay balanced, which worsens the body's leverage in the task. There is no feedback of the bad posture, which is the cause of many a backache.

Taijiquan instills the principle of inner balance, which forestalls the body from responding with the flaws of a bad posture. Taijiquan is not just concerned with the immediate physical balance, but that the neural circuitries elicit responses that do not compromise the leverage functionality of the body and the sequential kinetics that glues the momentum — the principle of yin-yang balance.

This is where the role Qi comes into play. Because

the sensation of Qi is associated with the cultivation of inner balance, in time, the body can use the Qi energy as a medium to discern and to resolve the yin-yang imbalances of muscle actions. This provides a Qi feedback to guide the muscle actions, thus a bridge in the neural gap. A feedback of Qi obstruction is viewed as a break in the sequential kinetics of the segments and a yin-yang imbalance. In other words, the Taijiquan player learns to use Qi dynamics to guide motion.

Taijiquan thus builds a Qi communication-link across the neural gap, which the classics literature describes as, "The command of the mind-intent Yi stirs the Qi energy, and the internal dynamics of Qi drives the motion". The physical motion is driven by internal Qi dynamics as commanded. This represents the harmonization of "internal dynamics and external motion" and the realization of the Yi-Qi-motion paradigm. The Qi sensation here can be thought as based on the vestibular receptors, proprioceptors, and gravireceptor, including the sensory receptors of pressure, vision, sound, touch and other bioenergy, which will have to be a subject of another paper.

As an application, the paradigm gives clarity to the motion of the arm viewed in the division of three sections: The root-end of the shoulder drives, the extremity-end of the hand leads, and the motion transmits in sequential kinetics through the middle-section of the elbow, so that the arm moves as a whole in momentum, and yet retains the maneuverability of the segments at the joints. In the command to issue a punch, the stirring of the Qi means cognizance of motion-connectivity of the upper arm, lower arm, elbow and hand. The internal Qi dynamics driving the motion imposes sequential kinetics in the activations - the lower-arm segment moves by the Qi-motion transmitting through the elbow (so the fist does not jump ahead), and the upper arm moves by Qi driven at the shoulder, thus aligning the momentum as one.

#### The centrality principle of the dantian

The actual task of fangsong to resolve the muscle actions for balance and alignment at each of the myriad joints is clearly a formidable undertaking. What makes it even more formidable is the tensile integrity of the skeletal frame structure, as the resolution at one joint affects that at another, thus requiring a recalibration each time. The fangsong operation seems nigh impossible in practice.

The charm of yin-yang pragmatics is that it reduces the unwieldy task of fangsong of the myriad joints to one guided by a centrality principle. Taijiquan's prescription is to simplify the joints into pairs of three and then to apply fangsong systematically. The three major pairs are: the shoulders and hips, the elbows and knees, and the hands and feet, which can be further subdivided in refinement. The simplification leads to the centrality principle.

The waist-groin junction enjoys an eminent status because the generation of waist power relies on the torque action and reaction at the junction. The functional significance is the transference of forces between the body and the ground and the junction demarcates a most proportionate distribution of masses between the upper and lower body.

The motion of the torso rides on the pelvic girdle. The vertebral column rests at the SIJ, and the pelvic movements occur at the ball-and-socket hip-joints. Thus, the pelvic platform provides not only support for the spinal column, but is also a conduit of motion and loads between the spine and the legs, which are described as the three levers by Vleeming [9]. Waist-power, described generally as executed at the waist, is the force transference between the three levers through the pelvic platform, negotiated at the triangle of joints — the SIJ and the two hip-joints.

Taijiquan refers to this waist-groin junction as the kua, which represents the complex of the triangle of joints and the pelvic platform. The kua serves as a natural junction of reference for the movements of body. And the midpoint of the kua junction serves as the center of reference for the fangsong resolution at all the joints, thus the point of centrality to guide the fangsong task. This central point coincides with the energy-point, known as the Dantian ("field of elixir"), described traditionally as three fingers below the navel and a third of the way inside. Note also that the Dantian location is approximately the center of mass of the body in a horse-stance posture.

The practice exhortation of "bending at the knees and relaxing the kua" (qu xi song kua) is to induce fangsong resolution of the kua relative to the Dantian to build foundational balance. This is then extended to the fangsong of the corresponding pair of the shoulders and kua, and then to the elbow-knee and the hand-foot pairs. Following in refinement, it can be further extended to any of the other joints of the body. By referencing to the Dantian center, the centrality of motion is nurtured at the point.

The centrality of the Dantian is not just a reference point in name. In referencing to the Dantian, the fangsong resolution is actually tempering and working each time on the yin-yang balance of the muscle actions at the triangle of joints, thus operationally developing the centrality of the Dantian. Also, crucially, the Qi cultivated in the fangsong resolution at each joint relative to the Dantian is nurturing a connectivity between the joint and the Dantian. This builds a web of Qiconnectivity of the joints centered at the Dantian, which forms the concrete basis of the principle of Dantian centrality, thus resolving the sticky problem of the matrix of joints in the cultivation of inner balance. In so doing, it is reducing the intractable problem of fangsong of the myriad joints to the centrality principle of "establishing the central status of the Dantian" [10].

The SIJ highlights as the hub of forces transferred from the trunk to the ground and vice versa (Lovejoy, 1988, Aiello & Dean, 1990) [9]. The Dantian is functionally at the same level as the SIJ. Conferring the central status of the Dantian is thus an affirmation of the SIJ as the hub of forces. Establishing the Dantian centrality is the fruition of the SIJ hub principle, namely, the body comprehension of the centrality. The principle of Dantian centrality is conveyed with the greatest emphasis by Xiaowang Chen in his teachings, which he describes most unforgettably and homily as making "the Dantian happy".

In the Qi paradigm, the constant attentiveness to the Dantian and particularly, the fangsong at the SIJ and hip-joints, induces the Qi energy to collect at the lower abdominal region, concentrating at the Dantian. In time, the nurtured concentration of Qi culminates as the "fullness of Dantian Qi". The fullness of Dantian Qi gives the body a deepest experiential appreciation of the centrality principle. With this achievement, the body is said to be invested with the principle of centrality. The attainment represents the maturity of inner balance and the mastery of the art.

The fullness of Dantian Qi is Qi-speak of the

formation of the centrality principle of the Dantian, which in turn is an articulation that the Dantian center is able to assert the SIJ hub principle. It should be emphasized that the investiture of the central status of the Dantian can only be earned through the long and arduous process of fangsong practice. It cannot be endowed. True Taijiquan masters are made not born.

# The "soft and hard" of Neijin — Taijiquan's kungfu redux

At the heart of a kungfu technique is the right force vector applied with the right postural setup for delivery or for leverage. This is apparent in the closequarter fighting skills of wrestling, judo, grappling, and joint-locking techniques. To be able to execute an armlock in practice is one thing, but under the conditions of interactive moves and counter moves of combat, it is quite another. Under the heat of combat, the body is less able to maneuver to apply leverage. Indeed, we often see fighters cling onto each other in a standstill, because they are unable to apply their techniques.

The force and leverage setup can be devised easily enough, but they must be produced on demand according to the changing conditions of the target in combat. And the kungfu technique must be supported by control in balance to be effective. Uncannily, Neijin responds with the right force vector in the right leverage setup as a matter of course in combat situations. That is the marvel of Neijin's basis of Taijiquan's kungfu prowess.

Infused with inner balance, the body is very conversant with movements at the joints, so can undergo change spontaneously in response, with ease and at will according to the loads, which describes the soft character of Neijin. With inner balance, the segments are in alignment and move in unison, so momentum is also maximized in the response, which depicts the hard character of Neijin.

The liveliness of Neijin is the interplay of its dual characters. This means that, in the interchange of softness and hardness, the body can change and maneuver with spontaneity according to the changing demands of the combat situation.

The Rou (softness) gives changeability to respond with a force acting in the right direction and the Gang (hardness) gives magnitude by the unison of

momentum. The duality accords precision to the kungfu maneuver, which makes the effort in the response appear "soft", in contrast to the strenuous exertion associated with brute force.

In short, the advantage of Neijin is that the Taiji body knows to deliver the right combination of Rou and Gang, as a reflex in the response of combat that manifests in the right force vector — the magic of Taijiquan kungfu touted in the classics.

For instance, in the skill of "leading an opponent to emptiness", the body responds with rou-softness to absorb the incoming force and with sufficient ganghardness to stay its balance, and when the attacking force is committed, the body would turn with ease at the kua pivot, leading the force to slide off to "emptiness". Note that if there were not a sufficient store of core strength, one would have been shoved off before any technique could come into play. Also, if the Neijin is not mature, one would have to push back to keep balance, thereby locking-up the body from being able to turn at the kua. The maturity of Neijin accords the springy liveliness and the natural ease of turning.

The skill of "borrowing the opponent's force" is simply one of taking advantage of the opponent's faltering momentum. And the skill of "four ounces overcoming a thousand pounds" is a statement of using the leverage of the body. But in order to move a thousand-pound load with the fulcrum placed half a foot away, the lever would have to be at least 2,000 ft long, which clearly would be impossible to emulate in the human body.

The leverage, of course, is not linear, but is that of "coiling". If the opponent is holding the tip of a screw-driver but you are controlling the handle, you will prevail with a small effort, no matter how strong he/she might be. The control at the kua is like the control of the screw-driver handle, which enjoys the tremendous advantage of the coiling leverage. The efficacy of coiling leverage rings in the echoes of the opening stanzas of the Song of Boxing Canon by Chen Wangting (c. 1600-1680), the 9<sup>th</sup> generation Chen Family patriarch who reinvented the family martial art tradition that would come to be known as the Chen Family Taijiquan [11].

Zong fang qu shen ren mo zhi Zhu kao chan rao wo jie yi Charging, retreating, back and forth, all can plainly see I fully rely on coiling as the basis of all my combat techniques.

The energy that powers the kungfu techniques is the coiling energy of silk-reeling motion (chansi jin). The waist power (dangyao jin) that emerges at the "extremity" (shao jie) in application, such as in a punch or an elbow strike, coils up from the Dantian center, and is supported by the reaction jin coiling in the opposite direction down to the feet, anchoring on the ground. This is an assertion of the SIJ as the hub of force transference between the ground and the upper body.

Fajin is an explosive release of jin at an extremity, like the crack of a whip. Fajin is activated by accelerating the Taiji motion, like stepping on the gas pedal in driving. But the body must be well regulated by the principle of inner balance. Otherwise, it would be like a car sputtering off the road if it were not in tune and out of alignment. With the segments linked in kinetic sequence, the release of jin power from the waist-groin at the extremity is explosively fearful as it is graceful, as witnessed in Chen Xiaowang's signature fajin [12]. However, without the rou-soft alignment at the joints, the force would not transmit in sequential kinetics. Fajin exemplifies best the gang-hardness of Neijin.

The rou-softness of Neijin is best exemplified in Qinna (joint-locking techniques). The rou jin accords liveliness of movements at the joints, thus allows the body to flow with the Qinna pressure by the opponent. For example, if the wrist is Qinna-locked, the change can be effected at the elbow or shoulder to relieve the pressure and to escape, and then to launch a counter-Qinna. The skill of Qinna is as much to joint-lock an opponent into submission, as it is to escape from one and to counter-Qinna.

### What are we training for in Taijiquan?

Taijiquan is a martial art not a dance. The enigma remains. While it is not regarded as a dance, most people who do Taiji do not treat it as a martial art either. The martial aspect of Taijiquan is culturally ingrained, but its pursuit does not have to be motivated to be a fighter.

Jack Ma, China's internet celebrity tycoon and an avid Taiji player, often alludes to the practice in TV interviews, as giving him a deeper understanding of the art's Taoist philosophical underpinnings. The majority practice Taijiquan for health benefits, which is the mainspring of its growing popularity. As noted earlier, the scientific studies have all been on the subject of its health benefits.

Given the TCM tenet that health is a store of robust Qi, the health benefits of Taijiquan are presumed by its Qi-nurturing function. But again, Taijiquan does not regard itself just as a Qigong for health therapy. The basis of its exercise is the cultivation of yin-yang balance. Thus, whether one is looking for health or for kungfu skills, the rationale of the slowmotion fangsong regimen remains the same, centered on inner balance as Qi and Neijin are developed. As a Qi-nurturing exercise it is a health therapy. Taken beyond where Neijin can be exploited, it is a kungfu art. That is, one gets both health and Neijin for the price of one same Taijiquan practice. Without the guiding yin-yang principles of practice, it is not Taijiquan.

Of the many health benefits of Taijiquan reported, the most commonly cited in the news media is the prevention of fall. The keen public health interest is because a fall in old age often proves to be catastrophic. The effectiveness of Taijiquan exercise in preventing falls has been established by extensive research and published in the scientific journals.

Actually, by the principle of inner balance, the biomechanics of balance is quite evident in every step a practitioner takes in the Taijiquan exercise. The relaxation-fangsong in the quest of inner balance, operationally, resettles the body at the joints in a better balance. The deliberateness of the slow motion builds a neural pattern of responses that will always settle the body in balance. Thus, even if the fall is not prevented, the response to settle in balance counters the faltering, and serves to mitigate a would-be disastrous fall.

The many other health benefits of Taiji practice are derived from TCM's theory that Qi and blood are inextricably intertwined, in concept and function. TCM sums it up thus:

Qi is the commander of blood

Blood is the mother of Qi.

In this Qi-blood inseparability, TCM's central tenet of Qi as the life-force energy that gives life and vitality in biology is easier to appreciate in the Qiblood circulation, delivering oxygen, nutrients, ions and hormones. The Qi-blood inseparability is borne out in Shin Lin's research, which shows that not only are blood flow and electricity increased but that the increases are coordinated in Taijiquan and Qigong [13], as well as in other Chinese therapies such as acupuncture, massage, and topical herbal remedies [14].

Taijiquan refers to the fullness of Qi in the blood as extending to the extremities of the hairs, causing them to raise as a bird's crest [15]. Thus, by TCM's Qi-blood theory, the fullness of Qi developed in inner balance inures to the blood in all its optimality to benefit the body's biology. In other words, inner balance delivers the full package of homeostasis to every system of the body's physiological environment — the basis of comprehensive health and wellbeing.

It should also be mentioned, peripheral to blood flow, Taijiquan's deliberative slow motion in fangsong supports the circulation of the lymphatic system. The fangsong and muscle actions provide a coherence of pressure at the lymph nodes, particularly at the feet and at the inguinal fold where there is a concentration of.

There is yet a greater benefit when inner balance is attained — the prize of bliss and tranquility of mind. The practice leads to meditation by the constant attentiveness in the process of fangsong resolution, which is the mind component of the practice. It has the effect of restraining the restlessness of the "monkey mind", and thus quieting the mind. The calmness of mind conduces towards focus, which reinforces attentiveness that further cultivates awareness and concentration. The discipline builds a sea of tranquility in the mind and one enjoys bliss and equanimity [16].

### Conclusion

The discussion of inner balance may have been motivated by the reward of Neijin and of the kungfu skills that flow from it. More fundamentally, the principle of inner balance forms the basis upon which we can build a pathway for the scientific exploration of Taijiquan.

The achievement of inner balance does not just bestow one gem, but the triple gems:

- •Neijin
- •Equanimity
- •Homeostasis



Grandmaster Zhenglei Chen in the Taming Tiger Posture at the scenic Zion National Park, Utah, USA.

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