A SCIENTIFIC INVESTIGATION INTO POSTURE TRAINING IN THE CHINESE INTERNAL MARTIAL ARTS: A MASTER'S THESIS

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MASTER OF ARTS in Martial Arts

by

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Abstract

The Chinese internal martial arts of Tai Chi Chuan, Hsing Yi Chuan and Pa Kua Chang are sister arts philosophically built upon Taoist foundations. They have been practiced in mainland China for hundreds of years, building a reputation as superb health practices and self-defence methods.

Although the physical approaches to self-defence and expression of power differ, all three arts devote a major part of training on solo posture work, both static and dynamic, where different postures are performed in a slow, flowing and meditative manner. Furthermore, all three martial arts lay their foundations on the same basic principles of standing, which can then be applied into literally hundreds of shapes or postures making up the backbone of a particular martial art.

This thesis sought to investigate scientifically each dissected pillar on which the basic internal martial art posture is based, in order to explore deeply and understand better the potential utility of these internal martial arts. Scientific studies dealing with human anatomy in the standing position, psychology of posture, breathing, meditative movement and mindfulness, relaxation and the energetic biofield, were searched and evaluated for their relevance to posture in the internal martial arts.

The results from the analyzed data reveal a surprising alignment of the principles of posture training in the Chinese internal arts to emerging scientific discoveries on health and human potential. This has profound implications for modern society's evidence-based health practices, whether preventive, palliative or even curative.

An advantage of the Chinese internal martial arts is that they can be readily practiced in a small floor area, without the need for equipment, and whenever one can spare even a few minutes in private. In today's hectic lifestyle, such a practice

can yield profound health rewards, both physically and psychologically. Other implications are the contribution of these arts to the further development of human potential and sports science, especially in psychology, myofascial biomechanics and biofield energetics, a new and exciting field of study.

Acknowledgements

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Last but not least, a big thank you to Mario Borg of Malta, a great practitioner of the internal. He is the direct student of Manfred Rottmann, inner door disciple of the legendary internal arts master Wang Shu Jin. He introduced me to, and keeps sustaining me in this wonderful journey in the Chinese internal martial arts. I consider myself truly lucky to have him as my teacher.

Dedication

I dedicate this work to my two boys, Yan and Gregory, whom I love so much.

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Introduction

The Chinese martial arts of Tai Chi Chuan, Hsing Yi Chuan and Pa Kua Chang were first grouped together as 'internal' arts in the literary work by the famous master and author Sun Lu Tang in the early twentieth century. They are primarily Taoist methods of self-defence, health preservation and spiritual cultivation, with an emphasis on energy cultivation or '*chi gung'* also written as '*qigong*'. Taoist theories of meditation and energy cultivation are regarded by many as the main source from which the hundreds of *qigong* methods extant today developed (Frantzis, 1998).

Recently many scientific studies on the positive health benefits of Tai Chi and qigong have been published, leading to increased attention on, and spread and popularity of these arts outside China. Virtually no studies have been done on Hsing Yi and Pa Kua so far.

Although the outer movements of the three martial arts appear to be different, all these arts have at their core the solo meditative practice of postures while standing still or moving slowly and mindfully, seeking maximum relaxation, slow quiet breathing, an erect spine and varying degrees of bent knees and particular ways of internal alignments of the myofascial system of the limbs and torso.

A major emphasis on feeling the inner body sensations of '*chi'* or internal energy during posture training makes the practitioner more and more open and experienced to benefits and new possibilities that allegedly result from such training (Smith, 2003).

This thesis seeks to investigate the multidimensional factors involved in the essence and foundation of the three Chinese internal martial arts; the static and dynamic standing posture training.

The Secrets of Standing Still

Zhan zhuang, or post standing, is a method of standing meditation found in all three martial arts that is still relatively unknown to the general public. It gained recognition as a powerful *chi* cultivation method through the efforts of the famous Hsing Yi master Wang Hsiang Chai, who designed this ancient practice around his new creation, Yi Chuan or Da Cheng Chuan in the mid- twentieth century (Yongnian, 2015).

A major part of training in this powerful offshoot of Hsing Yi is simply standing still like a tree, relaxing and feeling one's internal energy circulating within oneself as well as without i.e. merging with the energy of the earth and the sky. It is claimed that such an unorthodox training has multiple benefits in internal power and health (Chuen, 1991). Zhan Zhuang has even been used successfully in some hospitals in China through the efforts of Wang Hsiang Chai and continued by Professor Yu Yongnian (Yongnian, 2015).

Orthodox Hsing Yi Chuan makes use of its trademark 'santi' posture held for extended periods as a power building technique and the backbone of all other forms of the art (Frantzis, 1998).

Indeed, the prominent Western author Robert Smith wrote how the famous Tai Chi master Yang Cheng Fu used to practice by simply holding the 'Single Whip' and 'Play the Guitar' postures for extended periods of time in his later years (Smith, 1990). Practicing the various postures of the Tai Chi form separately as standing meditation and only later linking them in the signature slow flowing manner has been described as a Tai Chi Chuan internal secret by another authority (Fai-Wong & Hallander, 1991).

Famous internal martial arts master Wang Shu Jin also described Zhan Zhuang as an essential building block of internal martial arts training in his writings (trans. by Howard & Hsiao-Yen, 2009).

Recently, the real utility of standing posture training, and even the three martial arts as complete systems, has been described as primarily an ingenious method of energy/chi cultivation and development, even more than for self-defence or health benefits (Meredith, 2014). Once the feeling of energy is experienced as tangible and real in a static posture, the practitioner begins the dynamic practice of relaxed but well-aligned, slow sequences of postures pertinent to the three arts, while seeking to maintain the energetic sensations (Meredith, 2014).

The hints about the great importance of posture or stance work in the internal martial arts appear to be hidden in plain sight. 'Tanren', or repetitive slow drilling of one or two movements, is highly regarded as a method of power building (Rottmann, 2001). Famous masters of Pa Kua attributed their great power from endless hours of circle walking while only doing the single palm change (Frantzis, 1998).

The backbone of Hsing Yi Chuan is the static practice of 'santi' posture and the Five Element fists, which are five simple techniques on which the whole art is built. This minimalist approach was emphasized by Wang Hsiang Chai, the creator of Yi Chuan, who based his art on various standing postures and short drills trained repetitively, besides two man sparring and free fighting (Frantzis, 1998).

Literary contributions in English made to the internal martial arts

After the introduction of Tai Chi and later the other two internal arts, to the West in the 1960s, these arts gradually spread throughout America and Europe. A pioneer of Tai Chi Chuan was the famous master Cheng Man Ching, whose literary works translated in English helped throw light on the theoretical and philosophical basis as well as practical pointers on the internal.

His protégé, Robert W. Smith was also a prolific author who helped disseminate knowledge of these Chinese martial arts. Other highly skilled Western and Chinese practitioners who authored books and articles on this subject followed suit; Bruce K. Frantzis, Manfred Rottmann, Ellis Amdur, Yang Jwing-Ming, Peter Ralston, Mantak Chia, Scott Meredith, Serge Augier and Jonathan Bluestein among others.

Their collective contributions helped throw light on the Chinese internal martial arts with their trademark Taoist theories and culture and make them more understandable to the Western mind. Pertinent to the subject of *'chi'* and the philosophical basis of these martial arts, there have been classical writings by other Chinese masters and historians, some of which have been translated into English. Frequently their material has been described as 'archaic' and vague, however this may be the fruit of sincere attempts by experienced practitioners to communicate their pearls of knowledge of material that is so alien to common people as to make the task very difficult.

The language that does justice to the energy work and physiology of the internal arts may have been non-existent. Even in the modern age, this has proven to be tough, and the best language to do so may be modern science. Yet again, it has been pointed out that once a modern practitioner becomes personally experienced with the energy work, the classical writings of the old masters may prove to be very accurate and suddenly make a lot of sense (Meredith, 2018).

'Chi' has been described using various terminologies, like 'bioelectricity' (Chia & Li, 1996), 'internal energy', 'internal power' or 'subtle life force' (Frantzis, 1998) and 'feeling awareness' (Ralston, 1989). The physical medium through which this 'life force' flows as held by internal martial art theory has been targeted as the connective tissues or fascia which generates bioelectricity during motion (Chia & Li, 1996).

The importance of the myofascial chains and trains that permeate the human body in the transfer of forces within the martial context has been described by Bluestein (2014). A detailed exposition of the inner mechanics used by Chinese internal arts in power generation has been described (Rottmann, 2001).

In an excellent article Ellis Amdur sought to highlight the neuroplastic changes brought about by ‘standing still’ or repetitive drills called ‘tanren’, thus revealing a possible mechanism that makes this type of training so effective (Amdur, 2015). The usefulness of relaxing, opening the joints, aligning to gravity, calming the spirit and mental visualization of the ‘feeling awareness’, in correct internal training has been explained in Western terminology (Ralston, 1989).

This work seeks to study and dissect the essential components inherent in posture training common to all three main internal arts, and investigate them separately by searching for and studying scientific papers done on each component. This scientific investigation would hopefully shed new insight and knowledge relevant to the subject. This evidence-based material derived from an ancient Chinese system should have great potential and utility for modern man.

Methods

The Components of an internal martial art posture

Internal master Kuo Feng-Chih was very clear in his advice to his student Robert W.Smith (Smith, 2003). He explained that in training all the three arts require relaxation, slowness and evenness in action and breathing. Mind is paramount, while the 'chi' should be felt to permeate the whole body so that one is gradually remade and forged into naturalness (Smith, 2003). All three martial arts emphasize an internal spiraling or coiling involving the whole body subtly or more obviously, while 'cross linking' between all parts of the body ensures that any motion occurs with the whole body moving as one coordinated unit (Rottmann, 2001).

The spine is made flexible and strong, without any leaning but kept erect with the head held up as if suspended by a string. Breathing should be from the nose, natural and abdominal, while the knees are always bent to varying degrees while keeping the lumbar and cervical curvatures of the spine reduced. The tip of the tongue touches the hard palate and the chest is kept relaxed and down, not puffed up (Smith, 2003).

In accordance with the above guidelines, a preliminary search from Google Scholar, ResearchGate, PubMed, Medline, SportDiscus and Proquest were made using such words and phrases as Tai Chi/Tai Ji, Hsing Yi/Hsing I, Pa Kua/Ba Gua, Chi Kung/Qigong, 'chi'/'qi', life force, bioenergy, biolectricity, posture, scientific approach/studies/ research, on internal martial arts, meditation, stance work, breathing, standing meditation, anatomy and fascia.

It was soon evident that there are hundreds of scientific studies on Tai Chi and Qigong health benefits, but a paucity of material on the other two martial arts. Also the subject of 'chi' is still not well-addressed in the scientific journals, as opposed to the recently coined term 'biofield'.

Sieving through hundreds of other scientific works over a span of eight months while keeping the subject of internal martial arts posture training in mind, it became clear that the most productive and relevant searches needed to be for the following:

* Breathing

* Meditative movement and mindfulness

* Anatomy of the spine, musculoskeletal system, fascia and the upright posture in humans. This component was further branched into the neck, knee and ankle biomechanics, and stretching and joint movement range

* The psychological effects of posture

* Relaxation and physical performance

* The Biofield

Thus were formed the dissected components for the scientific investigation and research into posture training:

Internal martial art posture					
breathing	meditation / mindfulness	anatomy: fascia spine musculo-skeletal system	psychology	relaxation and performance	biofield

table 1

Finally another search from the aforementioned databases was carried out using the above listed phrases, and the resulting literature was again examined for its relevance to the subject. The papers that were deemed within context were grouped according to one of the six component subject titles. Preference was given to the most recent ones i.e.from the last 8 years up to May, 2018, however a few older ones were retained when deemed valid and useful.

Results

In total 85 scientific papers were selected and studied for their relevance to posture training in Chinese internal martial arts. These are organized in tabular form for ease of reference when analyzing the results.

Breathing
Caldwell, C. & Victoria, H.K. (2011). Breathwork in Body Psychotherapy: Towards a more Unified Theory and Practice. *Body, Movement and Dance in Psychotherapy, 2011, 1-13.* Retrieved from doi: 10.1080/17432979.2011.574505
Fokkema, D.S. (1999). The psychobiology of strained breathing and its cardiovascular implications: A functional system review. *Psychophysiology*, 36(2), 164-175.
Jefferson, Y. (2010). Mouth Breathing: Adverse Effects on Facial Growth, health, academics and behavior. *General Dentistry*. January/February 2010, 18-25.
Kuchera, M. & Kuchera, W. (1997). General postural considerations. In R. Ward (Ed.), *Foundations for osteopathic medicine.* Baltimore, MD: Williams & Wilkins.
Lundberg, J.O. (2008). Nitric Oxide and the Paranasal Sinuses. *The Anatomical Record*, Nov: 291(11): 1479-84.
Mattsson, B. & Mattsson, M. (2002). The concept of 'psychosomatic' in general practice reflections on body language and a tentative model for understanding. *Scandinavian Journal of Primary Health Care*, 20(3), 135-138.
Pelka, M., Kolling, S., Ferrauti, A., Meyer, T., Pfeiffer, M. & Kellmann, M. (2017). Acute effects of psychological relaxation techniques between two physical tasks. *Journal of Sports Sciences* Vol 35 2017- Issue 3. Retrieved from https://doi.org/10.1080/02640414.2016.1161208
Ruth, A. (2015). The Health Benefits of Nose Breathing. *Nursing in General Practice.* Retrieved from http://hdl.handle.net/10147/559021

Zhang, Z., Wang, B., Wu, H. et al (2017). Effects of slow and regular breathing exercise on cardiopulmonary coupling and blood pressure. *Med Biol Eng Comput* 2017; 55: 327-341

Table 2

Breathing

Recent research suggests that nose breathing is very beneficial for health. It has been estimated that about one third of people do not breathe correctly enough to sustain optimal health. Although breathing is a natural vital function, stress, a sedentary lifestyle, eating processed foods and excessive talking can lead to incorrect breathing habits (Ruth, 2015). Typically these habits lead to over breathing, such as mouth breathing, shallow upper chest breathing, sighing and noisy breaths.

Jefferson (2010) outlined potential side effects of chronic mouth breathing, which are poor facial and jaw growth in children, dryness in the mouth leading to increased risk of tooth decay, gum and throat infections, and increased risk of exercise-induced asthma.

This is because without the nasal passages to filter, warm and humidify the inhaled air, cold and dry air entering the trachea and bronchi (windpipe) causes thick mucus to be secreted. This slows the cleaning action of the cilia in the windpipe and also reduces the passage of oxygen into the capillaries surrounding the alveoli where active exchange of gases occurs in the lungs.

Nose breathing forces inhaled air to flow around shelf like structures situated inside the nose called turbinates, and into and out of various hollow cavities called sinuses, before entering the windpipe and the lungs. This increases resistance to an inhaled breath by about 50% compared to mouth breathing, helping to maintain elasticity of the lungs and proper function of the diaphragm (Ruth, 2015). Also, nose breathing allows the tongue to stay in the ideal position

touching the upper anterior hard palate, at rest, helping the proper development of the dental arches and jaws.

Furthermore, nose breathing allows nitric oxide gas produced in the nose and nasal sinuses to be inhaled along with incoming air. Nitric oxide is a strong bronchodilator (opens the diameter of the bronchi and bronchioles) and vasodilator (makes arterial blood vessels widen in diameter so blood can flow faster). This action helps lower blood pressure and increases the lungs' capacity to absorb oxygen (Lundberg, 2008).

Breathing through the nostrils with a closed mouth prevents hyperventilation because it results in a slower breath (Fried's work cited in Caldwell & Victoria, 2011).

Another consequence of over breathing such as mouth breathing, is that too much carbon dioxide is lost from the lungs. Although carbon dioxide is a waste product, it is also important to maintain the blood ph and is a catalyst for the release of oxygen from the haemoglobin in red blood cells. So when the carbon dioxide partial pressure in the blood falls, the bond between oxygen and haemoglobin is strengthened, resulting in less vital oxygen being released to the cells in tissues and organs around the body (Ruth, 2015). In fact, in nose breathing 10-20% more oxygen uptake occurs compared to mouth breathing.

In modern body psychotherapy the clinical intervention to help patients become aware of correct, diaphragmatic breathing is proven to be useful. This is because dysfunctional breathing patterns are regarded as a cause as well as a result of dysfunctional physical and psychological states. When breathing is disordered, anxiety and panic states are prone to happen, affecting cognition like decision-making (Caldwell & Victoria, 2011).

Posture has been cited as an important factor in correct breathing patterns. The ideal posture includes normal foot arches, vertical alignment of the ankles and a

horizontal sacral base, so that the centre of gravity is naturally situated around the lower abdomen (Kuchera & Kuchera, 1997). Correct breathing is seen as starting from the belly on the inhale, with the action of the diaphragm.

The slow deep inhalation results in a three dimensional expansion wave involving the length, side to side and back to front dimensions of the torso. Exhalation simply needs a gentle relaxation of the diaphragm, with minimal work done by small postural spinal muscles to maintain the vertical posture (Caldwell & Victoria, 2011).

Tension during breathing, especially in the throat and larynx, but also in the ribcage muscles, results in strained breathing. This leads to a reduced airflow and can negatively affect the immune and cardiovascular systems as well as be a cause of sleep apnoea (Fokkema, 1999).

Mattsson & Mattsson asserted that correct diaphragmatic breathing massages the internal organs promoting health, while releasing endorphins, the painkilling and happiness inducing chemicals produced by the brain, into the bloodstream (2002). Gilbert's work revealed that smooth and balanced breathing helps focused attention and good decision making (cited in Caldwell & Victoria, 2011).

The capacity of breathing to affect both the physical and the psychological may be because it is a vital function that can be both voluntarily controlled but also an involuntary activity. The diaphragm has both skeletal muscle that is controlled by the conscious mind, as well as smooth muscle that keeps working without conscious control (Caldwell & Victoria, 2011).

While unhealthy breathing patterns are acquired over time as a consequence of physical and psychological problems, the good thing is that these bad habits can be 'unlearned' and replaced with correct breathing habits.

A recent study showed that decreased, slow and regular breathing from 14 breaths per minute to 10 breaths per minute resulted in a reduction of blood pressure, a

longer pulse transit time and an increased cardiorespiratory coherence, indicating a shift towards parasympathetic nervous system activity and positive emotional states (Zhang et al, 2017).

A recent randomized control trial study by Pelka et al investigated the effects of psychological relaxation techniques as a method of recovery between two high intensity physical tasks i.e. sprints (2017). Systematic breathing as a method of relaxation recovery proved to enhance performances of the athletes or competitors.

Meditative / Mindful Movement
Benson, H., Beary, J.F. & Carol, M.P. (1974). The relaxation response. *Psychiatry* 1974; 37:37-46
Bhasin, M.K., Dusek, J.A. Chang, B.H. et al. (2013). Relaxation response induces temporal transcriptome changes in energy metabolism, insulin secretion and inflammatory pathways. *PLoS One* 2013: 327-341
Buric, I., Farias, M., Jong, J., Mee, C. & Brazil, I.A. (2017). What is the Molecular Signature of Mind-Body Interventions? A Systematic Review of Gene Expression Changes Induced by Meditation and Related Practices. *Frontiers in Immunology*; 8: 670. doi: 10.3389/fimmu.2017.00670
Campos, D., Cebolla, A., Quero, S., Breton-Lopez, J., Botella, C., Soler, J., Garcia-Campayo, J., Demarzo, M., & Banos, R.M. (2016). Meditation and happiness: Mindfulness and self-compassion may mediate the meditation-happiness relationship. *Personality and Individual Differences,* 93 (2016), 80-85. Retrieved from http://dx.doi.org/10.1016/j.paid.2015.08.040
Clark, D., Schumann, F. & Mostofsky, S.H. (2015). Mindful movement and skilled attention. Frontiers in Human Neuroscience, 9:297. doi: 10.3389/fnhum.2015.00297
Hospod, V., Aimonetti, J.M., Roll, J.P. & Ribot-Ciscar, E. (2007). Changes in Human Muscle Spindle Sensitivity during a Proprioceptive Attention Task. The *Journal of Neuroscience*, 2007 May 9, 27 (19): 5172-5178. doi: 10.1523/jneurosci.0572-07.2007

Jain, S., Shapiro, S.L., Swanick, S., Roesch, S.C., Mills, P.J. Bell, I. & Schwartz, G.E.R. (2007). A Randomized Controlled Trial of Mindfulness Meditation Versus Relaxation Training: Effects on Distress, Positive States of Mind, Rumination and Distraction. *Ann Behav Med* 2007, 33 (1): 11-21
Larkey, L., Jahnke, R., Etnier, J. & Gonzalez, J. (2009). Meditative Movement as a Category of Exercise: Implications for Research. *Journal of Physical Activity and Health*, 2009, 6, 230-238
Mehling, W.E., Wrubel, J., Daubenmier, J.J. et al (2011). Body Awareness: a phenomenological inquiry into the common ground of mind-body therapies. *Philos Ethics Humanit Med* 2011; 6:6
Ondobaka, S. & Bekkering, H. (2012). Hierarchy of idea-guided action and perception-guided movement. *Frontiers in Psychology* Dec 2012, Volume 3, Article 579. Retrieved from doi: 10.3389/fpsyg.2012.00579
Robot-Ciscar, E., Rossi-Durand, C. & Roll, J.P. (2000). Increased muscle spindle sensitivity to movement during reinforcement manoeuvers in relaxed human subjects. *Journal of Physiology (London).* 523: 271-282.
Ruge, D., Liou, L.M. & Hoad, D. (2012, April 25). *The Journal of Neuroscience*, 32 (17): 5705-5706. doi: 10.1523/jneurosci.0430-12.2012
Tang, Y.Y, Holzel, B.K. & Posner, M.I. (2015). The neuroscience of mindfulness meditation. *Nature Reviews Neuroscience* AOP published online March 15, 2015. doi: 10.1038/nrn3916
Wheeler, M.S., Arnkoff, D.B. & Glass, C.R. (2017). The Neuroscience of Mindfulness: How Mindfulness Alters the Brain and Facilitates Emotion Regulation. *Mindfulness.* doi: 10.1007/s12671-017-0742-x
Wulf, G. & Prinz, W. (2001). Directing attention to movement effects enhances learning: A Review. *Psychonomic Bulletin & Review* 2001, 8 (4), 648-660
Yeung, A., Chan, J.S., Cheung, J.C. & Zou, L. (2017). Qigong and Tai-Chi for Mood Regulation. *Focus* 2017; 00:1-8. doi: 10.1176/appi.focus.20170042

Table 3

Meditative / Mindful Movement

Larkey et al proposed meditative movement as a new category of exercise which is defined by some method of movement or posture, with a focus on breathing and a calm frame of mind with the aim of achieving a deep state of relaxation (2009). In meditative movement the mind is kept engaged in the movement itself and in the present moment, to the exclusion of extraneous thoughts. The body movements are typically slow, relaxed and flowing, however may range from dynamic movements to static postures.

A deep state of relaxation during meditative movement is also required and an intrinsic ingredient. Two methods described as meditative movements were Tai Chi and Qigong (Larkey et al, 2009). This paper outlined the growing evidence suggesting that these two methods show positive health improvements for blood pressure, mental health, functional balance and immunity.

Bodily movements have long been used as a medium to cultivate mental skills such as mindfulness, self-control and attention. Examples of such methods are Yoga and Tai Chi (Clark et al, 2015). It has been proposed that mindful movement practice could improve attention skills that might transfer to other forms of mental activity, as suggested by Feldenkrais, and this could have great benefit for individuals with ADHD (attention deficit hyperactivity disorder) (Clark et al, 2015).

Feldenkrais held that the quality of cognitive control, meaning improvement in how one directs oneself while moving, is more important that the movements themselves. Also, reduction of muscular effort while moving improves the thresholds of kinesthetic sensations and therefore the acuity of these sensations, hence improving sensitivity. Furthermore, movements done slowly and with small amplitudes may reduce the activation strength of existing hardwired motor

programs, and so enhance the ability to explore new ways of movement and inhibit habitual patterns of movement (Clark et al, 2015).

Bernstein (cited in Clark et al, 2015) noted that a large variability of sensorimotor training, along with effort reduction, would encourage the development of new motor skills, termed ‘dexterity’. Practices like Tai Chi, Yoga and other martial arts employ the strategy of incorporating continuous monitoring of one area of focus e.g. sensing the ‘tantien’ in the lower belly, while performing a set of various movements, which serve as a distraction (Clark et al, 2015).

Once students are able to build a new attention skill, the attention focus could be changed to something else, such as attending to feeling the ground, or feeling weight shifts, or feeling the viscosity of the air etc. This may be the mechanism underlying the potential cognitive function and attention improvements observed by the general population and individuals with ADHD who engage in mindful movement practices (Clark et al, 2015).

Modern science describes mindfulness as an open, engaged and non-judgmental awareness of the ever-changing present moment experience, both internal experiences of thoughts and feelings as well as external sensations (Yeung et al, 2017). It has been argued that a major mechanism of mindfulness is the anchoring of attention to interoceptive signals like breathing or body sensation (Mehling et al, 2011). These practices enhance non-reactivity to unpleasant thoughts and provide time to restore balance.

The well-known work by Benson et al (1974) found that meditation activates the parasympathetic nervous system, hence counteracting the stress responses triggered by an excited amygdala in the brain which sets off the hypothalamus-pituitary-adrenal (HPA) axis. This sympathetic nervous system cascade of events releases cortisol which increases blood pressure and blood sugar levels and suppresses the immune system.

The adrenal glands also release adrenaline or noradrenaline which increase the heart rate, bronchial dilatation and pupillary dilation. People with chronic HPA axis and sympathetic activation develop muscle tension, headache, fast heart rate, high blood pressure and shallow breathing along with anxiety disorders (Yeung et al, 2017). Meditative movements such as Tai Chi and Qigong, as well as energy healing, acupuncture, massage, progressive muscle relaxation and breathing techniques have been proved to be effective in countering the stress response, leading to increased well-being, lowered heart rate and blood pressure (Yeung et al, 2017).

Several studies have shown that various forms of meditation, including Qigong, mindfulness meditation and transcendental meditation have been shown to inhibit the sympathetic nervous system and improve immune function (Yeung et al, 2017).

A systematic review by Buric et al was conducted to examine changes in gene expression (effects on epigenetics) that occur after mind-body interventions such as Tai Chi, Yoga, Qigong, mindfulness, relaxation response and breath regulation (2017). Due to the limited number of studies done so far, Buric et al included both clinical and non-clinical samples and any type of research design. The review showed that mind-body interventions are associated with a downregulation of nuclear factor kappa B pathway, which is the opposite of the effects of chronic stress on gene expression. The study also suggests that mind-body practices may result in a reduction of inflammation-related diseases (Buric et al, 2017).

Bhasin et al studied the changes in the genome during a session of meditation in healthy, experienced practitioners and in novices (2013). They showed that relaxation response practice enhanced the expression of genes associated with insulin secretion, mitochondrial function and energy metabolism, and decreased expression of genes linked to inflammation and stress-related activity. The

benefits demonstrated were significantly greater in experienced practitioners compared to novices (Bhasin et al, 2013).

There is emerging evidence coming from neuroimaging studies that mindfulness meditation can cause neuroplastic changes in the structure and function of brain regions that regulate three main components of enhanced self-regulation. These three components are attention control, emotion regulation and self-awareness, and are reflected by consistent changes of the anterior cingulate cortex, striatum (caudate and putamen), medial prefrontal cortex, posterior cingulate cortex, insula and the amygdala in mindfulness meditators (Tang et al, 2015).

For instance, structural MRI (magnetic resonance imaging data) data suggests that mindfulness meditation can lead to greater brain cortex thickness and enhanced white matter integrity in the anterior cingulate cortex (ACC), which is the region in the brain associated with attention control (Tang et al, 2015). A cross-sectional study on Zen meditators showed a diminished age-related decline in attention performance as well as a decreased age-related decline of grey matter volume in the putamen in the brain (Pagnoni & Cekic cited in Tang et al, 2015).

The mechanism by which mindfulness meditation causes neuroplastic changes in various regions of the brain is still not well understood, however further research should pave the way for the regulated use of mindfulness meditation in clinical application for the treatment of depression, generalized anxiety disorder, addiction, attention deficit disorders and others (Tang et al, 2015).

What is clear is that plasticity induced in neural pathways indeed depends on the cognitive state, especially when a subject is engaged in a visual-motor task as opposed to when at rest (Ruge et al, 2012).

Kinesthesia is the awareness of the position and movement of the parts of the body by means of sensory organs (proprioceptors) in the skin, muscles, fasciae and joints. A study by Ribot-Ciscar et al suggested that in humans, the central

nervous system exerts a selective control of muscle spindle sensitivity via fusimotor neurons (2000).

It was shown that muscle spindle sensitivity to movement may be enhanced in fully relaxed subjects during a mental computational task (Ribot-Ciscar et al, 2000). In another study it was shown that focusing attention when completely relaxed on a proprioceptive movement task, for example when blindfolded, leads to changes in the sensitivity of the muscle spindles to movement, via changes in fusimotor control, so that accuracy and sensitivity increased (Hospod et al, 2007).

An interesting phenomenon of mindful meditating revealed by Wheeler et al is that after many hours of mindful practice, practitioners develop a kind of learned mindfulness, also called learned dispositional mindfulness, where they become more mindful of the world around them even when not meditating (2017). Experienced mindfulness practitioners showed improved orienting i.e. quicker reaction times on attention tasks, a higher degree of attentional processing efficiency and lower error rates on attention tasks, even when not actively meditating (Wheeler et al, 2017).

Mindfulness practitioners also show enhanced sensory perception (Kerr cited in Wheeler et al, 2017). Furthermore with greater experience in meditating, the capacity to attend to the present moment becomes less effortful. Preliminary evidence reviewed by Wheeler et al also points towards the capacity of mindfulness practitioners to experience negative emotions without adding further negativity brought on by past experiences or worry about the future, an ability which is very useful for psychological health (2017).

A randomized control trial compared mindfulness meditation with somatic relaxation training (Jain et al, 2007). It was concluded that brief training in both methods reduces distress and improves positive mood states. However mindfulness meditation is unique in reducing rumination and distraction

compared with somatic relaxation, supporting the theory that mindfulness meditation may reduce relapse of depressive illnesses by reducing the tendency to get stuck into a ruminative cognitive cycle (Jain et al, 2007). This is because mindfulness meditation seeks to cultivate non-judgmental moment to moment awareness to inner and outer stimuli, aiding the ability to redirect attention to the present moment rather than thinking about the past or the future. This comparative study indicates that reductions in rumination and distraction are unique to mindfulness meditation and not simply a result of relaxation effects.

A recent study explored the role of mindfulness and self-compassion in the relationship between meditation and happiness (Campos et al, 2016). Self-compassion is described as the desire to alleviate one's suffering and heal oneself with kindness. Groups with a high meditation frequency demonstrated higher levels of mindfulness, self-compassion and happiness. The study concluded with the observation that most mind-body interventions do not include self-compassion training, which could be vital in promoting happiness (Campos et al, 2016).

Studies investigating the effects of one's focus of attention while learning a new motor skill have shown that directing a performer's attention to an externally based focus like the effects of their movements is more beneficial than focusing internally on the minute details of a movement (Wulf & Prinz, 2001). This is because internal attentional focus tends to constrain motor actions and natural control processes, while a more detached attention allows automatic control processes to regulate movement. So for example, the golfer would focus on the trajectory of the golf ball during swinging, and the tennis player on the path of the ball, rather than how the hand is holding the club or the thumb is grabbing the racquet (Wulf & Prinz, 2001).

This appears to be aligned with the attention focus to feelings of centredness while staying aware of the tantien, or relaxed flowing movements while sensing

the air around oneself, during internal martial art training. Interestingly the tendency of Chinese martial arts to name every posture or movement with a flowery image e.g. ‘snake creeps down’, ‘repulse monkey’, ‘carry tiger to mountain’ etc. may be beneficial to the process of learning by focusing attention to the intended idea rather than to minutae of a new movement.

Ondobaka & Bekkering further suggested that this view on the nature of perception-action coupling should be extended to consider the influence of idea-guided action i.e. intent, on top of perception-guided movement, without the need of any intermediate cognitive process (2012).

This hierarchical ideomotor principle of action in execution can be explained simplifically in the act of making a phone call. One decides (the idea or concept) to make a phone call so the idea-guided action is followed by the perception-guided movement (using the sensory inputs of proprioception and vision) of transporting the phone to one’s ear (Odonbaka & Bekkering, 2012).

Anatomy: Musculoskeletal system and fascia
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Table 4

Anatomy: The Musculoskeletal System and the Fascial System

The traditional medical view of the muscles and tendons hanging onto the bony skeletal framework and causing movement at the joints through muscular contractions, has recently been challenged and revised through the increased study of the fascia. The Fascia Research Society coined the phrase 'fascial system' to better explain the important role of this previously neglected tissue.

The fascial system is regarded as the three dimensional continuum of soft collagenous connective tissue that permeates the whole body as both loose and dense fibrous tissue, penetrating and enveloping bones, muscles, nervous tissue and visceral organs, enabling structural support as well as an integrated functioning of all body systems (Adstrum et al, 2016).

Recently the concept of 'Biotensegrity' to explain the human body model gained widespread scientific approval. The protagonist of Biotensegrity was Dr. Stephen Levin, who showed that the human body is structured as self-tensioned continuous myofascial networks with the semi rigid, non-linear viscoelastic bones. These serve as floating, discontinuous compression struts, perfectly aligned and coordinated into an efficiently self- supporting neutral model that is functional on land, at sea, in air and in space, right way up or upside down (Levin, 2011).

The visceral organs as well as all the body systems i.e. cardiovascular, nervous, fascial etc. integrate structurally and even physiologically into this biotensegrity, while the spine functions as a tensegrity tower connecting and integrating into all the parts. A change in tension anywhere in this biotensegrity model is signaled to everywhere else by mechanical transduction (Levin, 2011).

Research is pointing to the vital role of fascia in spinal stability, considering that the spine is made up of viscoelastic, small vertebrae held together as multiple, frictionless joints stacked on top of each other onto which perches the head and onto which the four limbs are integrated. Maas and Sandercock showed that fascia transmit substantial inter-muscular and extra-muscular forces with muscular contractions, besides transmitting to and from attachments (cited in Driscoll, 2017).

In fact Reinhardt et al showed that an intact fascial system can create inter-muscular pressure or adjacent transverse loading forces that may even work against an individual muscle's force direction (cited in Driscoll, 2017). These complex force vectors may be beneficial for dynamic loading and stabilizing neighboring structures like the spine (Driscoll, 2017).

Intra-abdominal pressure e.g. during inhalation, and muscular pressures in the spino-pelvic region influence the tension of the thoracolumbar fascia, a major fascial 'train' that has an important role in spinal stability (Driscoll, 2017).

The intricate connection within this biotensegrity is made more clear by the discovery that muscles transfer most of their contractile forces onto fascial sheets rather than the tendon attachments to the skeleton. Furthermore muscles also transmit their forces laterally to neighboring muscles, both synergistic muscles as well as to antagonistic muscles across the limb, thus stiffening not only a particular joint but affect regions several joints away (Findley, 2011).

Movements like running, jumping and throwing a stone depend not only on the contraction of muscles, but largely on the elastic recoil of the fasciae supporting such ballistic movements (Findley, 2011).

Another exciting discovery is that fine fascial connections ramify deeply into the interior of cells, down to the nucleus. The work by Dr. Ingber showed that cells are biotensegrity structures in their own right, with balanced forces exerted between compression-bearing microtubules and tension-bearing actomysin filaments, with the tent pegs being integrin receptors (cited in Findley, 2011).

These integrin receptors anchor the cells to the extracellular matrix, as well as sense physical forces outside the cells, transmitting this information through the connections throughout the cell organelles including the nucleus, inducing specific biochemical reactions in the process (Ingber cited in Findley, 2011).

Indeed, the cellular effects of therapeutic methods like manual therapy, acupuncture and yoga-like stretching have been well-documented. The term ‘mechanotransduction’ has been coined to describe the different ways in which cells respond to different degrees of load such as pressure, stretch, tension etc. (Chaitow, 2015).

A review paper by Bai et al studied the evidence on the anatomical basis for the concept of meridians in traditional Chinese medicine (2011). The reviewed evidence supported the view that the fascial system of the human body may be the physical framework represented by the meridians and acupoints of TCM. The 3D construction of the human body by the visible Chinese human project, of the National Basic Research Program of China, as well as living body imaging data, show that the anatomy of the fascial network is consistent with the traditional meridian pattern.

Furthermore, studies on acupuncture showed that its efficacy relies on interactions with the fascia via the medium of needle insertion and manipulation

(Bai et al, 2011). The authors hypothesized that the stimulation of nociceptive (pain) receptors in the highly innervated fasciae, resulting in neurogenic inflammation and disruption of fascial physiology with health consequences, may be akin to a form of disruption of meridian energy (Qi) flow in TCM.

Another study highlighted the mechanism of acupuncture needle manipulation whereby the loose areolar connective tissue under the skin winds around the spiraling needle. This results in a cascade of events involving mechanotransduction leading to stimulation of fibroblasts, extracellular signaling and cell-mediated tissue relaxation (MacPherson et al., 2016).

Dynamic mechanical stresses and pressure gradients resulting from large movements during exercise as well as arterial pulsation, breathing and organ motions, are seen to be vital in the maintenance of supporting tissues like bone and muscle through the increase in extracellular fluid flow. This is because these stresses and pressure gradients encourage interstitial fluid flow, which is the transport system of beneficial chemicals as well as waste products to and from the cells (Findley, 2011).

Furthermore fibroblasts present in fascia are stimulated to differentiate into contractile myofibroblasts, and increases production of collagen which is an essential constituent in bone, fascia, skin, tendons and ligaments. Remodeling of bone has been found to be directed by the streaming potentials from the fluid flow throughout the bone canal system (Findley, 2011).

The increased interest in fascia has resulted in many scientific research papers and clinical fascia-related articles in recent years. This led to a great leap in practical applications of knowledge about fascia to health, sport and physical education. The fibroblast cells in the fascia have been found to be largely responsible for the early stages of healing in traumatized tissues.

Prolonged rapid movements distresses these fibroblasts, which start producing inflammatory chemicals. Standley & Meltzer found that 60 to 90 seconds of myofascial release or positional release leads to a normalization of these distressed fibroblast (cited in Chaitow, 2015).

Another study on bioengineered tendons showed that the healing rate of injured tissues is much faster when using gentle stretching than strong stretching. Three minutes of around 6% tendon stretch induced faster healing, while five minutes of 12% tendon stretch actually slowed down the healing (Cao et al, 2015).

Manual therapeutic methods that use isometric contraction have been found to reduce inflammation and speed up healing, by improving fluid movement in the fascia, thus improving drainage and flushing away inflammatory chemicals faster (Chaitow, 2015).

Parmar and colleagues have also shown that slowly applied isotonic-eccentric stretching in the rehabilitation of hip and knee replacement patients speeds recovery, as compared to traditional passive stretching (2011).

Separate studies by Blechschmidt and Chaitow revealed that the local architecture of the fascial system adapts to the strain loading history experienced by the fascia (cited by Schleip & Muller, 2012). This confirms that the fascial system can be trained for optimal strength and elasticity, leading to efficient performance as well as a high level of injury prevention.

Fascial remodeling results from a gradual increase in strain imposed on the fasciae, larger in magnitude than that experienced in normal daily activities. This induces the fibroblasts to remodel the collagenous fibre network into a more youthful wavy arrangement, with an increased elastic storage capacity (Schleip & Muller, 2012). Beneficial training is that which utilizes the elastic recoil of the fascia, as in loading over various extension ranges during jumping, squatting and many movements in between.

An effective stimulation of the fascial tissues appears to be a few repetitions of soft elastic bounces performed in the extreme ranges of motion available at that point in time. Also, slow static stretches result in anti-inflammatory as well as analgesic effects in inflammatory tissue conditions (Corey et al cited in Schleip & Muller, 2012).

Another training principle targeting fascia is the preparatory counter movement, meaning that before any movement is performed, one does a slight 'pre-tensioning' in the opposite direction. This increases the elastic tension in the fascial 'body suit' which drives an effortless movement. Timing is essential in this load and release mechanical principle utilizing the fascia (Schleip & Muller, 2012).

The fascia are utilized considerably when seeking to perform any movement in a smooth and soft manner, with gradual deceleration followed by gradual acceleration, thus avoiding jerky, abrupt motions. Aiming to achieve smooth and elegant movement while making a little noise as possible automatically brings the fascial system in full play (Schleip & Muller, 2012).

Another training principle targeting the fascial 'body suit' is that of training body movements that engage the longest possible myofascial chains, such as multidirectional, fluid motions incorporating spiraling rotations, and also adopting a lengthened stretch position and then doing small bounces in a soft exploratory manner. Dynamic extended brisk stretching movements while incorporating the countermovement within the action is also a good training method (Schleip & Muller, 2012).

The rationale of such training methods is the viscoelastic quality of the collagenous consistency of fascia, as well as the immensely innervated sensory and proprioceptive qualities of the fascia. Small specific movements interspersed with large extended motions can serve to bring proprioceptive attention and

sensitivity to areas of the body that have become neglected. The concept of a varied and creative movement experience seeks to prevent the sensorial dampening of the filtering function of the reticular formation of the brain, as well as the ‘feed-forward’ anticipation of the cerebellum in the hind brain when doing familiar repetitive movements (Schleip & Muller, 2012).

Another important consideration of fascia is the water retaining property of the collagenous architecture. During exercise, fluid is squeezed out of the viscoelastic fascial tissues, which subsequently lose their springy resilience and function less optimally. Short periodic breaks, for example by walking slowly, allow the fascial tissues to take up the nourishing fluid, like a sponge after having been squeezed.

This cyclical training principle is in line with fascial knowledge available today, and is the rationale of manual therapies like fascial release using foam rollers and other auxiliary equipment done slowly and firmly along various myofascial chains or trains (Schleip & Muller, 2012).

The research by Kjaer et al showed that unlike muscular strength training, fascia has the property of changing slowly but with much more long-lasting results, and after two or more years of consistent but mild training the fascial silk-like body suit becomes more injury resistant, elastic and sensitive (cited in Schleip & Muller, 2012).

A recent synthesis paper reviewed the force transmission capacity of fascia, which occurs both within limbs as well as in the course of myofascial chains (Wilke et al, 2018). Within the same limb, strain applied to one muscle may affect neighbouring synergists and antagonists through the connective tissue fascial linkages between them. A popular view of myofascial chains with muscles arranged in series, describes a system of 12 muscle-fascial lines connecting the muscles of the human body, suggesting direct continuity from head to toes (Wilke et al, 2018).

Another interesting finding is that fascia tends to be thinner in the arms than in the legs, and also thinner in the anterior regions of arms and legs than the posterior sides. This supports the view that myofascial force transmission is larger on the posterior regions of the body and in the legs (Wilke et al, 2018).

The Anatomy of the Upright Posture in Humans

In 1975 Farfan observed that the power generated by the legs and channeled to the upper body could not possibly be transferred efficiently by the weaker back muscles like the erectors (cited in Gracovetsky, 2008). This led to researchers discovering the important function of the fascial system, in the form of various myofascial linkages described as myofascial lines, slings and chains by various authors.

These myofascial linkages connect whole regions of the body and are responsible for producing smooth, coordinated movement, transferring forces generated by the lower body up through the trunk and into the upper extremities, and maintaining posture (Osar, 2014).

The myofascial system is categorized as the deep myofascial system (DMS) and the superficial myofascial system (SMS). The DMS comprises the deep muscles that are found close to the bone and joint surfaces and connected to the deeper fasciae that invest these muscles and blend with the tendons and ligaments including the joint capsules. Examples are the pelvic floor, transversus abdominus, multifidi of the spine and the diaphragm responsible for breathing (Osar, 2014). Richardson et al discovered that these contract milliseconds before movement thus providing a solid anchor base from where movement can occur further along the kinetic chain (cited in Osar, 2014).

Besides its vital role in breathing, the diaphragm along with other muscles in the DMS provides stabilization of the thorax, lumbar spine and pelvis, as well as

increases the internal pressure during inhalation and increasing stability of these regions (Osar, 2014).

Also when the internal abdominal pressure is sufficiently high to maintain a round belly, the lateral pull of the transversus abdominus muscles on the lateral raphe of the lumbodorsal (or thoracolumbar) fascia stretches the fascial sheet and induces a pulling force that brings the tips of the spinous processes of the spinal vertebrae together and towards the pelvis, thus causing spinal extension or straightening of the back (Gracovetsky, 2008). This mechanism is effective at any trunk angle.

The superficial myofascial system is made up of superficial and intermediate muscles that are fascially connected to form longer chains spanning multiple joint segments and responsible for movement of the trunk and limbs and generating huge amounts of forces required for throwing a ball, running or punching. The lumbodorsal fascia forming a part of the posterior oblique chain, the lateral chain and the anterior oblique chain are examples of the SMS (Osar, 2014).

Through the coordinated function of the fascia a powerlifter can lift 250kg, which is five times as much as the spinal musculature alone can support. When the trunk is flexed beyond 45 degrees to the vertical plane (as in bending over), the entire erector spinae muscles shut down by relaxing, and the tightened lumbodorsal fascia takes all of the load and forces transmitted from the legs to the upper extremities (Gracovetsky, 2008).

The viscoelastic property of collagen making up fascia, however, makes it impossible to load it continuously or injury will occur, so a cyclic mechanism of alternatively loading and unloading fascia and muscles is essential in the human body. This lets the fascial tissues sequentially stretch, rest and recover for yet another cycle.

The most important anatomical feature that controls this oscillatory distribution of forces between fascia and muscles is the lumbar lordosis, the natural inward spinal curve just above the buttocks (Gracovetsky, 2008). When the pelvis tilts so that the lumbar lordosis is reduced or straightened, or when the trunk flexes ie bends over, resulting in straightening of the lordosis, the forces are borne heavily by the lumbodorsal fascia rather than by the erector muscles.

In fact, during walking, the combination of pelvic and trunk oscillations are occurring, thus continuously redirecting power from the legs to the upper body (Gracovetsky, 2008). Henceforth walking can be sustained for a long period of time without injury and efficiently with minimal energy expenditure.

When standing, walking or running, energy minimization by minimal utilization of muscles and maximum use of the lumbodorsal fascia in transferring the power from the legs to the upper extremities has the benefit of minimizing stress at the intervertebral joints of the spine, hence reducing the risk of injury (Gracovetsky, 2014).

Gracovetsky showed that the unique characteristic of the human gait requires the spine to withstand large compression pulses as well as torsional forces. This is because human gait needs pelvic rotation in the horizontal plane, however there are no muscles in the horizontal plane that can do this directly (2014). Pelvic rotation is indirectly achieved by exploiting gravity, as in the ‘spinal engine theory’ put forth by Gracovetsky.

The powerful hip extensors like the hamstrings and the glutes lift the body creating potential energy which is then changed to kinetic energy when the body drops down hitting the ground with the heel and sole. This kinetic energy pulse travels up the leg causing pelvic rotation along the path towards the upper body. In fact walking and running are only possible when the center of gravity moves

even slightly up and down to allow the exchanges between potential and kinetic energy (Gracovetsky, 2014).

An interesting study studying the effects of pelvic and spinal alignment on thorax mobility and pulmonary function suggests that an improvement of the pelvic alignment can potentially improve thorax mobility and pulmonary function (Takeda et al, 2015).

Another recent study revealed a clear correlation between thoracolumbar curvatures of the spine and respiratory function in older adults (Rahman, Singh & Lee, 2017). This study suggests that an increase of both lumbar and thoracic curvatures (lordosis) over time is linked to a decrease in respiratory muscle strength and thickness and some parameters of lung function.

An interesting study on the effect of scapular position and pelvic alignment on core musculature in the prone plank position revealed notable results (Cortell-Tormo et al, 2017). It was shown that during the plank position a posterior pelvic tilt (reduced lumbar curvature) resulted in the largest abdominal musculature activation, while scapular adduction (shoulder blades move towards each other) increases the difficulty of the plank position in part due to the reduction of tension generated by the thoracolumbar fascia, thus increasing the load on the musculature.

In this study it was deduced that during the plank exercise the abduction of the scapulae (shoulder blades widened to create a round upper back) along with the posterior pelvic tilt result in stretching and contraction of the latissimus dorsi muscles and gluteus maximus. This stretches and stiffens the overall fascial system thus decreasing the muscular demands on the core (Cortell-Tormo et al, 2017). This shows that core stability is enhanced by the abduction of the scapulae and the posterior pelvic tilt (or reduction of the lumbar lordosis).

The thoracolumbar/lumbodorsal fascia has been shown to be vital in connecting the lower limbs via gluteus maximus to the upper limbs via the latissimus dorsi. Furthermore, the contraction of the transverse abdominis, and internal and external obliques, acting together, tightens the 'hoop' derived from the lumbodorsal fascia and thus increasing intra-abdominal pressure and the functional stability of the lumbar spine (Cortell-Tormo et al, 2017).

Another mechanism present in core stability and linking the lower limbs to the upper limbs is the cocontraction of muscles involved in the 'serape effect', which are the rhomboids, serratus anterior, external and internal obliques. These work together during rotational movements of the trunk (as in an overhead throw, or a round kick) to produce an opposition of the pelvis with the ribcage, producing a rotational windup and maximal stretch, in order to generate a huge summation of forces on the snap back when the stretched muscles contract to their resting lengths. The thoracolumbar fascia is the connecting system that makes the lumbosacral system biomechanically coupled to the legs and arms (Cortell-Tormo et al, 2017).

An experimental study on the effects of stabilization exercises on women with chronic lower back pain indicated that isometric stabilization exercises involving isometric prolonged contractions to achieve anterior and posterior pelvic tilt with rest in between, proved more helpful in reducing lower back pain than either isotonic pelvic tilt exercises or no exercise at all (Moussouli et al, 2013). Also, isometric stabilization exercises resulted in higher levels of energy and vitality felt by the subjects in their daily lives.

These benefits lasted for at least nine months after the 4 week long exercise program has been stopped. The authors postulated that this could be because in everyday life, such mundane tasks as carrying an object or rising from a chair involve trunk stabilization with core muscles working almost completely

isometrically to maintain trunk stability, so that the isometric exercises would be strengthening these muscles and improving coordination (Moussouli et al, 2013).

The Neck

The ideal posture is widely regarded as one in which musculoskeletal balance is maintained with minimal stress on the body and in alignment with gravity. Proper posture is considered essential for health. Forward head posture is a very common head-on-trunk malalignment and is usually shown by the measurement of a low craniovertebral angle (CVA).

Forward head posture can lead to neck pain, headache, temporomandibular joint dysfunction syndrome, muscular dysfunction and shoulder pain (Yong et al, 2016). Studies have reported that forward head posture causes mouth breathing in school-aged children, due to an alteration in the position of the mandible (lower jaw) resulting from the forward head posture (Lee et al, 2017).

A study on IT professionals diagnosed with postural neck pain, due to long hours on the computer, showed that the craniovertebral angle has a moderate negative correlation with neck pain intensity (Subbarayalu & Ameer, 2017). This means that the smaller the CVA becomes, the more the risk of increasing neck pain and disability. These findings support the idea that improving head posture should reduce neck pain and disability.

Forward head posture forces the deep cervical flexor muscles to lengthen unnaturally resulting in a mechanical disadvantage and reduced performance. The study also supports the practice of deep cervical flexor muscle training in order to improve neck pain, and to improve the capacity of the cervical spine to sustain an upright posture (Subbarayalu & Ameer, 2017).

Another recent study on explored the CVA and respiratory function in healthy smartphone users as compared to another group of healthy smartphone users who were prescribed a routine set of exercises (Lee et al, 2017). The first exercise targeted the deep neck flexor muscles by tucking the chin and holding for 10 seconds for 10 repetitions, and the second exercise was holding a plank while pushing up 1-2 cm by protracting the scapulae taking care to prevent winging of a scapula from happening.

The results showed that the exercise group showed a significant improvement of the decreased craniovertebral angle and also respiratory function in smartphone users. The improvement of respiratory function has been explained firstly because of the strengthening of the accessory muscles of respiration that were targeted in the exercises. Secondly, the improvement of the head and neck posture by the exercises also improved respiratory function (Lee et al, 2017).

Another study also reported that cervical lordosis due to forward head posture can negatively affect vital lung capacity (Lee et al, 2011).

The Tongue Position

A surprising pilot study by di Vico et al (2013) exploring the effect on tongue position in the mouth on knee isokinetic test performance revealed around 30% significant increase of knee flexion peak torque when the tip of the tongue is touching the hard palate between the upper front teeth interdental papilla and the first fold of the roof of the mouth, as compared with the tongue touching the inner surfaces of the front teeth or lying low on the lower teeth.

These findings prompted the authors to alert any future investigations into knee flexion about the need to standardize tongue position as well as further investigation into this phenomenon.

Knee Biomechanics

A study on the effects of knee position on the production of maximum force and rate of force development during an isometric squat has been done, with squat depths performed with the knees at 90, 120 and 150 degrees corresponding to the deep parallel squat, the half squat and the quarter squat (Palmer et al, 2017). Their findings suggest that performing isometric squats at higher positions (150 degree knee angles) may result in better peak force and force rate development than in the other two lower positions.

Another recent study analyzed the biomechanical responses of the knee cartilage and meniscus while performing three staple Tai Chi movements; Brush Knee Twist Step, Cloud Hands and Repulse Monkey, and compared them with responses during walking and jogging (Niu et al, 2017). The study showed that the Tai Chi movements increased the range of motion of the knees more than during walking or jogging. Also the Tai Chi postures exerted uniform and lower contact stress on the cartilage and meniscus of the knee joints, thus producing a desirable level of stress on the knees which may be beneficial to the knee joint.

In a study focusing on isometric knee extension in a semi squat position it was found that the isometric training increases the stiffness of human tendons in vivo besides increasing muscle strength and size (Kubo et al, 2001). The increased stiffness of the tendons has been assumed to help with the rate of torque development and shortening the electromechanical delay, which is the time lag between the nervous impulse and the tension development in skeletal muscle. All these adaptations are considered to improve physical performances during rapid motions (Kubo et al, 2001).

In a separate study the effects of different duration isometric contractions on human tendon elasticity in vivo were studied. The results showed the longer duration isometric training showed more increase in stiffness of human tendons

compared to short duration contractions, suggesting that training in high force but short duration exercise would not change the tendon structures significantly in comparison (Kubo, Kanehisa & Fukunaga, 2001).

Another study on squat depths and loads showed that the deeper the squat gets the more the stress forces on the knees increase exponentially, not linearly, underlining the importance of careful progression from a higher to a lower squat position in training (Cotter et al, 2013).

Another interesting research study targeting older men and women showed that slow movement, low-intensity resistance knee flexion and extension exercise can be an effective method for gaining leg muscle mass and strength, even more than moving at normal speed (Watanabe et al, 2013).

The effects of low-intensity resistance while performing slow movements as a form of exercise, on oxygen consumption, were studied (Mukaimoto & Ohno, 2012). It was found that slow exercise with low intensity resistance induces a much greater energy expenditure than high or low- resistance exercise at normal speed, and is followed by the same total excess post- exercise oxygen consumption for 3 hours after exercise.

The Ankle

A systematic review and meta-analysis on the usefulness of proprioceptive training for the prevention of ankle sprains has been carried out (Rivera e tal, 2017). Ankle sprains are the most common injuries suffered by athletes, and once an ankle joint has been injured the risk for reinjury is high. The financial cost, time lost during recovery and the possibility of long-term disability highlight the importance of preventive strategies.

The study revealed that exercises like balancing on one leg while doing a task like throwing or catching a ball, or with the eyes closed, can improve the proprioceptive/sensorimotor nervous system's ability to adapt to an ever-changing situation and so protect the body from injury. Other beneficial exercises are balancing on an ankle disc or wobble board. Proprioceptive training reduces a patient's risk of incurring a first time or a recurrent ankle sprain (Rivera et al, 2017).

Stretching and maximal joint range of motion

Stretching is widely used in sports and physical therapy to increase the muscle-tendon extensibility and the joint range of motion, desirable for normal function. It is generally assumed that extensibility increases due to increased passive tension applied to muscle-tendon units.

However in certain stretching scenarios this mechanism has been found to not occur as expected, suggesting a different physiological mechanism is present involving non-muscular structures i.e. the fasciae and the nervous system (Nordez et al, 2017).

It has been shown that stretching exercises of one limb resulted in increased range of motion of the contralateral limb (Chaouachi et al cited in Nordez et al, 2017). Furthermore, intensive stretching of the lower limbs increased the maximal range of motion of the upper distant limbs and vice versa (Behm et al, 2016).

Another study concluded that knee range of motion in extension is reduced when the patient is in the slump posture ie full lumbar and cervical (neck) flexion with these spinal curvatures completely rounded out, as compared to the neutral head and back posture.

It has been suggested that these findings point to the workings of the peripheral nervous system as well as the highly innervated fascial system , which are continuous tissues that span vast areas of the human anatomy from the lower to the upper limbs across the trunk (Nordez et al, 2017). The nervous system and the fasciae play an important role in the perception of the stretch that when sufficiently triggered with extreme strain can induce pain, hence limiting the joints' maximal range of motion.

Further research into this phenomenon is indicated, to scientifically verify how stretching of one area of the body can result in increased flexibility in another part of the body.

While it is probable that the effect of non-muscular structures on joint range of motion varies between different persons, new knowledge in this field will help with devising stretching protocols, and in the process refraining from using strong techniques which can lead to injury of delicate nervous tissue and myofascial tisses (Nordez et al, 2017).

The recent synthesis paper by Wilke et al confirmed that the existence of non-local exercise effects involving the myofascial chains has been well demonstrated in various studies (2018). Isometric stretching of calf and hamstring muscles has been shown to increase cervical spine (neck) flexibility, while self-massage of the foot resulted in an increased sit-and-reach distance reflecting increased hamstring stretching.

These non-local effects may be applied practically in cases of musculoskeletal disorders, where remote treatments may be indicated when a local application is contraindicated. These could also explain why local pathology is projected to remote regions of the body, seen in several health problems (Wilke et al, 2018).

The Psychological Effects of Posture
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Table 5

The Psychological Effects of Posture

Many studies have been done in the past few years on the psychological effects of posture. When adopting an expansive and erect posture, people tend to project power and authority to themselves and to others around them, while a constricted,

slouched posture has the opposite effect (Huang, Galinsky, Gruenfeld & Guillory, 2011).

Peper and Lin showed that emotions and thoughts affect posture as well as energy levels, while posture and energy also affect people's emotions and thoughts (cited in Peper, Booiman, Lin & Harvey, 2016).

In another study two minutes of standing in a collapsed or slouched posture resulted in endocrine changes in the blood, specifically significantly decreased testosterone and increased cortisol (also known as the stress hormone). On the other hand, standing in an expansive, erect 'power posture' increased testosterone and decreased cortisol (Carney, Cuddy & Yap, 2010).

Booiman and Peper reported that when a person stands in an erect posture, other people instinctively respond in a positive way, so that people's social experiences are indeed affected by these subtle thoughts and non-verbal communication in response to posture (cited in Peper, Booiman, Lin & Harvey, 2016).

In another study the subjects stood either in an erect posture or in a slouched posture, and raised their arm while attempting to resist downward pressure applied to their wrist area. The participants subjectively felt stronger and more able to resist the downward pressure while standing in the erect posture than when they stood slouched (Peper, Booiman , Lin & Harvey, 2016).

The authors stated that while the difference in strength in the shoulder, as demonstrated in this experiment, is due to different biomechanics in the two postures, it was shown that a slouched, downward looking posture made the subjects more powerless and hopeless. It was held that over time memories become embedded inside our body posture, which can covertly evoke associated memories and emotions as well as shifts in our energy level.

The work by Peper & Lin showed that when a person shifts from a collapsed posture to an erect posture, or from walking while slouched to walking lightly

with head held high, the feeling of subjective energy may increase significantly (cited in Peper, Booiman , Lin & Harvey, 2016). It has been asserted that just two minutes of posture change begins to bring about changes in one's hormones, strength and moods (Peper, Booiman , Lin & Harvey, 2016).

In another study it was found that a slumped posture induced the negative emotions of fear, hostility and nervousness, when compared to an upright posture (Nair et al, 2015). Nair et al also found that an upright seated posture helps protect against negative emotions when experiencing psychological stress (2015).

Another study investigated electroencephalogram (EEG) patterns under erect and slouched postures while remembering positive and negative events. It revealed that in a collapsed position much more time and effort is needed to evoke and maintain positive thoughts (Tsai, Peper & Lin, 2016). The clinical implication is that depressed people need to improve their posture and sit or stand erect while looking up, since in this posture there is more likelihood of accessing positive thoughts.

Another study by Shafir et al sought to identify using Laban Movement Analysis (LMA), the motor characteristics of movements that enhance the basic emotions of anger, happiness, fear and sadness (2016). This study was unique in that it was shown scientifically that it is the motor qualities of any movement, rather than specific motions, that can bring about certain emotions.

'Feeling angry' was predicted by advancing forward with a strong, sudden and direct effort, especially using a punching movement. Previous studies had already described the specific motions of leaning forward, strong, fast movements and forward bending of the head as expressions of anger (cited in Shafir et al, 2016).

'Feeling afraid' was predicted by enclosing and condensing the body, as well as by retreating backwards and leaning back, all clear responses to danger in animals (Shafir et al, 2016). Feeling fear was also predicted by extreme tension in the

muscles, also called ‘bound flow’, a motor quality where the muscles contract to bring about freezing, seen in animals faced with danger. These motor characteristics are seen in increased activation of the sympathetic nervous system (Shafir et al, 2016).

‘Feeling happy’ was predicted by rhythmic movements and jumping, as in dance. Other qualities were lightness and free flow. Lightness and free motions requires minimal tension. When the sympathetic nervous system is activated, as in situations perceived as ‘fight or flight’, there is increased co-contraction of muscles, and thus more muscle activation is needed to overcome this increased resistance to allow movements.

Light and free motions counter this quality, and the muscle proprioceptors may signal to the brain that no stressful situation is present, hence inducing the feeling of happiness (Shafir et al, 2016). Other motor qualities predicting feelings of happiness were enlarging the shape of the body in a horizontal as well as a vertical dimension, possibly because such changes produce feeling of power and dominance, creating feelings of security and so happiness (Shafir et al, 2016).

‘Feeling sad’ was predicted by movements done with the head down, arms hugging torso, sinking and passive weight with a limp body, communicating submission. The posture eliciting sadness was a contracted, shrinking one, with drooped shoulders (Shafir et al, 2016).

These findings are useful because they can be applied by anyone wishing to regulate one’s personal emotions through posture control. Anyone can choose to incorporate in his/her daily movements even some of those motor characteristics that enhance happiness, especially those that feel natural and comfortable.

On the other hand people can decide to reduce their daily habitual motions that align with predictors of negative emotions (Shafir et al, 2016).

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Table 6

Relaxation and Physical Performance

Research by Parnabas et al showed that relaxation techniques like imagery or visualization, meditation like Zen meditation, Yoga and Tai Chi, progressive muscle relaxation and breathing techniques are positively correlated to sports performance, chiefly by reducing stress and anxiety (2014). Relaxation leads to the reduction of oxygen metabolism, respiration, muscle tension and negative thoughts.

There are two categories of anxiety; the cognitive anxiety which takes the form of negative self-talk and expectation, and the somatic form of anxiety which is physiological and results in feelings of nervousness, muscular tension, rapid heart rate, sweaty palms and high blood pressure.

It has been estimated that 60% of Olympic athletes take banned substances to reduce anxiety and enhance performance (Wilson cited in Parnabas et al, 2014). Introducing relaxation techniques in the sports market has the potential to reduce drug taking among high level athletes as well as enhance performance.

Another study compared the effects of progressive muscle relaxation and autogenic relaxation on the moods of young, adolescent soccer players (Hashim & Yusof, 2011). Autogenic relaxation uses visual imagery and body awareness to relax the mind in order to relax the body, by using self-suggestions like getting heavy, warm limbs, a cool forehead, a regular heartbeat and breathing. Progressive muscle relaxation tenses and relaxes individual muscle groups in sequence and results in the ability to release muscle tension consciously.

Significant decreases in confusion, depression, fatigue and tension scores were observed for both techniques, while a decrease in anger scores was also found post-intervention (Hashim & Yusof, 2011). The study revealed that both relaxation techniques do not differ in their effects on mood. This suggests that skeletal muscle relaxation induces cognitive effects and vice versa! Mood regulation is important for athletes because successful performance is associated with above average vigor scores and below average negative mood scores (Morgan cited in Hashim & Yusof, 2011). Furthermore, mood regulation is an important self-regulatory process that is useful in daily life.

The benefits of relaxation technique training in sports has been well-documented. The advantages of using mental imagery and visualization in sports are well known (Murphy & Joudy, 1992). Relaxed focus and attention control training is also proven to be useful in sports performance (Nideffer & Sagal, 2001). The effects of progressive muscle relaxation on footballers' training has been studied by Jaworska et al (2015). They showed that relaxation training increased the effectiveness of footballers' training by increasing the distance measured by the Cooper test.

The Cooper test is used to measure the distance covered in 12 minutes of steady running, determined by the maximal oxygen uptake of the athlete. This study did not reveal a raise in pain perception threshold of the young subjects, possibly because the pain threshold of the athletes was already at a very good level (Jaworska et al, 2015).

It was suggested that progressive muscle relaxation therapy can reduce the number of injuries in sport and allow athletes to perform at their maximum potential. This is because relaxation enhances coping with stress, calms the practitioner and gives a feeling of confidence and greater internal control, allowing good quick decisions and better physical execution (Jaworska et al, 2015).

Other biological benefits of relaxation training for optimal sports performance have been studied. Progressive muscle relaxation has been shown to result in improved lung function (Vempati & Telles, 2002). Progressive muscle relaxation has also been shown to be an effective method of pain control (Emery et al, 2006). Biofeedback can have a real effect on heart rate and respiratory function, because the parasympathetic nervous system is brought under control, leading to a steady heart rate and smoother, quieter breathing with more overall oxygen uptake. This makes biofeedback a useful tool for treating asthma even in older patients (Lehrer et al, 2006).

In sports science the importance of recovery and rest between periods of physical exercise is well known. Without adequate recovery, the maximum potential of an athlete cannot be reached and overtraining or burnout can occur, leading to injuries and illnesses (Kellmann et al, 2018). A study by Pelka & Kellmann concluded that successful recovery can be different in different individuals with varied environments, different types of physical, cognitive and metabolic demands and personal preference (2017).

A valid approach may be systematic relaxation techniques which can be muscle-to-mind i.e. focusing on sensitivity to muscular tension, or mind-to-muscle i.e. the cognitive processes which bring about relaxation (Pelka & Kellmann, 2017). Systematic relaxation techniques, which need to be taught and practiced, include autogenic training (self-hypnosis), Eastern meditation techniques, visualization or imagery, progressive muscle relaxation, biofeedback, deep breathing, neurofeedback and mindfulness (Pelka & Kellmann, 2017). Furthermore, the timing of the recovery period using systematic relaxation methods can serve different goals, depending whether it is used before a physical task or competition, in between two strenuous exercises, or at the end of a training session. Relaxation as a recovery tool has been found to shorten healing time besides giving the benefits of stress reduction, anxiety control and increased parasympathetic activity (Pelka & Kellmann, 2017).

In the medical field a systematic review by Melo-Dias et al showed the usefulness of progressive muscle relaxation training for adults diagnosed with schizophrenia (2014). Studies revealed that daily practice of this technique resulted in significantly decreased anxiety and psychological stress and increased subjective well-being (Melo-Dias, 2014).

Progressive muscle relaxation has also been found to improve anxiety, depression and overall quality of life in patients suffering from pulmonary arterial hypertension (Li et al, 2015).

Another medical research work concluded that women who had progressive muscle relaxation therapy after undergoing hysterectomy surgery showed reduced stress, anxiety and depression than those who received only routine nursing care (Essa et al, 2017).

The Biofield

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Table 7

The Biofield

The term 'biofield' was coined in 1994 by a panel set up by the National Institute of Health (USA) to discuss complementary and alternative medicine. As a result, grants were proposed to study a variety of biofield therapies including Qigong, Reiki, healing touch and other subtle energy healing interactions. As a result of this research, much of the recent advances in evidence and knowledge about the biofield came about (Kafatos et al, 2015).

Based on recent evidence, biofield can be defined as a complex endogenously generated field surrounding and permeating living bodies that may have a vital role in information transfer processes that lead to homeostasis, which is an individual's balanced state encompassing the physical, mental, emotional and spiritual aspects (Jain et al, 2015).

Studies reveal that this biofield is actually a global energetic lattice made of different types of energy. Modern mainstream medicine makes widespread clinical and diagnostic use of the electrical and magnetic fields generated by the brain and the heart, through the use of electrocardiograms (ECG), magnetocardiograms (MCG), electroencephalograms (EEG) and magnetoencephalograms (MEG) (Hammerschlag, 2015).

Neurology and physiology accepts that muscle and nerve cells exhibit an electric high speed action potential, while mechanical stress in bone results in piezoelectricity.

Fasciae, skin and tendons exhibit electric streaming potentials, while intracellular electric potentials are involved in organelle function. Piezoelectricity and streaming potentials aforementioned are thought to respond to loads on bones, fasciae and tendons by regulating osteocyte (bone cell) and fibroblast (cells forming fibrous tissue) activity, thus affecting the density of these supporting tissues (Ahn & Grodzinsky, 2009). Electric fields generated intracellularly are also involved in the regulation of vital cellular activities like cell division, specialization of cells and growth (Zhao & Zhan, 2012).

Since electricity in motion generates a magnetic field in the surrounding space, magnetic fields are also detected around a living body by sensitive devices like the SQUID (superconducting quantum interference device) magnetometer. The work by Muehsam and Ventura shows that electromagnetic fields of amplitude similar to the cardiac field can affect gene expression in stem cells (cited in Hammerschlag, 2015).

The heart's magnetic field can be recorded from up to 5 feet away from the body surface, in the form of a magnetocardiogram. This magnetic field appears to carry information that can be detected by other persons or animals. For example the R waves of a person's ECG become perfectly synchronized with the EEG alpha waves of another person standing at a distance of up to 5 feet away (McRathy study cited in Hammerschlag, 2015).

The brain is another organ that generates electrical and magnetic fields detected as an EEG (electroencephalogram) and MEG (magnetoencephalogram) respectively.

These fields have been proposed in various studies to affect nerve cell synchronicity, circadian rhythm and cognitive processes in the brain (Hammerschlag, 2015).

Another form of energy field within the biofield is the coherent, ultraweak photon emissions (UPE) detected from the body surface as well as cell cultures. These UPE may serve important physiological roles. Fluctuations in UPE have been observed to correlate with EEG activity (Van Wijk et al as cited in Hammerschlag, 2015). Biophotons have the remarkable capacity to penetrate into and through cells and organs at high speeds, an interesting property for information transfer as compared to molecular signals which have to surmount various barriers (Hammerschlag, 2015).

An example demonstrating the action of the biofield is the relationship between the heart and the brain in a living body. Electromagnetic signals from the heart reach the brain instantaneously. Milliseconds later neural impulses in the form of signals from the heart reach the brain. Seconds later hormonal (chemical) and pressure wave signals arrive (McRathy et al cited in Hammerschlag, 2015).

An interesting field of study is the biofield receptor systems i.e. the mechanism whereby biofields are received and processed within the body. Three mechanisms have been proposed; the molecular level receptors which respond to electromagnetic signals in a biological way. These are present in the cell membranes as well as in the DNA, which has electromagnetic response elements (EMRE) within its structure. The other two mechanisms are charge flux sites in cell membranes and endogenously generated electromagnetic fields which respond to outside fields (Hammerschlag, 2015).

The collagenous fasciae permeating throughout the whole body seem to possess all the three types of biofield receptors. Fasciae communicate with the cells of all organs by the use of ‘integrins’, transmembrane bridging molecules.

These influence cell metabolism and genetic activity (Oschman's work cited in Hammerschlag, 2015). Collagen fibres within fasciae can conduct and modify photon pulses (Van Wijk et al cited in Hammerschlag, 2015). Through the mechanism of the water-protein relationship in collagen fibres leading to 'spin coherence' and 'quantum coherence', collagen in the fasciae is able to be ultrasensitive to electromagnetic fields (Hammerschlag, 2015).

Other forms of energy held as being present within the biofield and separate from the aforementioned electric, magnetic, electromagnetic and biophotonic energy have been termed 'subtle energy'. This term represents one or more forms of energy whose effects have been reported and which cannot be explained by classical physics and current mainstream biology. Examples of such biofield phenomena are distance healing effects, effects of intention on physical reality and effects on cultured cells (Hugie, 2014).

On the other hand, such phenomena can be more readily explained by modern quantum physics. The work by Tiller and other researchers shows that an unconventional energy can be transferred through intention, with the ability to alter physical, electrical and biological processes (cited in Hugie, 2014).

Quantum physics has replaced the outdated reductionist and molecular scientific view with a holistic one, where the body is seen as a macroscopic quantum system, hence resulting in 'quantum biology'. The role of the 'observer' and thus 'consciousness' takes prominence in quantum theory, where in von Neumann's view nature exhibits a free choice of response to an act of observation.

The observer takes a participatory role in the outcome of experiments, where the type of measurement chosen by the observer determines the outcome of the experiment, extrapolated as the creation of events (Kafatos et al, 2015). Quantum physics can be used to explain natural phenomena like the role of coherence in photosynthesis, the sense of smell, the ingrained compass inside migratory birds'

brains, coherence in microtubules inside cells, regeneration and quantum processes in brain activity (Kafatos et al, 2015)

An experiment that has recently gained a lot of attention is the ‘phantom leaf effect’, which gives further support and credibility to the biofield phenomenon. First described by Adamenko and recently verified by Hubacher, the experiment reveals an energy field detected by Kirlian photography or coronal discharge imagery, where the intricate morphology of a whole living leaf is revealed even after part of the leaf is cut off (cited in Kafatos et al, 2015).

The phantom leaf energy field is found to be electroconductive, interacting with magnetic and electrical fields and conducts current, leading Hubacher to conclude that it may carry information and energy and regulate physiological processes. This coronal discharge appears to be under the influence of a quantum level nonphysical field which is below the level of, supports and structures electromagnetic fields (Kafatos et al, 2015).

Recently the increased widespread use of unconventional medical therapies like biofield therapies, especially among patients with chronic pain, HIV and cancer (Baldwin & Trent, 2017) led to the modification of the term ‘Complementary and Alternative Medicine’ (CAM) to ‘Complementary and Integrative Medicine’ (CIM) where the conventional and complementary approaches are integrated in a coordinated way to improve medical treatment (Hufford et al, 2015). The National Institute of Health (United States) recognizes practices such as Reiki, Qigong, Healing Touch, Reconnective Healing and acupuncture as biofield therapies (Hufford et al, 2015).

The conventional medical approach is to segment human health into many specialized fields of study in the form of discrete systems, and great leaps in knowledge have been made. However, the continuance of human suffering and ever increasing medical costs in the modern world notwithstanding the great

advances in technology leads many to search for the missing link, where self-empowerment and the capacity to activate the innate human capacity for healing is understood and harnessed.

Scientists have proposed that the current segmental medical approach is actually jigsaw pieces of a larger holistic approach that fits in with the biofield approach, where a global field of energy and information guides homeostasis and is influenced by consciousness (Jain et al, 2015).

A biofield therapeutic approach that received considerable scientific scrutiny leading to further understanding of the biofield, is ‘distant healing intention therapy’ (DHI). DHI therapies entail directing a compassionate mental intention toward the health of another person who may be far away or close, but without direct contact between the healer and the patient. Examples of DHI are Reiki, Qigong, therapeutic touch, reconnective healing, Johrei and energy healing (Radin et al, 2015).

So far the clinical effectiveness of DHI has not been validated in high quality experiments, however assessments of ‘distant mental interaction with living systems’ (DMILS) in laboratory settings, show strong evidence that focused intention and attention actually do affect the human body and behaviour from a distance (Schmidt cited in Radin et al, 2015). The well accepted evidence for quantum nonlocality, leading to what Einstein described as ‘spooky action from a distance,’ and the evidence for quantum coherence effects in living systems provide a strong scientific basis for such phenomena (Radin et al, 2015).

Researchers have been studying the even wider view of the relationship between biofields of living things and the environment around them. The work by Harold Saxton Burr of Yale Medical School showed that changes in the electromagnetic fields of the environment, for example during a thunderstorm, significantly affected the biofield of trees (cited in Baldwin & Trent, 2017).

The work by Rein demonstrated that the ECG recordings generated by a person focusing on appreciative thoughts towards a cell culture of fibroblasts led to significantly increased DNA synthesis of these cells (cited in Baldwin &Trent, 2017).

Rein hypothesized that environmental electromagnetic fields may influence the collective frequencies generated by living cells, tissues and organs by entrainment, resulting in these small fields resonating with the external field hence altering them (cited in Baldwin & Trent, 2017). Preliminary studies suggest that reconnective healers may be able to access environmental fields that influence their personal biofields, and then these altered energy fields may be passed on to patients by entrainment (Baldwin & Trent, 2017).

The increasingly concrete evidence in biofield research and therapies has led to a significant increase in biofield device technology, with several devices already in the market both for diagnostic purposes as well as for therapeutic use. Diagnostic devices measure the biofield properties while the therapeutic devices manipulate biofield interactions (Muehsam et al, 2015). Biofield device technology will probably be a major influence for the furthering of research and integration of this field of study into the medical field.

Another type of biofield related device is that with the aim of offering protection from environmental electromagnetic pollution. An increasing number of people are becoming diagnosed with sensitivity or allergy to electromagnetic fields from mobile phones, wireless base stations, lap top computers and radars, resulting in the new medical field of Environmental Medicine (Oschman, 2017).

One of the most thoroughly tested device is the Pranan family of protection devices, which show evidence of the effective stabilization of various physiological processes.

The surfaces of these small, easy to carry devices have geometric patterns corresponding to the mathematical symbol known as the ‘golden mean’, ‘golden ratio’ or ‘phi’. This mathematical ratio has been found in quantum physics to be related to magnetic fields, as well as found throughout nature, ancient architecture and art (Oschman, 2017).

Work by Pall confirmed that living cells are very sensitive to minute energy fields even more than to larger fields (cited by Oschamn, 2017). Oschman hypothesizes that the mechanism for the conversion of harmful electromagnetic fields into biologically beneficial energetic frequencies exhibited by Pranan devices, involves resonances between geometric patterns in space i.e. between the geometric patterns on the surface of the device and the geometric patterns on the inner surface of the device which is kept close to the human wearer’s body (2017).

Oschman also cites the discoveries by Dr Guimberteau which show that the human skin and fascial tissue inside the body exhibit a microscopic geometric pattern in the form of a polyhedral framework. He proposes that these anatomical polyhedral patterns in the skin surface and throughout the fasciae are involved in the mechanism of action of the Pranan devices on the human body, and in the ability of the human body to serve as an antenna, picking various forms of energy fields in the environment (2017).

In essence, the geometric patterns on the Pranan devices resonate with the geometry of electromagnetic fields in space, modulating them into beneficial frequencies which are in turn picked up by the skin and faciae of the human body (Oschman, 2017).

Discussion

'From mastery of the postures, you will gradually awaken to interpreting energy. From interpreting energy, you will arrive at spiritual insight.'

Wang Tsung-yueh's Treatise on Tai Chi Chuan, translated by Wile (1983) pg. 120

Breathing

'Breathe regularly through the nose' - Sun Lu Tang's instructions in Smith (1990) pg. 122

The stressful and sedentary lifestyle of many people today has been shown to be a cause of incorrect breathing habits (Ruth, 2015). Dysfunctional breathing habits are regarded as both a cause and also the result of dysfunctional physical and psychological states (Caldwell & Victoria, 2011). Disordered breathing patterns have been linked to anxiety states and affect cognition processes like decision-making.

However, the good news is that studies have shown that through proper, regular training, bad breathing habits can be 'unlearned' and replaced with good breathing habits (Caldwell & Victoria, 2011). Internal martial arts training, with its suggestion to develop long, smooth and deep natural breathing, is a useful tool with which to unlearn bad breathing habits.

Breathing through the nose as opposed to mouth breathing aids in filtering, warming and humidifying the inhaled air before reaching the lungs (Jefferson, 2010). Nose breathing is also credited with helping to maintain the elasticity of the lungs and proper function of the diaphragm, while allowing the tongue to stay in the ideal position touching the front part of the roof of the mouth. Another

benefit of nose breathing is that 10-20% more oxygen is taken up by the lungs as compared to mouth breathing (Ruth, 2015).

All these positive effects of breathing through the nose are very useful both in everyday life as well as in physical exercise, as in a martial art and other exercise methods.

'Watch how a child breathes and then do likewise' - Kuo Feng Chih's advice in Smith (2003) pg. 116

Small children breathe naturally and abdominally without conscious thought, and likewise the internal martial arts aim for this. Breathing is deep, natural and comfortable, without too much attention given to it during training in the three major internal arts of Tai Chi, Hsing yi and Pa Kua. Rigidly synchronizing inhalation or exhalation with particular movements during a form is discouraged, but the practitioner eventually finds that breathing settles down naturally and effortlessly.

Tension during breathing, leading to strained breathing results in reduced airflow and has negative effects on the immune and cardiovascular systems (Fokkema, 1999). A decreased, regular breathing pattern results in a shift towards parasympathetic nervous activity and a positive emotional state (Zhang et al., 2017). Furthermore, focused attention and enhanced decision making are linked to smooth, balanced breathing (Caldwell & Victoria, 2011).

'When the chi sinks to the tantien the internal organs can relax and move, and open and close with each breath' - Cheng Man Ching (Man Ching, 1985), pg. 62

Indeed, diaphragmatic or abdominal breathing has been shown to massage the internal organs which is beneficial, and also to result in more endorphins, the painkilling and happiness chemicals, being released by the brain into the blood circulation (Mattsson & Mattsson, 2002).

Meditation/ Mindfulness

'If you can practice with a quiet mind and a calm spirit your movement will be active and nimble'. - Sun Lu Tang in Smith (1990), pg 122

'*Internal boxing is essentially moving meditation……The internal requires quiet, stillness……a total presence'.*- Robert Smith in Smith (2003), pg 21

Meditative movement has been described as a new category of exercise where the mind is kept engaged in the movements to the exclusion of extraneous thoughts. Deep relaxation is essential, with movements typically slow and flowing but can also range from static postures to dynamic motions (Larkey et al., 2009). The Chinese internal martial arts certainly fall into this category of exercise.

The internal martial arts advise the practitioner to keep a constant awareness on the 'tantien', an area below the navel that corresponds to the center of gravity. In the words of the Tai Chi master Cheng Man Ching; 'The most important thing is to keep the mind and chi in the tantien, just like a hen incubating her eggs' (Wile, 1985 pg 33). The implication of this imagery chosen by the master is clear, that when the mind is focusing on the tantien a natural process of growth and nurturing is spontaneously happening.

This mental focus is maintained while doing movements which serve as distractions. Gradually, other mental awareness foci are added, like feeling the air pressure during the movements as if swimming on dry land (Hennessy, 1995, pg 123). Others are feeling weight bearing on the separate feet, feeling below the ground and 360 degrees spatial awareness. This type of mental focus exercise has been suggested as a mechanism whereby cognitive function and attention skills improvements have been observed in mindful movement practice (Clark et al., 2015).

The increased relaxation during movement improves thresholds of kinesthetic sensations and so improves sensitivity (Clark et al., 2015). In the martial arts sensitivity is a vital attribute, and the internal martial arts make tactile sensitivity a staple training attribute through soft and relaxed sensing hand drills, called ‘tui shou’ in Tai Chi and also Hsing Yi and ‘rou shou’ in Pa Kua (Frantzis, 1998).

Furthermore, a variety of sensorimotor training with effort reduction leads to the development of ‘dexterity’ (Bernstein cited in Clark et al., 2015). This is strikingly akin to what master Sun Lu Tang advised as cited above.

Mindful, slow movement may also improve the learning of new movement skills by reducing the activation of ingrained motor programs (Clark et al., 2015). A study by Wulf and Prinz showed that directing a performer’s attention away from the minute details of a movement helps with the learning of a new motor skill (2001). This can be applied to internal martial art training where attention is focused on the ‘tantien’ during posture training.

Another related interesting feature of the Chinese martial arts is the tendency to give flowery names to even simple looking movements, which in effect conveys an image intended to aid performance of the posture. Examples include ‘Monkey offers peach’ in Pa Kua, ‘Snake creeps down’ in Tai Chi, the 12 animal forms of Hsing Yi and many others. This particular feature of the Chinese martial arts nomenclature may help beginning students learn more efficiently by seeking to imitate the action of the animal rather than focusing on the many minute details.

Meditative or mindful movement has been shown to enhance non-reactivity to unpleasant thoughts and give time to restore balance in individuals (Mehling et al., 2011). Meditative movement has been shown to be effective in countering the stress response and resulting in increased well-being, lowered blood pressure and heart rate and improved immune function (Yeung et al., 2017).

Studies also suggest that mind-body practices may lead to a reduction of inflammation-related diseases (Buric et al., 2017). The relaxation response during meditation was shown to enhance the expression of genes associated with insulin secretion, mitochondrial function and energy metabolism (Bhasin et al., 2013).

These epigenetic effects of mind-body practices like meditative movement which result in more energy availability are obviously beneficial in the martial arts which ultimately require physical manifestations of speed and power. These studies also shed more understanding on the several health benefits attributed in many scientific studies to Tai Chi and Qigong, methods of Chinese internal martial art training.

Studies on mindfulness practitioners show that after prolonged practice they acquire a 'learned dispositional mindfulness' whereby the practitioners become more mindful of the world around them even when not meditating (Wheeler et al., 2017). This improved spatial awareness is very useful in self-defence, where a person is able to observe and avoid a potentially dangerous situation from happening.

Other positive spillover benefits of mindful practice are quicker reaction times and lower error rates on attention tasks, enhanced sensory perception and the ability to experience negative emotions without adding further negative emotions acquired in previous experiences (Wheeler et al., 2017). Interestingly, all these effects are desirable in the martial context.

In another study people who meditated frequently showed higher levels of mindfulness, self-compassion and happiness. Self-compassion, the desire to heal oneself with kind thoughts, has been shown to promote happiness in people (Campos et al., 2016). On a similar note, in the Chinese internal martial arts, which are heavily influenced by Taoist and Buddhist philosophy, there exist practices like the 'inner healing smile', where positive intent is given to inner

organs, tendons and bones, usually done in standing meditation (Chia and Li, 1996).

This is claimed to have health benefits through strengthening of the internal physiology. Furthermore, posture and form training in the internal arts is encouraged to be done with a happy, peaceful attitude, while a common advice is to relax the facial muscles into a faint smile.

Evidence is showing that mindfulness meditation can cause neuroplastic changes in the structure and function of certain brain regions that regulate attention control, emotion regulation and self-awareness (Tang et al., 2015). Other studies showed that neuroplasticity is enhanced in the mindful state especially when engaged in a visual-motor task (Ruge et al., 2012). This correlates to the practice of postures and forms in the internal martial arts, supporting the theory that neuroplastic changes do occur in such training (Amdur, 2015).

Studies on fully relaxed persons who were doing a mental computational task revealed that muscle sensitivity to movement was enhanced (Ribot-Ciscar et al., 2000). Also, focusing attention on a proprioceptive movement while relaxed also increases accuracy and sensitivity in blindfolded subjects (Hospod et al., 2007). These studies indicate the role of maximum relaxation in kinesthesia i.e. the awareness of the position and movement of the body through proprioceptors in muscles, skin, fascia and joints. This also explains why relaxation is a key tenet in posture training of internal martial art training.

Kinesthetic acuity in the martial arts is of vital importance, especially when one is in the chaos of a combat situation where one has to instinctively and speedily process a lot of information coming not just from the sense of sight, but from tactile, proprioceptive, hearing and sound sensory input. Hence the ‘sensing hand’ drills of ‘tui shou’ and ‘rou shou’ while maximally relaxed and with arms in light contact, sometimes done blindfolded.

Anatomy: The Musculoskeletal System and the Myofascial System

'Our posture should be erect and relaxed, able to control the eight directions'. - Wang Tsung-yueh's treatise on Tai Chi Chuan translated in Wile (1983), pg 107

'When the lowest vertebrae are plumb erect

The spirit reaches to the top of the head.

With the top of the head as if suspended from above;

The whole body feels itself light and nimble'.

Tai Chi Classics in Man-Ching (1981), pg 10

'...and use the tenacious energy (energy from the sinews) instead of the hard force (force from the bones of the body).' - Cheng Man-Ching in Man-Ching (1981), pg 126

It is clear that great strides have been made in the understanding of the anatomy of the human body. Recently the importance of the fascial system as an enveloping and deeply pervading system intrinsically linked to the musculoskeletal system to form the 'biotensegrity' of the body, has been shown (Adstrum et al., 2016). A direct continuity of myofascial chains from head to toes with the capacity to transmit forces, has been recognized (Wilke et al., 2018).

It has been shown that muscles transfer most of their contractile forces onto fascial sheets rather than tendon attachments to the skeleton, as was traditionally held (Findley, 2011). Furthermore, an intact fascial system can create inter-muscular pressure and adjacent transverse loads that may even work against the direction force of a particular muscle contraction. These complex force vectors are beneficial in dynamic loading and spinal core stability (Driscoll, 2017).

Breathing in deeply with the abdomen and muscular pressures in the spinal-pelvic regions (as in the pelvic tilt where the lumbar curvature is straightened) create

intra-abdominal pressures that increase the tension of the thoracolumbar fascia (Driscoll, 2017). This is a key contributor to spinal stability and force transmission from the lower body to the upper extremities, or vice versa as in absorbing external forces.

Such complex mechanisms may be involved in internal martial arts concepts like ‘peng’. Here specific alignments such as rounding of the back at the scapular region, straightening of the cervical (neck) and lumbar curvatures (lordosis) and internal adjustments of the elbows, fingers, knees and many other areas of the body lead to a unified structure. This has minimal muscular tension but physically able to withstand considerable forces that can be dissipated vertically downwards to the ground. All internal martial art postures should have this ‘peng’ quality, and this is the physical basis of ‘iron shirt’ skill.

The Fascial Bodysuit

Other studies highlighted the presence of the well-innervated fascial network that enveloped and connects all parts of the body into one integrated whole. It has been shown that stretching one limb increases the range of motion of the other limb (Nordez et al., 2017). Stretching of the lower limbs increases the range of motion of the upper limbs and vice versa (Behm et al., 2016).

When one is slumped i.e. with a curved back, knee extension range is reduced. It has been suggested that the highly innervated fascial system triggers the increased strain of the stretch as pain, thus limiting the maximal range of motion (Nordez et al., 2017). Other evidence for the non-local exercise effects involving myofascial chains includes the isometric stretching of calf and hamstring muscles that leads to increased neck flexibility, and foot self-massage that increases hamstring stretching capacity (Wilke et al., 2018).

The Chinese internal arts postures aim to unify the whole body into one integrated whole, with the lower body taking precedence over the upper body and the lowered stances serving to strengthen and stretch the legs, feet and ankles considerably. Tai Chi master and author Cheng Man Ching has been reported as telling students that the posture 'Snake creeps down' is all the stretching exercise one needs. Recent studies support this view by suggesting that the stretching of the pelvis and lower limbs has non local effects of flexibility in the upper body also.

It is widely held that a well-balanced myofascial system resulting in an optimally balanced biotensegrity leads to spontaneous correction of minor mal- alignments of bones and joints, as can be confirmed by advanced internal martial art practitioners who experience 'cracking' release of tight spinal, hip and other joints during posture training.

Power generation is always developed from the legs and feet and transferred and augmented up the pelvis and back to be discharged through the striking surfaces like the fist, palm, forearm, elbow and even the shoulder and head.

'The root is in the feet, energy issues up through the legs, is controlled by the waist and is expressed in the hands and fingers'. - Yang Lu Chan's commentary to The Tai Chi Chuan Classic, in Wile (1983), pg 102.

Interestingly, studies support the view that the fascial system could be the physical framework of the meridian theory of Traditional Chinese Medicine of acupuncture (Bai et al., 2011). The meridian theory of acupuncture is traditionally an integral part of Chinese martial art theory. Acupuncture holds that correct stimulation of particular points on the energy meridians results in an optimal and unhindered flow of *chi* throughout the body, with beneficial health consequences.

Research into acupuncture has provided more knowledge of fascia and connective tissue. It has been found that the physical movement by twisting of

acupuncture needles results in the winding of areolar connective tissue layers that sends mechanotransduction impulses which signal responses in connective tissue fibroblasts. The resultant stretching of tissue causes extracellular signalling and active cell-mediated tissue relaxation (MacPherson et al., 2016).

Head posture

The instructions on head posture in the internal martial arts are very clear; the head should feel as if suspended from the top of the crown by a string from above. This aligns the head to gravity and prevents forward head posturing or tilting in any direction. Studies confirm the benefits of such a posture, even showing evidence of related optimal respiratory function and lung capacity, as well as prevention of neck pain (Lee et al., 2017).

The tongue position

'Your mouth is gently closed, your tongue touching the roof of the mouth'. - Sun Lu Tang in Smith (1990), pg 122

The reasons given for this instruction have been to increase salivary flow which is beneficial for health, to allow the flow of 'chi' to flow unimpeded downwards to the tantien, and for the practical reason so as to prevent one from biting the tongue during a fight. The pilot study by di Vico et al. suggested that the knee flexion peak torque increased by 30% when the tip of the tongue of the study subjects touched the anterior part of the hard palate, as opposed to a lower position (2013). This may suggest that physical performance may be significantly enhanced by this tongue position. Further research in this field is warranted.

The Knees

In the postures of Tai Chi, Hsing Yi and Pa Kua the knees are always bent to varying degrees. The degree of the depth of the stance depends on the fitness level of the practitioner and the degree of the training intensity aimed for. The stances are all varying modification of the squatting position, and can be described as isometric training in the static postures, with variable degrees of concentric and eccentric muscular activity in the slow moving postures kept at constant depth.

A recent study showed that three staple Tai Chi postures increased the range of motions of the knees more than walking or jogging, and produced a beneficial level of stress on the knee joints (Niu et al., 2017). Isometric semi squat training was found to increase the stiffness of human tendons, muscle strength and size of leg muscles. These lead to improvements of physical performance during rapid movements (Kubo et al., 2001).

Palmer et al.'s findings suggest that performing isometric squats at 150 degree knee angles may result in better peak force and force rate development than with knee angles of 120 degrees or even 90 degrees (2017). This would indicate that postures done at medium depth are more beneficial than deeper stances vis-a-vis force production. Another study suggested that human tendons showed the most changes with longer duration isometric training rather than short duration but high force exercises (Kubo, Kanehisa & Fukunaga, 2001).

These findings implicate that the extended periods of lowered stance postures done in static standing or slow form training of the internal martial arts are conducive to beneficial adaptations of the lower limb tendons. However practitioners need to be cautious in progressively deepening their squatting stances, since the stress forces on the knees increase exponentially not linearly from a higher to a lower squat position (Cotter et al., 2013).

Another study that is relevant to the internal arts is that by Mukaimoto & Ohno, who found that slow movement with low-intensity resistance induces a much

greater energy expenditure than high or low resistance exercise done at normal speed, and exhibits the same total excess post-exercise oxygen consumption for 3 hours after the exercise is finished (2012). This would be in line with the view that even done very slowly, the forms of Tai Chi, Hsing Yi and Pa Kua are considered a moderate form of exercise, notwithstanding the deceptively leisurely pace of the movements.

In the rehabilitation of hip and knee replacement surgery patients it has been shown that slow isotonic-eccentric stretching speeds recovery more than the traditional passive stretching (Parmar et al., 2011). This is another indication of the health benefits of slow isotonic-eccentric exercise which is what the slow moving semi-squat postures of the internal martial arts can be described as.

Finally, isometric contraction methods that are used in manual therapy have been shown to reduce inflammation and speed healing by improving fluid movement in fascia (Chaitow, 2015). Incidentally, static postures in standing meditation (zhan zhuang) involve isometric activity of the major leg muscles. This intense exercise of the leg muscles as seen in static and dynamic posture training in the internal arts has also been called the ‘second heart’, since blood and lymph circulation from the lower limbs to the upper body is enhanced.

The Ankles

Proprioceptive exercise like balancing on one foot while doing a task, or balancing on a wobble board, reduces the risk of ankle sprains (Rivera et al., 2017). In the posture training of Chinese internal martial arts there are continuous opportunities for similar proprioceptive exercise.

Postures like the Tai Chi ‘Golden cockerel stands on one foot’, the Hsing Yi ‘phoenix’ form, the Hsing Yi/ Pa Kua snake and monkey forms involve striking with a foot or knee and can be done slowly and with full balancing control.

Furthermore, every step within an internal form requires complete weight shifts with full control even while performed very slowly, since even a momentary uncontrolled dropping of one's weight is seen as an opening or vulnerability to an attack (Rottmann, 2001). This has been likened to the deliberate stepping movement of a cat, hence the term 'cat step protocol' (Meredith, 2014). Thus an internal form can be a very useful opportunity to train ankle strength, flexibility and proprioception.

Power generation

A powerlifter can lift 250kg but spinal muscles alone can support 50kg. This is explained by the coordinated utilization of the fascia (Gracovetsky, 2008). It has been shown that when the pelvis tilts so as to straighten the lumbar lordosis (curvature), forces in the pelvis and back become borne mainly by the lumbodorsal/thoracolumbar fascia rather than by the erector muscles (Gracovetsky, 2008).

In the upright posture and during walking, the power from the legs to the upper body is ideally transferred via the lumbodorsal fascia so as to minimize stresses on the intervertebral joints of the spine (Gracovetsky, 2014). The lumbodorsal or thoracolumbar fascia has been described as the connecting system that joins the pelvis and lower back regions to the upper and lower limbs (Cortell-Tormo et al., 2017).

These findings support the requirement of the internal arts to keep the 'lowest vertebrae plumb erect' via the pelvic tilt, so that the power from the feet and legs can flow upwards unimpeded as efficiently as possible along the myofascial trains.

Wilke et al. found that fascia is thinner in the arms than in the legs, and thicker in the posterior regions than at the front (2018). This suggests that myofascial force

transmission is largest posteriorly i.e. along the back and through the legs (Wilke et al., 2018). This is aligned to the internal martial arts' teaching that power is generated from the feet and legs and transferred up the pelvis and back to be released in the hands.

An interesting observation was that the increase of both lumbar and thoracic curvatures of the spine is linked to a decrease in respiratory muscle strength and lung function (Rahman et al., 2017). This suggests that the recommendation in the internal martial arts to reduce the lumbar and cervical lordoses through postural control has salubrious effects as well as biomechanical advantages.

Studies on the prone plank exercise showed that when the scapulae or shoulder blades are abducted or widened to create a round upper back and the pelvis is tilted so as to reduce the lumbar curvature, the overall fascial system is stretched and stiffened, effectively reducing muscular demands on the core and enhancing core stability (Cortell-Tormo et al., 2017).

These findings can be extrapolated to the upright posture when the raised hands are receiving frontal forces which are absorbed by the whole body. Conversely, in the opposite direction, forces generated by the lower limbs and moving along the back and through to the issuing hands, are most efficiently transferred through the aforementioned pelvic tilt and rounded shoulders and upper back. This is also a basic tenet of posture training in the Chinese martial arts, with the scapular positions termed 'bear shoulders'.

Another mechanism of power generation that has been scientifically studied is the 'serape effect', where the pelvis is moved in an opposition with the chest to produce a rotational windup and stretch, to be released in a powerful snapback involving various myofascial linkages (Cortell-Tormo et al., 2017). In the internal arts this 'serape effect' is overtly seen in Pa Kua, with its constant twisting and turning. However similar myofascial involvement is found in the more hidden

spiralling movements of Tai Chi and Hsing Yi. In fact, in the three martial arts coiling and uncoiling of varying degrees are constantly occurring from the fingers, wrists, forearms and arms and onto the torso and pelvis and even down to the legs and feet.

Da Mo's Tendon Changing and Bone Marrow Washing Exercise

The Buddhist monk Da Mo (also known as Bodhidarma) traditionally has been credited with devising this set of qigong exercises to strengthen the inner constitution of his student Chinese monks, around the 6th century AD (MacRitchie, 1993). These exercises eventually became integrated into existing self-defence methods. The postures of the internal martial arts are also regarded as effective health methods for strengthening the whole body internally.

Science has recently begun to explore new fields in human anatomy and medicine. Research showed that dynamic mechanical stresses and pressure gradients as occur during exercise, as well as in deep breathing, organ movements and arterial pulsation, result in better interstitial fluid flow at the cellular level. This fluid flow transports beneficial substances and waste products to and fro the cells (Findley, 2011).

These stresses and pressure gradients also stimulate fibroblast cells in the fascia to differentiate into contractile myofibroblasts and to increase the production of collagen, the building material of fascia, tendons, ligaments, skin and bone (Findley, 2011). Another revealing discovery is that streaming potentials that result from fluid flow throughout bone canal systems direct the remodelling of bone (Findley, 2011).

These discoveries are very much in line with the ancient qigong theory of changing the tendons and washing the bone marrow.

The internal martial arts' emphasis of sinews development over muscle

Research has shown that fascia changes much more slowly but with much more long lasting results than muscles (Schleip & Muller, 2012). After two or more years of consistent, moderate training the fascial bodysuit becomes more injury resistant, elastic and sensitive (Schleip & Muller, 2012).

In the internal martial arts it is well known that 'sinew' strength can be developed and maintained into old age, as opposed to muscular size and strength. In fact, a widely held view in the Chinese martial arts is that it is possible for skill, timing and sinew based power to be retained by old masters who can defeat younger and faster attackers.

'The human body has three layers of membranes – outside the muscles, outside the tendons and outside the bones. These membranes act like an inner tube, and Tai Chi strengthens these membranes so that they become impervious to blows'.
- Cheng Man Ching in Hennessy (1995), pg 124

Fascial remodelling is stimulated by gradual increases in strain on the fascial system, bigger than that experienced in normal daily activity, and which utilizes the elastic recoil of the fascia (Schleip & Muller, 2012). There are several suggestions on such fascial training available in scientific literature.

One is the practice of soft elastic bounces done in the maximum range of motion possible at that point in time (Schleip & Muller, 2012). In the Chinese martial arts it is common practice to hold each posture awhile even during form performance and sink slightly further, without the bounces. This method has been advocated in energy centric training (rather than for fascial strengthening) in internal art postures held statically, and called the 'counter sink protocol' by its proponent (Meredith, 2014).

Another fascial training is the preparatory counter movement, where a slight ‘pre-tensioning’ in the opposite direction results in a more powerful effortless movement when released. Also, movements that engage the longest possible myofascial chains through spiralling rotations are a good exercise for fascial stimulation (Schleip & Muller, 2012).

These mechanics are very predominant in the internal martial art postures and forms. The aforementioned coiling movements are spiralling in nature, involving practically the whole body from feet to hands. In stepping from one posture to the other the weight is completely loaded from one foot to the other, which has elements of ‘pre-tensioning’ in it including waist rotations which power the following movements.

This has been called ‘swing and return’ by Cheng Man Ching, the Tai Chi master. Complete weight shifts and whole body propulsion using counter movements ingrained in every posture seamlessly flowing to the next, are clearly evident also in Hsing Yi and Pa Kua stepping.

Movement performed in a smooth and flowing manner while making as little noise as possible utilizes the fascia considerably (Schleip & Muller, 2012). This type of movement is staple in internal martial art form training.

Another fascial training concept is that of varied and creative movements, with small specific motions intermingled with large extended movements. This leads to increased proprioception and sensitivity awareness to areas of the body that have become neglected (Schleip & Muller, 2012).

While the internal martial art forms contain a wide range of movements obtained by flowing from one posture to the other, this concept is further utilized in unrehearsed shadow fighting where the practitioner imagines an opponent and shadow fights using spontaneous movements that are in line with internal martial principles. Besides helping the student become familiar with spontaneous whole

body movements needed in fighting, in preparation for actual sparring, this is seen to have the advantage of training the fascia.

Traditionally internal martial artists increased the resistance while doing the forms by holding heavy weapons such as the broadswords, spear, long staff and also going through the postures while holding iron rings and a heavy ball. Pa Kua in particular has a large variety of weapons training (Smith, 2003).

The principles of the internal postures were retained but the resistance could be increased progressively. Furthermore, the depth of the stances could be increased gradually, increasing the work done. This type of training would be recognized as fascial training where strain on the fascia is increased gradually.

An interesting research finding is the water retaining property of collagen in fascia, similar to a sponge. During exercise, fluid is squeezed out of the viscoelastic fascia, which loses its springy resilience leading to a decrease in optimal function. Thus, short periodic breaks have been recommended during prolonged exercise, to allow the sponge-like architecture of the fascia to reabsorb the lost fluids (Schleip & Muller, 2012).

Interestingly, this method of training with short periodic breaks has been described by the internal master Sun Lu Tang (translated in Meredith, 2014, pg 275). He described how after finishing a formal sequence of Hsing Yi Chuan, he would stand still in quiet meditation, feeling energetic movements inside his body. Again, while the emphasis of internal training is not physical but energetic, research is showing that such methods benefit fascial development.

The Psychological Effects of Posture

Research is showing that posture and energy levels affect people's emotions and thoughts, and vice versa (Peper et al., 2016). Even standing in an expansive 'power posture' was shown to increase testosterone and lower cortisol (stress hormone) levels in the blood (Carney et al., 2010). Adopting an expansive, erect

posture results in the projection of power and authority while increasing self-confidence.

Assuming a slumped, constricted posture has the opposite effect (Huang et al., 2011). Also, when a person assumes an erect posture as opposed to a slumped one, the subjective feeling of increased energy occurs.A study has found that even just two minutes of posture change starts to bring changes in hormones, moods and feelings of strength (Peper et al., 2016).

The internal martial art postures can be regarded as ‘power postures’, both because of the erect anatomy and also because they are martial in nature, with the intent compared to a cat or a falcon about to pounce on its prey (Wile, 1983, pg 108). Postures such as ‘Single Whip’ and ‘Playing the Guitar’ of Tai Chi, the ‘Santi’ pose of Hsing Yi and the coiled posture of the Pa Kua circle walking training are just a few examples.

It has been shown scientifically that the motor qualities of a movement, not the specific movement itself, can bring about certain emotions (Shafir et al., 2016). ‘Feeling afraid’ was predicted by leaning back, retreating backwards, enclosing the body and extreme tension in the body muscles. ‘Feeling happy’ was predicted by rhythmic dance-like motions, lightness and free flowing movements with minimal tension. ‘Feeling happy’ was also predicted by enlarging the shape of the body both horizontally and vertically, possibly because such a posture change produces the feeling of power and security also (Shafir et al., 2016).

Finally, studies have pointed out that when a person stands in an erect posture, other people respond instinctively in a positive way, perhaps to the subtle thoughts and body language non-verbal communication that occurs when this erect posture is assumed (Peper et al., 2016).

It is evident that posture training in the Chinese internal arts, being so expansive, relaxed, tall and erect, is conducive to feelings of happiness, energy, security and

power. And according to a study, these positive feelings do not come after many hours of practice; just two minutes are enough to bring significant changes (Peper et al., 2016)!

All these psychological changes are beneficial not just in terms of health, due to a reduction of perceived stress, but also in relational attributes, since it has been shown that the body language and subtle thoughts that follow such a posture change, are taken up subliminally by other people.

It has long been known that self-defence begins with a self-confident body language and awareness, since potential muggers target their victims depending on such cues as a slumped posture, a lack of spatial awareness and other signs of an easy prey. Finally, in a fighting scenario, the subjective feeling of confidence and power is essential to success or even survival.

Relaxation and Physical Performance

'Relax is the prime rule; without it the others avail little'. - Robert Smith in Smith (1999) pg 283.

The effects of relaxation on sensitivity and kinesthesia in the human body have been discussed in the section on meditative movement and mindfulness. Research points out that relaxation techniques are also beneficial to sports performance because they reduce anxiety and stress, as well as reducing oxygen metabolism, respiration needs and muscle tension, as well as crippling negative thoughts (Parnabas et al., 2014).

Progressive muscle relaxation and autogenic relaxation were compared and both were found to decrease depression, fatigue and confusion as well as anger scores in adolescent soccer players (Hashim & Yusof, 2011). This suggests that

relaxation of the skeletal muscles induces positive cognitive effects and vice versa.

Another study on progressive relaxation technique on footballers' performance showed that the distance measured by the Cooper test increased after relaxation training, implying increased maximal oxygen uptake by the players (Jaworska et al., 2015). It was suggested that relaxation techniques reduce sports injuries because they enhance coping with stress and give the feeling of confidence and improved internal control, leading to good decisions taken and better physical execution.

Studies on progressive relaxation showed that it resulted in improved lung function (Vempati & Telles, 2002) and is an effective pain control method (Emery et al., 2006).

All these research findings suggest strongly that the basic tenet of the internal martial arts, called the 'soft arts' by some, which is maximal relaxation, is actually correct and beneficial in a physico-mental endeavour such as a martial art. Relaxation appears to improve physical performance and endurance as well as improve pain tolerance, a useful attribute in a fighting scenario.

Modern sports science accentuates that without adequate recovery, the full potential of an athlete cannot be reached and overtraining, burnout and injuries follow (Kellmann et al., 2018). Relaxation training as a method of recovery between workouts has been found to reduce stress, anxiety and increase parasympathetic activity, as well as shorten healing time (Pelka & Kellmann, 2017).

Again this gives credence to Sun Lu Tang's description of his training method previously described, where he advocated standing completely still and relaxed for some time in between lines of Hsing Yi forms.

The Biofield

'Do not seek the external, seek the internal, the 'chi'. That is, the heart of the matter'. - Cheng Man-Ching in Man-Ching (1985), pg 63

Based on recent evidence, the 'biofield' has been described as a complex, endogenously generated energy field surrounding and permeating living bodies, that guides homeostasis and is influenced by consciousness (Jain et al., 2015).

Types of Energy identified within the Biofield

So far electric, magnetic, electromagnetic and biophotonic energy as well as 'subtle energy' have been described within the biofield. Modern physiology clearly shows that muscle and nerve cells exhibit an electric high speed action potential, while fascia, skin and tendons also possess electric streaming potentials.

Mechanical stress in bone results in piezoelectricity (Hammerschlag, 2015). Intracellularly, electric potentials are involved in organelle function, in the regulation of vital cellular activities like cell division, growth and specialization (Zhao & Zhan, 2012). Western medicine makes widespread diagnostic use of the electric fields generated by the brain and heart, through the use of ECG (electrocardiogram), and EEG (electroencephalogram).

Physics holds that electricity in motion generates a magnetic field in the surrounding space. Magnetic fields can be detected around a living body with the help of devices like the SQUID magnetometer. The heart's magnetic field is measured by a MCG (magnetocardiogram), and appears to carry information that can be detected by other persons or animals (Hammerschlag, 2015).

The brain's magnetic field is measured as a MEG (magnetoencephalogram), and the brain's electric and magnetic fields have been suggested to affect neurone

synchronicity, circadian rhythm and cognitive processes within the brain (Hammershlag, 2015)

Another type of energy is the coherent ultraweak photon emissions (UPE) detected from body surfaces and even cell cultures, and biophotons may serve the important physiological role of high speed information transfer between cells and even organs (Hammerschlag, 2015).

'Subtle energy' describes one or more forms of energy whose effects have been reported but cannot be explained by classical physics and biology. Examples include phenomena like distance healing effects, and the effect of intention on cultured cells and physical reality (Hugie, 2014). These phenomena are however more readily explained by modern quantum physics.

In quantum physics the role of the 'observer' and so 'consciousness' takes prominence and is seen to influence the outcome of experiments (Kafatos et al., 2015). The famous experiment of the 'phantom leaf' suggests that the coronal energy field that persists after the leaf is cut off may serve to carry information and may be under the influence of a quantum level nonphysical field that is below the level of, and supports electromagnetic fields (Kafatos et al., 2015).

Another research field that supports the quantum view of the biofield is the study of DMILS (distant mental interaction with living systems) in laboratory settings, where focused attention and intent appear to actually affect the human body from a distance, and can be explained by quantum nonlocality and quantum coherence (Radin et al., 2015).

With this scientific body of evidence on the biofield, it appears that the term *'chi'* as used in Chinese traditional medicine and the internal martial arts may be one or a combination of, or even all of the above mentioned types of energies, recognized intuitively and experientially by generations of ancient Chinese masters. That the Chinese managed to study, describe and meticulously chart the

biological effects of this *'chi'* as found in the complex traditional medicine acupuncture meridian theory is an impressive feat in its own, even without considering the veracity or lack of, this model.

Another interesting observation from these scientific studies is the crucial role of the 'observer' or consciousness. In the Chinese internal martial arts, the mind is supreme over the body. Titles like Hsing Yi Chuan (Form of Mind Boxing) and Yi Chuan (Mind Boxing) hint strongly that the mind is vital to these arts. In the Tai Chi Classics likewise;

'If the mind acts as a guide, the chi will follow….. our mental attitude should be calm'. - Wang Tsung-yueh, translated in Wile (1983) pg 105.

Furthermore, the calm, mindful mind advised in the internal arts can be compared to the 'observer' described in quantum theory, doing nothing effortful except just being aware and observing, letting everything happen naturally. This is in line with the Taoist concept of 'wuwei', which can be translated as 'doing nothing extra'. With regular practice of the postures, one will find that progress is happening naturally:

'Do you have the patience to wait till your mud settles and the water is clear? Can you remain unmoving till the right action arises by itself?' - Lao-tzu, (trans. in Mitchell, 1988, Ch15). This line from the Tao Te Ching can be interpreted to describe the process of energy cultivation through the standing postures of the internal arts, where the gradual spontaneous stirrings of *chi* are observed and felt in any practitioner who perseveres with the training.

'Friends, if you desire your chi to circulate freely throughout your body, you must receive correct instruction in the Thirteen Postures'. - Wang Tsung-yueh, trans. in Wile (1983), pg 105

Biofield receptor biological systems

Three mechanisms whereby energy fields are received and processed within the body have been described:

i. Molecular level receptors in cell membranes and DNA. These respond to electromagnetic signals in a biological way
ii. Charge flux sites in cell membranes
iii. Endogenously generated electromagnetic fields responding to outside fields (Hammerschlag, 2015).

The collagenous fascia which envelopes and permeates the whole body even down to the cellular level seems to possess all three types of biofield receptors. Collagen fibres conduct and modify photon pulses (Van Wijk et al. cited in Hammershlag, 2015). Also collagen in the fascia is ultrasensitive to electromagnetic fields, as explained by 'spin coherence' and 'quantum coherence' (Hammerschlag, 2015).

Fascia communicate with all the cells of the body via 'integrins', transmembrane bridging molecules which influence metabolism and genetic activity (Oschman cited in Hammerschlag, 2015). On a similar vein, it has been shown that electromagnetic fields of amplitude similar to the cardiac field can affect gene expression in stem cells (Muehsam & Ventura cited in Hammerschlag, 2015).

This is remarkable in showing that energy can affect the physical body at the genetic level, since stem cells are the undifferentiated cells with the potential to specialize into various types of tissue cells.

A person focusing appreciative thoughts towards a cell culture of fibroblasts led to significantly increased DNA synthesis of these cells (Rein cited in Baldwin & Trent, 2017). Interestingly, this correlates with the 'inner healing smile' qigong practice previously discussed in the meditation/mindfulness section. Likewise,

internal posture practice should be done with a mental attitude of calmness, ease and feeling happy (Smith, 2003).

These novel discoveries, where even minute energy fields influence the proper functioning of human cells even at the genetic level, should have a profound impact on modern medical sciences. In fact, work by Pall confirms that living cells are very sensitive to very small energy fields even more than to larger fields (cited in Oschman, 2017).

The new theory of quantum biology sees the human body as a macroscopic quantum system (Kafatos et al., 2015). This is very similar to the Taoist and Classical Chinese medical theory, where the human body is seen as a micro-universe, existing in an intimate relationship with the outer universe around us.

In recent years there has been an increased use of unconventional medical therapies like biofield therapies among patients with chronic pain, HIV and cancer (Baldwin & Trent, 2017). This led to the newly coined term 'Complementary and Integrative medicine' (CIM) where conventional and complementary medical approaches are integrated (Hufford et al., 2015). The National Institute of Health of the United States recognizes Qigong, Acupuncture, Reiki, Reconnective Healing and Healing Touch as biofield therapies (Hufford et al., 2015).

The missing link in conventional medicine may be the possibility for self-empowerment and the ability of every sick patient to activate the innate human capacity for healing (Jain et al., 2015).

The Relationship between the Biofield of Living organisms and the Environment

The Classical Chinese Taoist theory as espoused in the internal martial arts holds that in posture training one can draw from the health giving *chi* of heaven and

earth. In the ‘Yellow Emperor’s Classic of Internal Medicine’, thought to be 4000 years old, the Emperor tells the court physician:

‘I have heard that in ancient times there were so-called Spiritual Beings; they stood between Heaven and Earth, connecting the Universe…’ - (Chuen, 1991, pg 30).

In the internal these lines are understood to describe the tapping of the human body to the *chi* of the sky and the *chi* of Earth, to meet and be stored in the *tantien* in the lower abdomen (Wile, 1985, pg 33).

Research showed that changes in environmental electromagnetic fields as occurs during a thunderstorm, significantly affected the biofield of trees (Saxton Burr cited in Baldwin & Trent, 2017). It has also been hypothesized that environmental electromagnetic fields influence the collective frequencies generated by living cells by entrainment, resulting in these minute fields to resonate with the external field hence altering them (Rein cited in Baldwin & Trent, 2017). Preliminary studies suggest that reconnective healers may access environmental energy fields to influence their personal biofield and pass them on to patients by entrainment (Baldwin & Trent, 2017).

Biofield device technology sheds more light on this subject. More and more people are being diagnosed with sensitivity to electromagnetic fields from mobile phones, wireless base stations, lap tops and radar, resulting in the new medical science of Environmental Medicine (Oschman, 2017). The Pranan brand of protection devices shows evidence of beneficial stabilization of disrupted physiological processes.

The inner and outer surfaces of these portable devices have geometric patterns corresponding to the mathematical symbol known as ‘phi’, or the ‘golden ratio’, which in quantum physics is related to magnetic fields (Oschman, 2017). It is hypothesized that these geometric patterns on the Pranan devices resonate with

the electromagnetic fields in space, modulating them into beneficial frequencies which in turn are picked up by the skin and fascia of the human body (Oschman, 2017).

Another interesting observation is the discovery by Guimberteau that skin and human fascia possess a microscopic geometric pattern in the form of a polyhedral framework (Oschman, 2017). Oschman further hypothesized that these geometric patterns of the fascia and skin are involved in the ability of the human body to serve as an antenna, picking up various forms of energy fields from the environment (2017).

From the Chinese internal martial art viewpoint, these are very exciting findings. Training in these methods is preferably done in open, clean spaces with trees and countryside, and in the big cities public parks are the usual meeting places for groups or individuals training in Tai Chi, Hsing Yi and Pa Kua. This is considered to allow the practitioners to make use of the vitalizing *chi* of fresh clean air (Frantzis, 1998).

A Hypothesis on Energy work in Posture Training

The various standing postures of zhang zhuang and all the other postures of the three major internal arts have been devised by generations of Chinese masters to assume the optimal conditions for maximal energetic flow within and beyond the human body, while having the potential of self-defence use. From the data from many studies analysed in this thesis, the author suggests a hypothesis on what is happening in the internal martial arts postures based on plausible mechanisms:

1. The human body's various energy fields merge into a global energy field which can be either in harmonious synchronicity with its constituent parts and hence result in a strong, vibrant field, or else the different types of energy fields can interfere with and oppose each other to result in a weaker

overall energy field. This resultant energy field of the human body is seen to be in a constant relationship with the environmental energetic fields.

2. The energy absorption and conduction properties of the fascial system can vary in efficiency depending on the anatomical polyhedral framework, which may vary depending on the degree of tonus of the fascia within the biotensegrity of the human body.
3. Just as the acupuncture needle twisting motion results in a sustained stretching of the subcutaneous loose connective tissue signalling a cascade of beneficial systemic responses by mechanotransduction, so can the proper tautness of the fascial system achieved in correct posture alignments result in a somewhat similar effect. It is interesting to note that the method of ‘cupping’ in traditional Chinese massage of necessity also affects the superficial fasciae under the skin. This possible mechanism is supported by internal martial art theory that specific postures have specific beneficial health effects (Frantzis, 1998). This supports the notion that specific postures influence the fascial system of the body in specific ways resulting in specific physical, physiological and energetic effects.

The optimal condition for energy flow in the human body is achieved through a mindful state with small, specific adjustments of the musculoskeletal system.

This results in the biotensegrity having the ideal amount of balanced myofascial tonus that allows energetic flow and achieves the optimal polyhedral geometric pattern for energy absorption and flow. There is no interference from extraneous electromagnetic fields that result from excessive muscular tension and neural activity. The calm meditative mental attitude also results in the brain electromagnetic (and other) field properties that are most conducive to an unhindered and strong energy flow throughout the body.

These adjustments of a supple and relaxed musculoskeletal system include the erect posture, tucking in of the pelvis and lengthening of the spine via raising of

the crown, rounding of the scapulae, deep abdominal breathing and the bent knees, all of which have been seen to engage the myofascial chains more and muscular tension less. Another adjustment is the spiralling or coiling movements which firmly 'wrap up' the myofascial chains.

A small giveaway supporting this hypothesis is the attention in the internal martial art postures to the '*hu kou*' or 'tiger's mouth', which is the space between the stretched thumb and forefinger (Smith, 1990). This minor opening effectively tightens the fasciae in the fingers, hands, forearms up to the arms, in continuity with the fascial system in the rest of the body, as per the non-local effects of fascial training described in detail in the previous section. Indeed, all the various training suggestions (described in the section on anatomy) to strengthen the fascial body suit may serve this energy enhancing function as well.

This hypothesis reconciles the importance of muscular relaxation, a meditative state of mind as well as the physical requirements of the Chinese internal arts, with each other.

Finally it is worthy to note that while fascia do seem to be involved in the conduction and absorption of energy, they should not be confused with the energy itself, just as a wire is not the electricity that it conducts. This was succinctly explained by Tai Chi master Cheng Man Ching:

'As a tire is strengthened by air, so is the skin by the chi, with the membranes or linings of the skin playing the role of the rubber tube in the tire.' - Man-Ching (1981), pg 11

This assertion by Master Cheng is incidentally the energetic foundation of internal kung fu, where the physical anatomy i.e. fasciae and musculoskeletal system may become energized and able to withstand physical blows without harm, while the balancing of the internal physiology prevents disease from settling in (Hennessy, 1995, pg 124).

Conclusion

This thesis has sought to study the postures of the Chinese internal arts from a scientific viewpoint. Six essential constituents that are ingrained in every posture have been identified. Recent scientific papers dealing with each of the six topics were collected and reviewed in this investigation. The results marked clearly visible dots on a clean sheet, which when joined together traced a much clearer picture of the internal martial arts postures.

It is important to point out that while this study identified six sections, in reality they are not separate or mutually exclusive, and in the human event of being alive they merge into one holistic entity.

It is evident that Tai Chi, Hsing Yi and Pa Kua are based on scientifically approved principles, a remarkable finding given that these methods were conceived in ancient China and certain features have only recently been discovered by modern science.

The three internal arts are based on sound anatomical and biomechanical principles which result in optimal physical performance as well as physical and mental health promotion. This investigation throws more light on understanding how Tai Chi, the best well-studied of the three internal martial arts so far, has been scientifically shown to be such a broadly health-giving practice.

The deep, slow breathing from the nose, the meditative movement, the erect, relaxed posture with major emphasis on myofascial exercise with minimal muscular tension have been clearly shown to have health benefits and optimal physical performance potential.

An interesting feature of the internal arts is the energetic practice, which has been found to be based on classical and quantum physics. Concepts like ‘chi’ which were so readily and widely dismissed in the West as cultural relics or cryptic and arcane ways of describing an Asian martial art, should now being taken more seriously and with a much smaller sized pinch of salt.

Even today, there are observers and practitioners of the Chinese internal arts who reject the concept of *chi* in favor of a purely physical, biomechanical approach. This thesis amply demonstrates that this approach is mistaken and akin to the proverbial throwing the baby away with the dirty bath tub water!

Based on the data analysis, a hypothesis has been put forward regarding the conditions for the optimal energy absorption and conduction through the body. Once the mechanism of a strong and unimpeded *chi* flow is identified, other human endeavors outside the internal martial arts will be able to adopt these features and super charge existing practices.

What is so remarkable with the Chinese internal arts is the seamless integration of multiple crucial factors such as breathing, relaxation and various other anatomical considerations, mindfulness, psychology and bioenergy into one holistically combined practice. This makes internal art posture training an efficient, convenient and freely accessible time-tested method of self-empowerment and rejuvenation, unlocking the health-restoring potential in the human body, with profound implications towards preventive, palliative and even curative medicine for today's hectic and stressful lifestyles.

This work should also help practitioners of the internal martial arts understand more what the training entails, so as to keep persevering in daily, manageable doses of practice time. So far, students largely relied on faith in their teacher's instructions and in the system, which is obviously valid and essential. However the discoveries gained in this study should consolidate the traditional approach.

Training in these Chinese internal martial arts may make practitioners ever more aware of environmental issues that plague modern society. This is because according to Taoist theory the health nourishing *chi* of the heavens and earth that is freely available to anyone who taps it, depends on an unpolluted environment. So practitioners slowly may become more conscious of the importance of clean air, pure water and wholesome food, and realize more acutely that their own well-being and that of future generations depends on an untainted Nature.

Finally, it is possible that when one realizes that well-being can be achieved simply by standing still in a posture, or by going through a slow, flowing sequence of postures in a peaceful setting near Nature, one may experience gratitude, leading to humility, and a step closer to a spiritual awakening.

Recommendations

While a better picture of the internal arts has been traced by joining the dots available, further research will provide even more dots on the page, making the resulting tracing even more accurate and clear.

Further research addressing the hypothesis presented in this work would be welcome. More studies are needed in investigating the biofield and biofield therapies like acupuncture, qigong, healing touch and others. Other fields of interest for future research would be fascial and energetic involvement in such practices as 'iron shirt' training, the effects of mind intent and bioenergy on inanimate objects and living organisms, and specific health benefits not just in Tai Chi practitioners but also in Hsing Yi and Pa Kua practitioners.

The last two martial arts deserve more scientific studies, so that the three arts could be compared and recommended to those sections of the population who are most suited to each method. Lastly, further exploration into the effects of the tongue position that would follow up on the preliminary pilot study previously described, would also be very interesting and open up new possibilities and knowledge into the functioning of the human body.

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