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Generating Body Strength Through Taijiquan Motion

Abstract

The neural circuits work very well to match, functionally, between the commands of an action, such as to swing a club, and the activation of muscles that result in the action. But the responses of neurobiology cannot be relied upon to recruit the right muscles necessary to meet a demand of high-level performance in power output, which one may want, such as a good long golf drive. The neural signals from the motor cortex do not activate the muscles at the right levels to produce the power drive that the body is capable of. Indeed, very often, many of the responses, conditioned by behavioral convenience, turn out to be obstacles, which form "barriers of neurobiology" to one's training to advance. This paper examines the issues through the lens of Taijiquan, and explains how it's unorthodox slow -motion methodology cultivates the body senses that elicit responses to overcome the barriers, and to generate the ideal motion of Taijiquan, which gives rise to force that is consummate.

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Introduction

We may be created equal in the design of the musculoskeletal framework, which bequeaths our bipedal functionality, but we are not created equal in the use of our muscles, as evident in athletics and dance. While it is true that a person endowed with bigger muscles can lift heavier objects, physique alone is not a reliable predictor in the outcome of a contest of strength. Our underdog instinct applauds with delight whenever a person of smaller build overcomes a larger in sports and martial arts. The factors in generating body strength are not just about developing muscles, but crucially, how they are recruited and how they align in coordination.

We are presumed to have control over our voluntary muscles, but many of the muscle activities of our physical actions operate under the radar of our consciousness. We may have command of action, say to touch the nose, but between the command at the top hierarchy of the body's motor system and the final signal output to activate muscles at the bottom, there is a complex of neural activities, which we are not conscious of. The communication to the muscles may travel along the same neural pathway, but the neuronal signals are not the same. We have no direct control over what occurs within the huge gap of neural processes, and we are cognitive only of the final outcome of the action itself—the finger touching the nose. Of course there is no issue of performance in the outcome of this action. But in sport actions, the outcome determines the game—victory or defeat.

We rely on training to improve on our actions, but we have to leave entirely to faith that the neural system will make the right connections to recruit and align the muscles. As hard as we train, we cannot produce the long drives of top golfers. Even for professional athletes, practice can sometimes hit a wall, unable to progress. These points to some responses of the central nervous system that are obstacles to training. It evokes the question: Are elite athletes born or made?

This paper looks at these questions through the lens of Taijiquan. We stay guided by the quest of generating body strength to avoid being drawn into the esoteric nature of Taiji. We navigate the terrain of neurobiology[1] to find if there is a faculty in the brain that integrates the inflow of sense data to produce the maximal strength that the body is capable of.

We begin by looking at the mechanics of waist power, as it is the main source of power action in both sports and martial arts. The discussion provides a common ground on which to overlay physiology and physics, and the framework of Taiji yin-yang theory, to study the factors of generating waist power. The approach forces one to evaluate the esoteric concepts of Taijiquan in terms of science.

It turns out that the "regulation" we seek in the gulf of neural activities to discipline muscle activations underlying body motion of an action lies not in science, but in the traditional concepts of qi-energy and the Taiji theory of yin and yang. The methodology of Taijiquan provides a solution path to overcome the training obstacles that arise from the responses of the neural system.

Waist power

The waist is involved in all actions demanding of strength. The power source of athletic and martial prowess—a 400-yard drive in golf, a 95mph fast ball in baseball, an ace serve in tennis, or a knock-out punch-is at the waist. A study in slow motion of the power action of professional athletes shows the mechanics of the waist—the rotation of the upper body at the waist is supported by the lower body turning in the opposite direction, and the posture is balanced between the left and right.[2]

The waist, more precisely, the junction at the hip joints, forms a division that distributes the muscle masses between the upper and lower body in a most even proportion, compared to other joints. Thus turning at the waist accords the most balanced support between the muscles of the upper and lower body. The control at the waist to generate power has long been recognized in Taijiquan, described in several passages of Taijiquan classics as in the phrase, *zhuzai yu yao* □□□□ (control center at the waist).

Explaining the biomechanics of waist power is the easier part. What is difficult is to get the body to synchronize the lineup of the upper and lower muscles to produce the torque action and reaction in mutual support and balance at the waist junction. The neural responses that activate muscles in generating waist power vary widely among individuals. That is why there is such a disparity of waist power output, especially, between the casual and professional athletes. How much can training do to narrow this disparity?

Behavioral responses of muscles

A novice associates a long drive with hitting the ball hard. In swinging the golf club hard, the muscles of the arm and shoulders would inadvertently dominate, causing the arm to jump ahead of the rest of the body in the action. The effect of this would be to deprive the drive of the muscle power of the other parts of the body, particularly, of the legs.

In the anxiety to produce power in the swing, the response of neurobiology is to activate the primary muscles underlying the action first and not attend to the coordination of muscles at the waist to ensure a greater power output. Hence, the very desire of a long drive often elicits a response that frustrates the mechanics of generating optimal waist power. That is why weekend golfers find it elusive to improve their long drives, despite many dollars and sessions spent at golf clinics.

Another example that illustrates the behavioral responses of muscles that undermine the task at hand is that of picking up a box. For convenience, we bend forward to reach for the box, but keep the bad forward-leaning posture as we exert force to lift it, causing many a back sprain. The reflex response is to reinforce the back muscles to keep the leaning posture from falling, not to adjust the posture. We do not think of bending at the knees for a better posture and support to lift the box, which is a better way to apply waist power. We are mostly unaware of the debilitating effects of the poor posture as they occur, until after the fact. In other words, the response of neurobiology and psychology is to activate muscles immediate to the task, driven by behavioral convenience, less to weigh the postural effects on balance.

This dominating behavioral response is actually quite typical of the muscles of the hand. The neuroanatomy of the hands actually provides a basis for this behavior. The map of the motor cortex—the part of the brain that sends signals to activate muscles of voluntary movements—depicts an outsize image of the hand, which represents the disproportionately high distribution of neurons in the motor cortex allocated to the function of the hands (Figure 1).

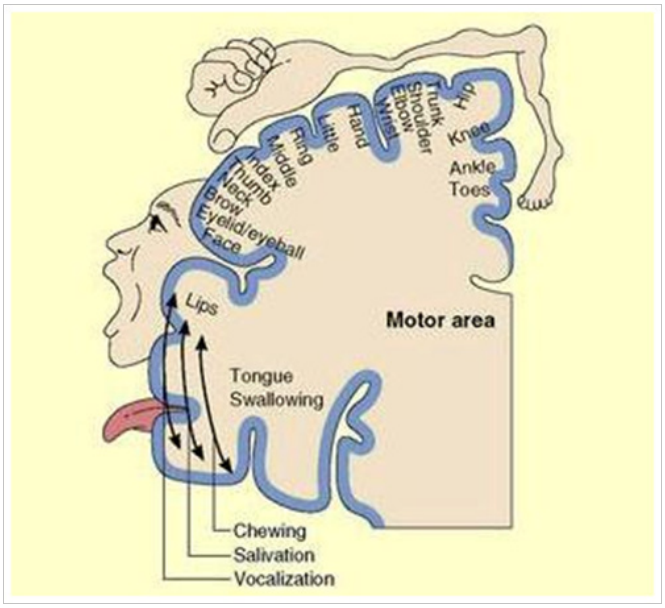

Figure 1 Motor map (motor homunculus) showing the disproportionately large hand representation mapped to the motor area by Dr. Penfield.[3]

The fineness and precision in the control of the hands come from a relatively large number of motor neurons, each innervating a relatively small number of muscle fibers, some in the tens. Anyone, young or old, can learn to use the chopsticks! By contrast, in the big muscles of the arms and thighs, a motor neuron innervates hundreds to thousands of muscle fibers.

This high distribution of neurons to the hands provides not only dexterity and versatility, but influences the hand's impetuousness in our actions. Indeed, our mobility culture is hand-oriented. The hands would always impulsively reach out first, say, to retrieve a cup of coffee, causing many a fried keyboard. The dominant behavior develops a habit of the hands jumping ahead in action. Coupled with the behavioral response of activating muscles immediate to the action, such as to throw a punch, the arm would lunge out ahead of the rest of the body, thus cutting off the waist power. This is the main reason why we find it hard to generate the waist power we need in sports and martial arts. In other words, the exalted hands that give us the arts of our civilization can also be the bane in producing body strength.

The dominant behavior of the hands is a trait of response that poses a great challenge to training in sports and martial arts. How much can we discipline the body to restrain this behavior?

Control of voluntary muscles

The control we have of our voluntary muscles is only of the command of action, not of the muscles directly. We do not decide what muscles are to be recruited, or how much or how fast they should contract. The motor neurons that activate the contractile actions of the many muscles underlying the motion are pre-programed in neural circuits that work under the radar of consciousness, like the operating system of a computer. How does training address this opaqueness of neural signals and the discipline of muscles that we have no direct control of?

The brain processes a lot of sensory input for our bipedal functionality, but it does not always produce the signal outputs with respect to better results in actions. For instance, in the case of picking up the box, the brain does not get feedback of the body's bad posture, but instead sends signals to reinforce muscle actions to keep the poor leaning posture in balance, exacerbating the condition. The body responds by reflex to reinforce muscles as an immediate remedy to keep balance, not by making global postural adjustments.

We are not wired to be cognitive of postural factors. The brain does not have a faculty that integrates sensory input of postures nor of the underlying muscle forces with regard to a better power output. However, we can figure out the ill effects of bad postures and body mechanics indirectly, and learn to incorporate them as part of the sensory input.

Often our control of voluntary muscles fails to account for the behavioral responses that hinder the body mechanics of generating waist power. This muscle behavior is compounded by the opaqueness of the neural signals in producing body motion, and inadvertently, it builds barriers of neurobiology in training of sports and martial arts. Let us review briefly the activation of voluntary muscles in the central nervous system.

Neural signals to voluntary muscles

The information flow between the brain and the body is a two-way traffic, descending and ascending along columns of nerves in the spinal cord. Far more data flow in than out, typically in the ratio of twenty to one. Outflow of command descends from the brain, carried by motor neurons to activate muscles to produce motion, and sensory information collected from the body flow up the spinal cord to the brain. The nerves are organized by the vertebral location where they exit the spinal column: the cervical (neck), thoracic (chest), or lumbar-sacral (lower back) vertebrae. The nerves branch out by this division to serve the different regions of the body.

Muscles powering the hands, arms and upper body are innervated by nerves in the cervical and the first two thoracic vertebrae, and those

powering the feet, legs, and buttocks, by nerves in the lumbar and sacral portions of the spinal cord, and they are distinguished between the left and right. We have volitional control of muscles in the sense that the command signal of the action originates at the conscious part of the brain—the cerebral cortex. A neuron cell in the motor cortex literally traverses down the passage in the spinal cord, where it connects (synapses) with a motor neuron, which then physically exits from one of the vertebrae and wires to the muscle it innervates. In other words, the neural signal that activates a muscle of volitional movements is carried by only two neurons, making up a strand of the neural tract from the cortex descending along the spinal cord directly to the muscle in the cortico-spinal pathway. The simplicity of this link in the neural network is deceptive—behind the signal output is an integration of a complex of signals from other parts of the body and brain to the motor cortex. Moreover, muscles of other parts of the body are also activated in concert to support the single action.

The muscles powering the different segments of the body are activated separately by their motor neurons. Thus the neural wiring of our central nervous system accords independence of movements of the different parts of our body, between the left and the right and the upper and the lower, as well as of the extremities. This independence endows us with the richness and versatility of the art of body motion. But it can also frustrate demanding actions that require muscles to work together—the muscles become stubbornly accustomed to their independence and habits, and so may not work the way we want them to. Indeed, it is often the development of this behavioral stubbornness that is hindering the mechanics of generating body strength.

To throw a punch, the output command is carried by motor neurons of the cervical cord to the arm and fist. The command also incorporates neuronal signals that travel further down the spinal cord to motor neurons of the lumbar-sacral cord to innervate muscles of the lower body to support the punch action. We are conscious of the punching action, but we are usually not aware of the muscles of the lower body supporting the action. Yet the power output of the punch action depends critically on the neural signals to the muscles of the groin and the legs to align in mutual support between the upper and lower body and on the integrity of the bipedal structure in balance.

If we can summon the waist-groin muscles by command so that the rotational motion of the torso is in sync with that of the base in their mutual support and balance, then we can achieve long drives in golf consistently. But there is no faculty in the cerebral cortex that integrates the coordination on the fly. One endowed with a coordinating facility of the waist-groin to control rotational motion, enjoys an ease of movements at the pelvic joints, which gives an advantage in generating waist power. A talented athlete is born with this advantage.

If one is not born with this talent, how can one train to overcome the behavioral stubbornness of the muscles set by habits and independence, to improve on one's golf drive for instance? To see what we are up against, let us review the major muscles that keep the structure of the spine and ribcage erect, particularly, the muscles of the midsection.

The axial muscles that keep the trunk erect

The architecture of the skeletal frame of the torso—the prominent ribcage hanging at the upper part of the vertebral column—does not inspire confidence of a sound structure, even before it is loaded with internal organs. The sacrum at the vertebral end sits precariously on the pelvic bones. At the top, the first vertebra, euphemistically named atlas, holds the skull. Besides the support of vertebral column at the sacrum, there are no other skeletal props between the ribs and the pelvis. What gives functional integrity and stability to the trunk as a flexible, strong and erect structure are the intervertebral ligaments, fascia and muscles as well as the many axial muscles on the front and back.

Two muscle groups that work like straps keep the trunk erect: erectus abdominis (the two columns of "six-pack" muscles) on the front and erector spinae, the muscles along the spine on the back. The six-pack muscles attach at the sternum above, and at the pubic bones below, so that when they contract, the trunk is pulled forward.

The muscles of the second group—the erector spinae—are a collection of three major muscles that run along the spine, bulging as the two noticeable ridges on each side. They attach at the lower end of the spine—the lumbar-sacral vertebrae—and insert at the upper section of the spine—the cervical and thoracic vertebrae. Their contraction pulls the vertebral column back. They work with the erectus abdominis in antagonistic pairs to stabilize the erect structure of the trunk. As each left or right column of the erectus abdominis and erector spinae are innervated independently, the muscles contract in various combinations to give the versatile angular bending as well as the turning motions of the torso.

Three deep muscles secure and stabilize the precarious structure of vertebral column sitting at the base on the pelvis (the sacroiliac joint). One (psoas muscle) attaches at the lumbar vertebrae to the femur thigh bone below the head, and another (iliacus muscle) also attaches to the femur head, but its top part is attached to the pelvic crest (ilium). Together they form the iliopsoas muscles often mentioned in the discussion of lower backache. A third muscle, the quadratus lumborum, lies behind the psoas band; it binds the lumbar vertebrae to the pelvic crest at the back. The principal function of these inner muscles is to secure and stabilize the core support at the lumbar-pelvic seat, thus maintaining its balance and integrity.

There is another group of major muscles that hold, support and protect the internal organs in the belly cavity—the abdominal muscles. These consist of three sheets of muscles-the external abdominal oblique, the internal abdominal oblique, and the transverse abdominis—that wrap around the waist like a corset. They are made up of two halves, one around on each side, and are joined by fascia tissues at the back and front, and are "zipped" on the front in a middle vertical sheath (called linea alba). The muscle sheets attach variously to the lower ribs at the upper part and to the pelvic crest at the lower part, to collectively provide a firm yet flexible support for the abdomen, which is expandable for pregnancies and beer bellies. The individual muscle sheets are innervated independently and provide rotational movements as well as changes of intra-abdominal pressure that facilitates abdominal breathing—and belly dancing.

However, we are not cognitive of these groups of muscles in their function of stabilizing the trunk's erect structure and balance. We can bend forward, backward or at any angle, as well as turn at the waist, but we cannot move the rib bones individually like we do the fingers and toes. The places where these muscles attach are designed more to support bipedal functionality and balance than to produce torque power at the waist. Nevertheless, the output of torque power of the waist depends critically on the alignment and balance of the abdominal muscles, the axial muscles and the prime-mover muscles.

Neural responses in generating waist power

To harness fully the waist power, the torque action of the upper body must be supported by the torque reaction of the lower body. The

muscles of the arms, shoulders, and torso must align to produce the upper body rotation in unison, and likewise, that of the groin and legs of the lower body, turn in the opposite direction. At the same time, the muscles between the left and right sides must also balance in the rotational action. Most crucial of all, the major muscles of the limbs (the appendicular muscles) must work in harmony with the inner axial muscles to maintain the balance and stability of the trunk's erect structure. This also requires that the erectus abdominis, the erector spinae and the iliopsoas must also work in tandem, together with the abdominal muscles to keep the integrity of the waist's turning motion.

However, the command to issue waist power does not always elicit responses of signals that would activate muscles in the mechanics described above to generate the full power that the body is capable of. In the waist-power command, while the prime-mover muscles may be activated voluntarily to produce the rotational motion, the function of maintaining the integrity of the erect structure in balance is involuntary. We are not conscious of a good portion of the neural signals to the axial muscles. In other words, in any action, the responses of neurobiology produce a mix of neural signals, of which large parts go to maintain the integrity of the bipedal structure.

The final output of neural signals that innervate the muscles is a function of a complex of sensory input from the body to the brain, but we have no cognition of the process, let alone conscious control of it. Whatever the mechanism of this function, it is not the design of neurobiology to produce maximal output in power as one wishes. That is why we cannot improve our golf drives at will, despite dedication of practice.

The training to develop waist power is not just a physical exercise to develop muscles and strength. It has to break the habitual responses of muscle behavior, and then to cultivate responses of neurobiology that attend to the alignment and balance of the axial and prime-mover muscles. Taijiquan's approach is to nurture a comprehensive balance, called "inner balance," with which one disciplines the alignment of muscle actions in balance.

Inner balance

The action of picking up a box illustrates a posture of physical balance that suffers from imbalance internally. One bends forward to reach for the box. The reflex response activates the back muscles to reinforce the support of the forward-leaning posture to keep it from falling over. This elevates the level of muscle activations, which burdens the postural structure, and makes it stiff and hard to respond in change, which are symptoms of internal imbalance. We can modify the response to reduce the "excessive" muscle activations in the task by bending at the knees. The adjustment renders a stronger posture with less stress and muscle activations; it provides not only a better balance but also a better leverage to lift the box. The adjusted posture has a better "inner balance" of the muscle actions in the task. More importantly, the body can learn to decipher the stiffness and tightness of the structure as symptoms of inner imbalance of the underlying muscle actions. It is this imbalance that impedes motion flow and the ease of change in movements, which compromises performance output in actions.

Another common situation that illustrates a breach of inner balance is seen in a medical checkup. When you take a deep breath, as asked to by the doctor, the chest is heaved up and the abdomen is hollowed in habitual response. The body becomes top heavy and stiff, and it topples easily with a gentle nudge. The physical balance in terms of the position of the center of gravity relative to posture remains the same, but the inner balance is breached. More muscles have to be activated to brace up the chest. The excess of muscle actions deployed in the top-heavy posture renders the structure weak internally-a symptom of inner imbalance.

More subtle to discern is a breach of inner balance in the vertebral column when turning at the waist, due to the spinal curvatures. The waist rotation introduces an axial torsion, which causes the curved vertebrae to move between the sagittal plane. Our gait is defined by the coupling of the axial torsion and the spinal swaying, a consequence of the curvatures, particularly the lordosis, which is exploited by models, rocking their pelvis side to side rhythmically in the catwalk. While evoking aesthetically sensual appeal, the slight backward lean introduces inner imbalance at the hips. The study of the biomechanics of the axial torsion and the vertebral curvatures of the neck, thorax, lumbar and sacrum, pioneered by Serge Gracovetsky, has spawned the Spinal Engine Theory.[4] As it turns out, the spinal engine drives much of the internal dynamics of Taijiquan, which is a topic of another discussion.

We define *inner balance* as a state where the muscle actions underlying movements and support are neither excessive nor deficient. This balance incorporates the internal dynamics of the muscle actions at the joints and therefore the balance of axial and appendicular muscles in alignment. The comprehensiveness of the balance is underpinned by the ease and liveliness of change of motion at the joints within the structure. The approach presumes that our postural configuration is flawed with inner imbalance. The strategy of training is to reduce the errors of imbalance, moving through states of lesser stress towards inner balance.

Governed by the principle of inner balance, in the execution of any action, the axial and inner muscles are aligned with the prime-mover muscles in balance. Therefore, the output power of the waist-power action is optimal by virtue of inner balance. In other words, body motion inspired by inner balance is ideal; unimpeded by imbalance of muscle actions, the motion is fluid, lively and agile.

Taijiquan, with its roots in martial arts, treats the cultivation of inner balance as paramount. The art may be cast in the esoteric theory of yin and yang, but its slow-motion methodology is pragmatic. By following the course of Taijiquan practice, one nurtures sharpness in awareness that cuts through the barriers of neurobiology, and the body becomes imbued with the principles of yin and yang, which subsumes inner balance.

The taiji theory of yina and yang

The Taiji concepts of yin and yang, being uniquely Chinese, are foreign to Western culture. Taiji philosophy has roots going back to the antiquities of time. The Chinese thinkers of old resorted to Taiji theory to expound everything of man between heaven and earth—it served as a "grand theory of everything." Far from being relegated to history, the theory survives the millennia to the present.

The yin-yang lexicon still appears in common usage in Chinese culture: food, health, medicine, music, calligraphy, art, *fengshui* geomancy, etc. and of course martial arts as in Taijiquan. Taiji philosophy permeates Chinese thinking—the yin-yang duality serves as its organic logic, as mathematical logic is to science.

The theory posits that, at the most fundamental level, the essence of all things manifested is their yin and yang. Taiji is a study of the dynamics of yin and yang as governed by the yin-yang principles. The theory prescribes that yin and yang are not static; in yin there is

yang, and in yang there is yin; though opposite in character, yin and yang are mutually in aid of one another; and the ideal state is Taiji balance, where there is no excess of yin or yang. In application, one identifies the conditions of yin and yang and finds solution-paths in the dynamics that lead to yin-yang balance.[5]

Think of Taijiquan as Taiji theory manifested on the musculoskeletal structure, where yin represents deficient muscle actions, and yang, excessive muscle actions. The practice regulates motion to be in accord with the Taiji principles of yin and yang. Taiji training then becomes a process of developing a solution-path towards Taiji balance by reducing the errors of excessive or deficient yin or yang.

The ideal Taiji motion—one in accord with Taiji yin-yang principles—is of grand Taiji order. The well-regulated motion gives rise to a comprehensive force that can be applied in timely response with precision and optimal strength. The strength is uncharacteristic of physical muscular force—there is hardly any indication of exertion in the execution; it appears hidden, and thus is dubbed "inner strength." This inner strength is at the heart of Taijiquan's amazing kungfu prowess that one hears of. And most enticingly, Taijiquan kungfu mellows with age.

This pronouncement usually evokes an immediate reaction of surprise and disbelief. The unorthodox slow-motion practice cannot be further from the speed and power of sport actions, both absent in Taijiquan. If anything, the exercise is opaque and not geared towards developing any specific power action.

More challenging is that Taiji theory does not offer any tools to analyze yin-yang balance. The organic logic of yin-yang duality does not lend to a reductionist model to study structure and balance as in engineering science. We cannot allocate so many yins here or so many yangs there as in a balance scale, as the theory does not quantify the values of yin and yang. The balancing of yin and yang seems intractable. There are no sense-receptors in the body for yin-yang balance, as manifested by the muscle actions. We sense our balance only after it is lost when we try to recover—we have no cognition of our body's center of gravity. We cannot activate the muscles directly to balance their actions, as we do not communicate with the muscles.

Taijiquan relies on the yin-yang theory to navigate the maze of neural connections by developing the pragmatics of deciphering and resolving the errors of imbalance. It does so not by analysis but operationally, by nurturing responses of neurobiology that incorporate the factors of inner balance with the methodology of fang song.

Methodology of fangsong—relaxation

While there are no neural inputs of inner balance—we cannot sense inner balance—we can learn from the sensory inputs of the effects of imbalance of muscle activations. Taijiquan cultivates the senses to decipher the effects of imbalance, such as top -heaviness and the symptoms of stress and stiffness, and then uses these sensory inputs to elicit responses of neurobiology to correct for the imbalance. For instance, when we sense the flaw of top-heaviness, we can mitigate it by relaxing the chest—letting the upper body "sink" with the breath so to speak. This is described as *hanxiong* □□" containing the chest," which has the opposite effect of bracing up the chest.

Let us examine the muscle actions supporting an arm held out to the side horizontally. You can stretch the arm out, tensing it (rendering it too yang), or you can let it droop (too yin). There is physical balance in both cases—the arm's weight is balanced by muscle forces—but the underlying muscle actions are different in their relative exertion. From this example, we can see that there are multiple combinations of muscle actions supporting a posture in balance. What is a preferred combination of muscle actions in the support?

If you held the arm in position for duration of time, tenseness would set in, indicating that certain muscles were working harder than others. The discomfort would elicit a response by relaxing or letting go to relieve the tenseness in a state of lesser stress. In effect, the relief is brought about by a reset of the muscle actions with less tightness or exertion. These are the rudiments of the mechanism of *fangsong* □□, which means "to let loose, relax."

You can simulate fangsong in the arm with the Taijiquan practice rule of "sinking the shoulder and dropping the elbow" (*chen jian zhui zhou* □□□□). Or you can enlist a friend to hold the tip of a finger of the extended hand, and let the arm drop, so that it suspends like a cable between the shoulder and the held finger. The muscles become relaxed in the reset of the muscle actions holding the arm-the yang-tenseness is reduced, thus improving on the balance.

In the case where the arm is held loosely and droops like a plant that has not been watered—the yin situation—the resolution is trickier. Extending the arm would introduce tenseness. Taijiquan's extending action is described as "stretching the tendons and bones" (*shen jing bagu* □□□□). This "internal" stretching strengthens the arm, and removes the yin-slackness, without adding extraneous yang; it breathes yang-vitality to the laxity and reduces the yin imbalance.

In practice, what fangsong does is to relax whenever there is tenseness, and to stretch internally whenever there is laxity. The practice inculcates the senses of imbalance, and develops the fangsong tool itself to reduce the errors of yin-yang imbalance.

However, fangsong does not reallocate muscle actions to seek balance. The methodology develops the cognition of the errors of yang (effects of excessiveness) and yin (effects of deficiency). The mechanism of fangsong simply resettles the muscles actions to stay in the middle ground between the yang-tenseness and the yin-laxity. The methodology in effect is reducing the errors each time in the fangsong process. It should be noted that the pragmatics of recognizing too much or too little of yin or yang in the relative sense is sufficiently resolvable by the soft logic of yin and yang. In this way, the margin of errors tapers over time, and in the convergence, the body approaches the state of Taiji balance. In other words, one achieves the goal of inner balance by the process of reducing errors, not by seeking it specifically. This exemplifies the quintessence of the Tao of "doing without doing" (*wei wu wei* □□□)—achieving Taiji balance without striving for it.

In essence, the fangsong process is nurturing the responses of neurobiology that attend to the factors of inner balance in muscle actions. This builds the neural circuitries that elicit responses that respect inner balance.

The paramount status of the pelvic joints and *dantian*

The practice task remains, which requires the application of fangsong at the hundreds of joints and bones to resolve the imbalances of muscle actions, clearly a most formidable undertaking. What makes it even more formidable is that resolving imbalance at one joint may affect the muscle actions, thus balance at the other joints. This is because the soft tissues and fascia enveloping all the muscles and bones of the body define a tensile integrity. This means that the process requires a constant feedback of muscle adjustments at multiple joints, an analytical task we are not equipped for. Taijiquan

offers an ingenious solution that resorts to the traditional concepts of *dantian* and *qi*.

Taijiquan simplifies the many joints into subdivisions of three sections and three correspondences, so that fangsong can work through them systematically in refinement. This is discussed more thoroughly under Chen Changxin's *Ten Essential Principles*.[6]

Taijiquan recognizes that of the major joints—hip, knee and ankle of the leg, and shoulder, elbow and wrist of the arm—the hip joints are preeminent. This is driven by bipedal functionality, which relies on the hips as the junction of division between the upper and lower body (discussed earlier in waist power). The Chinese term for the pelvic joints is *kua* □, which refers to the inguinal fold to connote its functionality disposed to forward folding.

The fangsong methodology develops the *kua* as a base of reference to resolve the yin-yang imbalances at the other joints. It begins by applying fangsong to the pelvic joints relative to the midpoint between the kua. This point coincides functionally with the *dantian* □□, a point in the abdomen described as three fingers below the navel, and about one-third the way inside. Keeping the pelvis level in fangsong induces the axial torsion and the spinal sway to integrate with the vertebral curvatures with lesser stress. This develops the dantian and the kua as the foundational base of reference to assess the other joints systematically in the subdivisions.

The fangsong of the shoulder-kua correspondence penetrates the vertebral imbalances and cultivates the integrity of the torso motion. Extending the fangsong to the elbow-knee, and then to the hand-foot correspondence, covers the body-frame, which can be refined by further subdivisions. The continual fangsong tempering of muscle actions relative to the kua and dantian builds a connectivity of motion centered at the dantian.

More crucially, the constant reference to the kua and dantian serves to centralize the fangsong feedback of the other joints. By virtue of this centralization, the fangsong is operationally working to coordinate the readjustments at the multiple joints each time. In time, the practice culminates in establishing the dantian as the control center of body motion, which signifies the mastery of the art. The maturing of the centrality of the dantian is referred to in the Taijiquan literature as:

□□□□□□ *Yi dantian wei hexin*

Establishing the central status of the dantian

The principle of dantian centrality not only imbues the body with comprehensive balance, but also provides a motion-connectivity of the different parts of the body to the dantian, thus a deeper perceptivity of motion. Dantian centrality harmonizes the muscles of the abdomen and the axial muscles to consolidate the integrity of the trunk's erect structure in balance. Thus dantian centrality facilitates the finer discipline of the torque action and reaction at the kua junction in generating waist power. The other half of the story of Taijiquan's ingenious solution is qi energy.

The medium of qi energy

The fangsong methodology cultivates a sensory input of energy flow that complements the physical tempering of the body—it taps on the so-called life-force *qi* energy. The concept of *qi* □ circulating a system of passageways or meridians in the body is fundamental in Traditional Chinese Medicine. However, qi has eluded science, but the body relates to qi readily in practice. Indeed, the age-old Chinese system of medicine has yet to be reconciled with physiology.

We take qi as given in Traditional Chinese Medicine but we develop it as guided by its function as an agent of fangsong to discipline body motion. This renders a representation of qi that ties it to the mechanism of fangsong and a comprehension of qi in terms of muscle activations and kinetics.

We treat qi as a bio -energy and study its association with motion. We can think of the body's sensation of qi as a composite of senses picked up by receptors in the joints, ligaments, tendons and muscles, such as of proprioception, pressure and touch. We approach qi developmentally, as the body cultivates its sensation rather than defining it. So in Taijiquan or *qigong* □□ (any exercise of qi energetics), qi can be viewed as a developed sensation of bio-energy.

At the beginning, the fangsong mechanism relies primarily on the senses of yang-tenseness or yin-laxity of muscle actions. Upon sensing tenseness, the practitioner relaxes to reduce excessive muscle actions; and upon sensing slackness, he stretches internally to reinforce deficient muscle actions. As the fangsong reduces the errors of tenseness and laxity, the body registers an easier flow of motion, as current with less resistance, and with it a sensation of energy flow, which is attributed to qi. The rudiments of qi energy usually manifest as a warm or tingling sensation in the hands. In the early phase of practice, the sensation of qi is intermittent but gradually firms up over time—the more the errors of imbalance are reduced, the stronger the sensation of qi. This builds an association of fangsong and qi. In other words, the perception of qi is developed from the many sensory inputs in the process of fangsong.

The deliberative and slow-motion modus operandi induces attentiveness and nurtures a calm state of mind that heightens awareness, which develops perceptiveness. In time, with fangsong reducing more and more of the errors of yin-yang imbalance, the sensation of qi gains more strength and clarity, and at the same time, one also develops deeper perceptiveness. Then when the qi development reaches a certain maturity, the practice elevates to the internal phase: The body resorts to the qi medium to discern and resolve the errors of imbalance.

Qi and inner balance

As the practice advances, the effects of imbalance become more subtle, requiring sharper fangsong tools to discern and to resolve. So failing to develop sufficiently perceptive tools, the practice can be stymied. However, the Taiji methodology has a meditative component that, combined with the developed qi, maintains and sharpens continually the fangsong tools.

At the higher levels of practice, imbalance delves in the deeper vestiges of muscle activations. Fangsong requires keener perceptiveness to penetrate and resolve the imbalance at the deep muscles that secure and stabilize the joints and bones and the vertebrae, particularly at the lumbar-sacral region. This inner fangsong probe relies on qi to discipline the deep muscles to align with the prime-mover muscles in balance in their support and actions.

Through the continual use of qi in fangsong, the sensation of qi flow becomes infused with motion flow. In the fusion of qi and motion, one learns to direct motion through qi. With this development, the practitioner realizes the *yi-qi-motion* paradigm (*yi dao, qi dao, qi dao, shen dong* □□□□,□□□□): The mind *yi* □ (mind-intent) commands and initiates qi; qi arrives, and activates motion. With this paradigm, the elusive task of disciplining the muscle actions underlying motion is functionally reduced to a manipulation of qi as directed by the mind-intent. This advancement in practice is also described as "qi breaking through" (*qi da tong* □□□).

Even as the practice of Taijiquan moves into the internal phase and the fangsong process grows more and more into one of qi energetics that entails meditation, it remains driven by the rationale of reducing imbalance towards Taiji balance. Grounding qi in inner balance builds a qi-based comprehension of the principle of dantian centrality—the motion-qi connectivity centered at the dantian.

In practice, the qi nurtured by the fansong tempering at the kua collects in the pelvic bowl. The constant reference to the kua and dantian induces a buildup of qi that concentrates in the dantian, referred to as *dantian qi*. The maturing of full dantian qi accords the discipline of the deep muscles of the trunk and the pelvic girdle at the kua-groin region, so that they harmonize with the prime-mover and appendicular muscles in the integrity of support and balance.

From this perspective, the cultivation of inner balance is the development of the fullness of dantian qi (*dantian qi baoman* □□ □□□), which culminates in the formation of the central status of the dantian. This consolidates the body-wide motion-qi connectivity centered at the dantian. The development also represents the actualization of the yi-qi-motion paradigm— dantian qi becomes vested with the authority to direct motion, under the command of the mind yi. The investiture of the central status of the dantian signifies the mastery of the art, which can only be earned through the kungfu process of time and effort of *chiku* "eating bitterness."

From the perspective of health, the imbalance of the deep muscles is a deeper source of stress. The affliction of chronic pain due to this kind of stress is more tricky to alleviate—it cannot be reached by simple physical therapy or heat-plasters. The more deeply rooted cause of stress requires acupressure to penetrate into the deeper layers of muscles. That is why Taijiquan and some qi energetics exercises, as well yoga, have proven to be efficacious as a health therapy for chronic stress.

Inner strength—*neijin* □□

How does inner balance translate to the "inner strength" that underpins the kungfu prowess of Taijiquan, where the weaker can overcome the stronger, or the slower the faster? Does it deliver a long drive in golf? Is it different from the force of a knock-out punch? More to the point, what is the force generated by a Taiji body?

The body produces two kinds of force. The first is the force of the contractile actions of muscles, which generates motion. The second is the force created when body motion is blocked or resisted. The force of a punch that inflicts damage to the nose is the force generated when the face stands in the way of the punch—a consequence of the collision between the head and the fist; the muscles only produce the motion of the punch. While bigger muscles produce greater contractile force, muscle bulk alone does not determine the outcome of the punch.

How strong a punch is also depends on what is hit. A karate chop that breaks a brick does not produce the same force when it strikes a pillow. Force is created in the collision impact between the fist and the target—a result of a change in motion, more specifically, a change in momentum. The force that arises from a change in momentum is just an observation of Newton's Second Law of Motion.

Average Force = Change in momentum/Time duration of the change.

Therefore, to produce force, the issue should be about regulating body motion to involve the different parts of the body to move in unison to generate more momentum, not just about building muscle bulk. The more unified the body mass is in motion, the greater the momentum, thus the greater the force when called upon in use. Also, the less the body is under the stress of muscle imbalance, the more the body can maneuver at ease. These two factors are embodied in motion that is regulated by inner balance.

Taijiquan's training of tempering the body (and mind) is all about regulating body motion to comply with the Taiji principles of yin and yang, which leads to the establishment of the central status of the dantian. Imbued with this principle, the Taiji body responds with inner balance intact, and its different parts move in unison as directed by dantian qi. The force that arises from the change of the ideal Taiji motion (momentum) results in the consummate force of inner strength or *neijin* □□. The force delivered is consummate because with inner balance, the axial and appendicular muscles are aligned in balance.

The term *neijin* □□ is often referred to simply as *jin* □, dropping the qualification of *nei* □ (inner), which merely points to the non-physical characteristics of jin. Neijin is defined by its dual character—the "softness" (*rou* □) of yin and the "hardness" (*gang* □) of yang. This gives us *rou jin* and *gang jin*, which manifest the yin and the yang of jin. The key feature of jin is the ease of change between its *rou* and *gang* in application.

The concept of *neijin* seems more metaphysics than physics, but the body relates to the *rou* and *gang* readily. The brain's output signal to the muscles is not data of a force vector. In application, the body responds in *rou* and *gang* to produce the direction and magnitude of the force needed. For example, in moving heavy furniture, we play to find its center of gravity by a feedback of trial and error, and adjust our body posture to use leverage to move the object along. The body uses *rou* to adjust the right posture (direction) for leverage, and *gang* to unify body mass in exerting force (magnitude), which translates to the appropriate force vector needed. In this way, the body responds in the right combination of *rou jin* and *gang jin* to the load and maneuverability of the object.

The physics of the prowess of neijin

The phenomenon of martial prowess ascribed to neijin seems to defy the laws of physics. Often depicted is an elderly Taiji expert, whose physique is distinguished only by its ordinariness, thus least to be associated with physical prowess. Yet with neijin, he disposes of a bunch of hooligans descending upon him with ease and seemingly little effort. However, much of the feat's wonderment appears only to be so, being set against an expectation that visible strength and speed should triumph.

The fist of a punch may be fast, but the parts of the body closer to the trunk move at much slower speed. One can catch and block the punch with lesser speed by intercepting it at the upper arm. At close range, the fist that relies on the extension of the arm, loses its advantage of speed.

The Taiji body—one infused with the yin-yang principles—responds in *gang jin* (the hard mode of neijin) when the need arises to project force, by dantian qi which aligns muscle mass in generating the motion. The *gang* response unifies more body mass in motion, producing greater momentum and thus greater force in confrontation. In the *rou* (soft) mode, the body responds with fluid agility by undergoing change within the body frame at the joints, but continuing to maintain inner balance. That is, the *rou-gang* interchange enlivens the body to respond accordingly to the changing situation in combat while inner balance—control—remains intact.

Very often, in a tussle, one pushes back hard against the opponent as a natural reaction, believing that doing so would save one from

being pushed over. Also, the body, being predisposed to linear motion, responds in action along the same direction. The outcome in the confrontation would then be predictable-the stronger person would prevail. Fighting back traps one in a locked-horn position and, under pressure, the body cannot maneuver.

Taijiquan offers a "yielding" game plan. Instead of fighting back, force with force, the body's inner balance responds by settling into the kua, thus directing the opponent's force to the ground. This is effected by the response of *rou jin*—the soft *jin* receives and absorbs the push by adjusting internally at the joints to stay firmly balanced without resisting. Then, with control accorded by dantian centrality, he can at will turn at the waist to redirect the push to the side, causing the opponent to falter. In this way, the opponent's force is "guided into emptiness" (*yin jin luo kong* □□□□). It should be noted that there must be sufficient *gang* (hard) force of neijin to support the soft maneuver or else one would have been shoved off before the skill could come into play.

Upon sensing the opponent's loss of balance, the Taiji expert immediately follows through with a short burst of hard (*gang*) *jin* to propel him off. Aided by his own faltering momentum, the opponent is cast off impressively, several meters with ease. This is the skill of "borrowing the opponent's force against himself" (*jie li lai da ren* □□ □□□). The effectiveness of these techniques is predicated on the Taiji player's development of neijin, which is the basis of the liveliness in the interchange between the *rou* and *gang* that manifests in the changing force vector needed in the response.

The oft touted Taijiquan skill of "four ounces repelling a thousand pounds" (*si liang bo qian jin* □□□□□) points to some tremendous leverage that can be tapped to one's advantage. In order for a small effort of four ounces to move a thousand pounds placed at six inches from the fulcrum, the lever would have to be over an unmanageable length of 2000feet! Clearly, it would be impossible for the musculoskeletal structure to effect a linear lever system of such an advantage.

Taijiquan gains its remarkable advantage by simulating the leverage of a screwdriver. That is the advantage of controlling the handle of the screwdriver against the opponent holding the tip. The body turning at the waist-*kua* acts as the handle turning a screwdriver. For instance, if the arm is seized in a grip, the kua turns as the handle of a screwdriver, against the part of the arm held by the opponent as the tip. With the overwhelming advantage of screwing leverage, no matter how big or strong the opponent is, the grip is broken. Thus, with seemingly a little force of "four ounces," one overcomes "a thousand pounds."

The physics is the easy part. The hard part is to get the body to emulate the action of a screwdriver to affect the leverage in application. The skill flows from the dantian as the control center accorded by the formation of dantian's central status, which disciplines the body's rotational motion. Taijiquan's training of regulating motion by the yin and yang principles also incorporates the discipline of the rotational movements of body segments, described as "silk-reeling training" (*chansi gong* □□□). The rotational mode is implicit in body motion, but in the Chen Style Taijiquan, the discipline of the coiling *chansi* component is explicit. More of *chansi gong* can be found in the author's book.[7]

The mechanics of generating waist power in sports and Taijiquan are the same in the torque action-reaction at the waist junction, but the defining difference is inner balance. In Taijiquan, the waist power or *dang-yao jin* □□□ is inspired by inner balance. The force of Taiji, powered by neijin with the ease of change between *rou* and *gang*, is lively and agile, and responds spontaneously to changing combat situations. In sports, the action is motivated by outcome—how fast, far, or high—which can come at the expense of control in an overextension of muscle actions, resulting in injury. The tennis player might be able to retrieve a ball, but in the overstretch, he might not be able to recover in time for the next volley.

Reflex response of inner balance

The actions of a Taiji body are cultured in the principle of inner balance. Taijiquan's defining feature is that inner balance is kept intact at all times—the fruit of the formation of the central status of the dantian. With dantian centrality, the Taijiquan expert responds spontaneously with a combination of *rou* and *gang* of neijin, which can vary to produce an appropriate force vector to counter an offense or defense at hand. Guarded by inner balance, the expert is kept from being disadvantaged as he maneuvers in his response to the myriad changes in combat.

Inner balance is a crucial factor in all bipedal balance and functionality, not just in combat. Inner balance extends significantly the parameters within which the body can self-adjust to keep balance. For instance, when accidentally stepping on a banana peel, in the reflex to recover, the body, infused with dantian centrality, responds with the factors of inner balance, by settling into the kua to keep balance, thus mitigating a fall that is often catastrophic in old age.

The deliberative slow-motion training that painstakingly conditions responses to incorporate inner balance, also cultivates mindful awareness of the fangsong resolution, which refines perceptiveness. The penetrative perceptivity cuts through the thicket of the multitudes of underlying muscle actions via the qi medium. The practice of mindful fangsong is consciously volitional and relies primarily on the pyramidal pathway to carry the neural signals, but the development of dantian centrality occurs in the restfulness of meditative insight—of the extra pyramidal pathway. That is, while the Taiji body is developed consciously (activated through the cortico-spinal tract), the response of inner balance in usage is by reflex. This represents a disciplinary crossover between the pyramidal and extra pyramidal pathways that consolidates the strategies to keep inner balance. In this way, the Taiji expert is not burdened with inner balance, just as one is not concerned with balance in normal routine activities. With inner balance intact, the expert is thus free to dispose of his opponents with martial maneuvers at will. It is no wonder that kungfu peers have long regarded Taijiquan's martial skills as of the highest order.

The reflex response of inner balance renders the Taiji expert stable and unmovable as a mountain, since his balance remains solidly intact. This is dramatically demonstrated by Grandmaster Chen Xiaowang who stayed unmovable by Longwu, a two-time Asian strongman champion. The strongman, hailed an Asian Hercules, could move an eighteen-wheeler truck and nudge a car into a tight parallel parking spot between two cars, but he failed to move the older and smaller master an inch, in an open challenge of three one-minute rounds. The master merely stood there, attending to his dantian centrality to keep inner balance without fighting back, as the strongman pushed and shoved at him with all his Herculean strength to no effect.[8]

This is the fruit of the process of time and effort in practice—which is what the term, kungfu (*gongfu* □□) means. To conclude, a Taijiquan master is trained not born. Indeed, one often reads in the biographies of Taijiquan masters that many were once sickly, and were prescribed the Taiji exercise therapy to nurture their health and constitution.

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Biography

C.P.Ong is the author of the newly released book, *Taijiquan: Cultivating Inner Strength (Neijin)*. He is a 20th generation lineage successor of the Chen Family Taijiquan as a disciple of both Grandmasters Chen Zhenglei and Chen Xiaowang. He is also privileged to receive extensive instructions and guidance from Grandmaster Zhu Tiancai. He first began his Taijiquan studies in 1972, learning the Guang Ping Yang Style from Master Y.C. Chiang in Berkeley, CA. He is also a student of vipassana (insight) meditation and had attended several intensive meditation retreats in Buddhist monasteries in Yangon, Myanmar. He received his Ph.D. in Mathematics from University of California. Berkeley in 1973.

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