

SCIENTIFIC PROPOSITIONS FOR BRAIN REFORMATION BY MAILUN CHAN DING

PEI-CHEN LO¹ & MING-LIANG HUANG²

¹Professor, Department of Electrical Engineering, Institute of Electrical and Control Engineering,
National Chiao Tung University, Hsinchu, Taiwan

²Supervisor, Shakyamuni Buddhist Foundation, Datong Dist.,
Taipei City 103, Taiwan

ABSTRACT

More than merely brain-neuroplasticity, heart-to-heart imprint sealing (HHIS) Chan Ding completely changes the normal brain traits and regenerates a new brain with superior self-healing capabilities for various physical, psychological and mental ailments. Differing from the mind-body intervention in most meditation techniques, Chan Ding is exclusively heart-dominant, more correctly, brain dominated by heart. By activating the ten-mailuns system in Chan Ding, practitioners disclose the unique brain functioning scheme, documented in Diamond Sutra, for connecting physical entity to spiritual entity. In the process of brain reformation, three important mailuns play the crucial role. ChanXin mailun inside the third ventricle creates powerful field to harmonize all neurons in the brain into a tranquil brain. ZhiHui Mailun at corpora quadrigemina enables the physical body to be in tune with nature. FaYan Mailun at hypothalamus elicits the pure egoless compassion with great bliss. Chan Ding with tri-mailuns resonance effectively universalizes all brain neurons to construct a *detached* brain and evokes photoelectric potency of brain neural network.

This paper for the first time reveals the intrinsic mechanism of exclusive brain reformation through HHIS Chan Ding. Chan-Ding EEG (electroencephalograph) of the brain cultivated by tri-mailuns resonance reveals rather persistently focalized and stationary cortical inter-regional interactions particularly in the central-frontal midline region.

KEYWORDS: Brain-Neuroplasticity, Heart-to-Heart Imprint Sealing (HHIS) Chan Ding Completely Changes

INTRODUCTION

Human brain nowadays has been always under the conditions of overwork and high stress that directly harm the physiological, mental, and psychological health. To cope with much heavier information-processing demands, more high-tech professionals are practicing orthodox HHIS Chan Ding in Taiwan. Up to the present, little has been disclosed with respect to the mechanisms and phenomena of HHIS Chan Ding conveyed to China in 470 – 478 by patriarch Bodhidharma and then to Taiwan about one hundred years ago by the 84th patriarch Jing Zai (Appendix I). Since 1990s, a large number of practitioners have proved the efficacy of HHIS Chan Ding in treating many chronic diseases, infections, acute symptoms as well as mental and psychological problems. Hence, more people began to practice HHIS Chan Ding in Taiwan. Various cases of the effective treatment and health benefit of Chan Ding arouse our interest in the physiological, mental, and spiritual states during Chan Ding. In the course of investigating this particular practice, we disclose the remarkable distinctions of Chan Ding from those worldwide popular meditation practices including Yoga and transcendental meditation (TM) from India, Japanese Zen, and Tibetan Buddhism [1, 2]. Briefly, Chan Ding follows the “heart-dominating” principle while meditations are mostly “mind-cultivating” practices. This article mainly reports the

hypotheses proposed to explain the mechanism of Chan Ding, without encompassing the brain and mind, that could optimize the brain plasticity for a healthy and blissful life.

As addressed by Goleman [3], the human brain has not had a hardware upgrade in about 100,000 years. It is still operating on the basis of ancient “fight-or-flight” response activated by amygdala and possibly recorded by hippocampus. The amygdala once in response to emotions tends to dominate the entire brain functioning. Chan-Ding practitioners further realize the inherent causation law conducted by amygdala and hippocampus that encode (or, are programmed by) the subconscious, *manas* (subliminal consciousness) and so-called past-life karma (destiny, fate). The functional characteristics of amygdala and hippocampus accordingly affect the behavioral traits and personality. Through Chan Ding, practitioners initiate the process of cleansing all conscious states in preparation for entering the realm of true nature deeply in the heart. Such process involves the functioning alteration of major components in the brain that cause the formation of *karma* memory.

“The doorway to true nature is in the heart, and the key for the door is the spiritual entity,” instructed by current Chan patriarch Wu Jue Miao Tian. In *Prajñāpāramitā* Chan Ding, Chan patriarch firstly disclosed the ten-mailuns system capable of effectively purifying the negative memories and karmas in the brain and converting the clinging brain into tranquil, detached brain. Human brain and neural networks act as an important medium for connecting physical entity to the spiritual entity. Orthodox Chan Ding requires the guide of Chan-heart Imprint (ChI) from Chan patriarch. At present dozens of thousands of practitioners in Taiwan are practicing orthodox Chan. HHIS Chan Ding enables practitioners to arouse the intrinsic, natural-latency capabilities possessing the spiritual healing power. A number of successful evidences of “*mailun therapy*” start to arouse more attention during the past two decades. A branch of Chan lineage was exported to Japan in the 12th century and became well-known with the name of Zen. Although Zen meditation is currently practiced worldwide, it appears to be mingled with some popular meditation techniques that have been widely practiced in Western societies since 1990s. During the past decades, a number of meditation techniques have been developed and practiced all over the world. Despitely different schemes, almost all the meditation practices are aimed to better manipulate the mind, brain function and physical state of practitioners through mindfulness concentration and respiratory regulation. Scientific basis behind meditation has been well explored after thousands of scientific papers were published [1–12]. There has been no literature report of Chan Ding except some scientific papers published using the term “Chan/Zen meditation” during the past decade [13–22]. Based on previous results in [13–22], this paper for the first time presents the scientific hypotheses and mechanisms of brain reformation by *mailuns* activation in HHIS Chan Ding.

MATERIALS AND METHODS

All the propositions and hypotheses are derived from the evidences and practical experiences of thousands of Chan-Ding practitioners who have been corroborating the results in their body, mind, and spirit. Scientific studies can only explore less than one hundredth of the truth proved by years of Chan Ding. This report includes innovative research ideas for the future study, to our belief, by taking one step further beyond physicalism.

Chan Ding applying the same sitting posture as meditation, nevertheless, undergoes totally different brain-mind functioning in order to disclose true self (true nature, true heart) deeply inside the organ heart. Chan Ding includes four different stages, the beginning, the deep, the righteous, and the *Prajñāpāramitā* Chan Ding. Chan Ding explores a totally new, ultimate blissful and healthy body-mind-spirit state. Chan patriarch enlightens the spiritual heart of a practitioner by ChI. Every human being owns ChI (true nature with perfection wisdom) residing in the heart. Contaminations

(disease, worry, karma, etc.) of body, mind, and spirit form the hindrance to accomplishing ChI. Practitioners hence practice ten-mailuns purification Chan Ding to reform the brain and revitalize the physical body. As illustrated in Figure 1, the ten mailuns corresponding to ten spiritual realms are the doorways (passages) that connect the physical life to spiritual entity and finally to true nature of reality.



Figure 1: Ten-Mailuns System: (From Bottom to Top) WuShi, WuMing, JiXiang, MingSe, RuYi, MingXin, ErKong, ZhiHui, FaYan, and ChanXin Mailun

With respect to the ultimate aim of Chan-Ding practice, mailun signifies the wheel center of all lives in reincarnation process. Every mailun has its spiritual power and correlates with specific physiological, mental, and spiritual functions. HHIS Chan Ding enables practitioners to be finally in tune with ten mailuns naturally. Among them, ChanXin inside the third ventricle of the interbrain and MingXin inside the heart are especially important because the true heart resides in MingXin mailun and has ever struggled for liberation from all bindings to ascend to ChanXin mailun. ChanXin, like the shining beacon, is required to be always “on” to facilitate the purification of the other mailuns. ZhiHui and FaYan inside the head are another important mailuns for reforming the brain functioning. Practitioners can clearly perceive subtle vibration from corpora quadrigemina out spreading to occipital cortex and cerebellum upon the activation of ZhiHui mailun. FaYan Mailun might totally convert the reward center into blissful and compassionate network.

Chan practice emphasizes the cultivation and disclosure of the eternal, noumenal light of wisdom of true nature. No word, no image, no sound, no anything in form can be involved in Chan transmission that is signified as the unique teaching outside the scriptures. To effectively help practitioners become detached in order to enter into the righteous (third-stage) Chan Ding, current Chan patriarch Wu Jue Miao Tian developed the ten-mailuns purification HHIS Chan Ding scheme in 1999 that sagaciously integrated the principles of Taoism, TCM (Traditional Chinese Medicine), and Diamond Sutra. Dozens of thousands of practitioners have been benefited by the practice. The following propositions proposed are based on results of analyzing Chan-Ding EEG and empirical evidences collected from practitioners’ experiences.

Propositions for Brain Reformation

Chan-Ding practitioners evoke the invaluable potency of ten mailuns for driving and energizing the meridian

system (qi-flow channels), nervous system, circulatory system, and many other organ systems. Purification and strengthening of mailun energy promotes the Chan-Ding state from physical (the beginning) to detached, spiritual (the righteous), and finally to eternal state (*Prajñāpāramitā* Chan Ding) of reality. Liberation from the brain-mind dominance becomes the essential step. The intrinsic mechanisms can be interpreted through the six propositions below.

Proposition 1: ChanXin Resonance Harmonizes all Brain Neurons

Chan Ding is the important scheme for connecting with spiritual entity and realizing the macrocosmic realm of life. To cultivate the spiritual power, or ‘shen’ in TCM, the liberation of the *earthly* brain and mind is essential. The term ‘earthly’ is used to reflect the deeply rooted traits of the brain being bound by the time-and-space perception as well as the sensory and intellectual awareness of physical world. According to Cosimo Urgesi’s clinical studies on 88 neurosurgery patients [23], selective damage to left and right inferior posterior parietal regions induced a specific increase of self-transcendence. Nevertheless, Chan Ding based on a more natural and intrinsic scheme leads to modulations of neural activity in frontal-central and temporal-parietal regions for launching for macrocosmic realm and transcending experiences. The core mechanism relies on the mailuns resonance with ChI. By intensively continuous focus on ChanXin, an exclusive photoelectric energy surges from the third ventricle and propagates throughout the entire brain to harmonize all the brain neurons in the way that brain becomes more tranquil and pure at every moment. This process of brain reformation substantially changes not only the physiological functioning of the brain but the mental, emotional, and psychological traits. Practitioners gradually reach the state of internal mental serenity with blissful spirit all the time. The upgraded brain stays in the Chan-Ding state all the time, yet, exhibits remarkable creativity and superior mindful attention, besides their ultimate compassion and euphoria.

To investigate the effect of such intensive ChanXin vitalization, we analyzed the mass centers (C_x , C_y , C_z) of brain potential mappings at the prominent positive peaks (abbreviated as PMCs) of 30-channel EEG (electroencephalograph) signals recorded from Chan-Ding practitioners and normal healthy volunteers without Chan-Ding experience. The EEG signals screened for analysis were mainly slow-alpha (8 – 10 Hz) dominant. The PMCs are computed from the largest five magnitudes, $EEG(i)$, among 30 EEG channels as follows:

$$C_x = \frac{\sum_i EEG(i)x(i)}{\sum_i EEG(i)} \quad C_y = \frac{\sum_i EEG(i)y(i)}{\sum_i EEG(i)} \quad C_z = \frac{\sum_i EEG(i)z(i)}{\sum_i EEG(i)} \quad (1)$$

where $(x(i), y(i), z(i))$ indicates the coordinates of channel- i electrode. Based on the SCS (subject coordinate system) used by Brainstorm [24], origin of the coordinate system is the midpoint of the line connecting left and right pre-auricular points, x -axis points to the nasion, y -axis points to the left pre-auricular point, and z -axis points upwards. Figure 2 displays the evolution of PMCs, at top view, for 35-minute Chan-Ding EEG (Figure 2(a)) and 20-minute resting EEG (Figure 2(b)). PMCs of Chan-Ding EEG are relatively focalized in the frontal-central region, while PMCs of resting EEG are dispersed in a wide area including frontal, temporal, and parietal lobes. Let y -length denote the length of left pre-auricular point to right pre-auricular point. The average deviation of PMC from the origin is 30% (48%) y -length along y -axis for Chan-Ding practitioner (control volunteer).

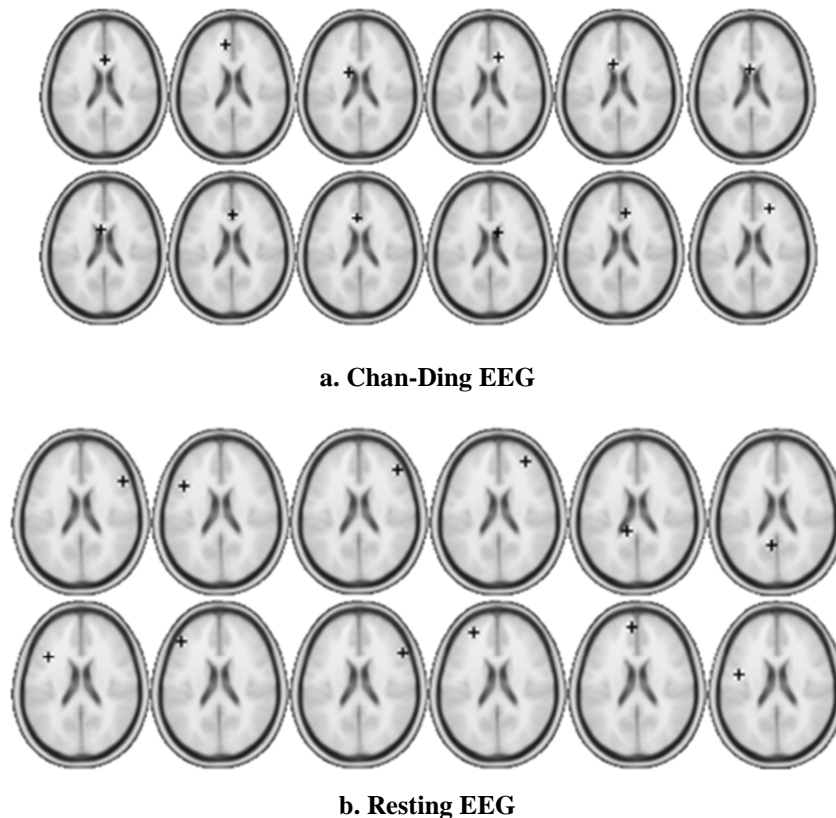


Figure 2: Mass Centers (Symbol ‘+’) of Brain Potential Mappings, Top View, at EEG Prominent Positive Peaks. (a) 35-minute Chan Ding EEG, and (b) 20-Minute Resting EEG

Proposition 2: Tri-Mailuns Resonance activates the Inverse Process of Hippocampus-Limbic System accompanying with Persistently Midline-Dominant EEG

Interbrain (diencephalon) reformation is an important step to realize the “detached, true-heart driven” brain. Such a brain exhibits a unique thinking pathway involving the heart (true nature). The frontal lobe can encode the true-heart wisdom. To liberate the wisdom of true heart, practitioners experience the process of “cleansing past karma” in HHIS Chan Ding. The mechanism involves the ChanXin-FaYan-ZhiHui (tri-mailuns) resonance with ChI to develop the field energy inside the brain that activates the inverse process of hippocampus-limbic system for purifying all the subliminal interference and past karmas. Brain neuroplasticity resulted by tri-mailuns resonance leads to the remarkable strengthening of Fz-Cz-CPz midline regional neural networks. To demonstrate this phenomenon, spatial interactions among brain local neural networks were evaluated in consideration of the nonlinear dynamics of the brain under alpha-rhythmic oscillation. Nonlinear interdependence quantified by similarity index $S(\mathbf{X}|\mathbf{Y})$, the influence of *source* signal \mathbf{Y} on *sink* signal \mathbf{X} , was applied to the nonlinear dynamical model in phase space reconstructed from 30-channel EEG [18]. Appendix II describes the scheme of evaluating $S(\mathbf{X}|\mathbf{Y})$. Consider the brain dynamics undergoing slow-alpha (9 Hz) oscillations. Figure 3 illustrates the *active* brain mappings for different EEG electrodes playing the *source* role in dominating over the other regions. Red color (value of 1) indicates the greatest effectiveness of the source electrode on the particular brain region. Chan-Ding EEG demonstrates apparent frontal-to-centroparietal, midline dominance, rather distinct from the common parietal-occipital dominant behaviors in resting EEG (Figure 3, right plot).

Such midline (Fz-Cz-CPz) dominating behavior in EEG spatially nonlinear interdependence strongly correlates with the perception of grand, sacred-purity energy flowing in through the medial longitudinal fissure when practitioners

practice Chan Ding intotri-mailuns resonance [18]. All neurons of the entire brain become in harmony with tri-mailuns resonance, resulting in fast purification and emptiness of all mental activities. Consequently, metabolism and oxygen consumption decrease to such an extent as to activate the unique respiration manner, MingSe-mailun respiration, similar to the “fetal breathing” with extremely low pulmonary function. In the case, practitioners enter into the righteous Chan Ding with the well-balanced autonomic nervous system, *Wu-Ji* heart (Appendix I), tranquil mind, and detached brain.

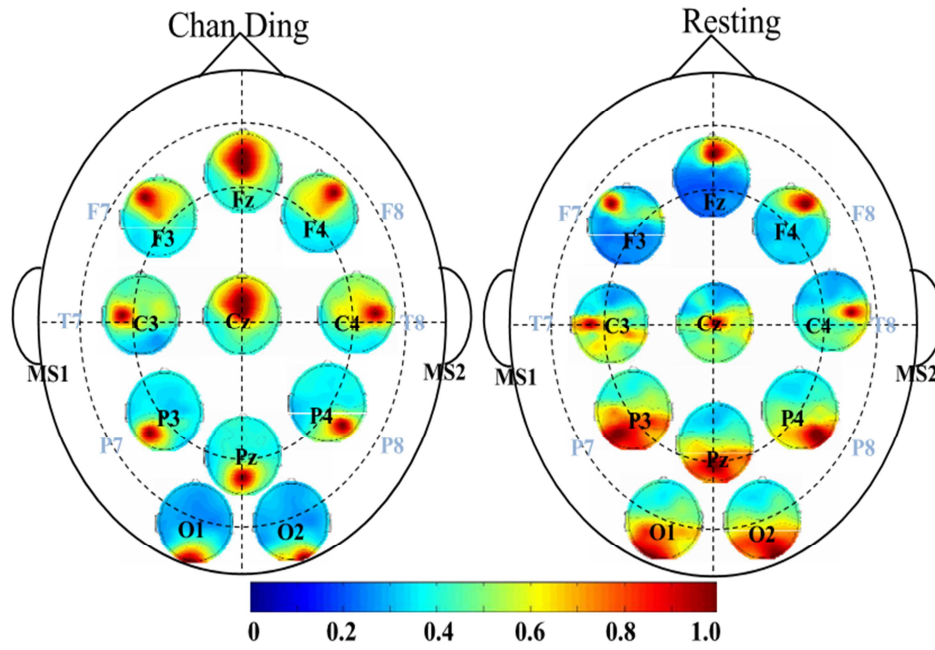
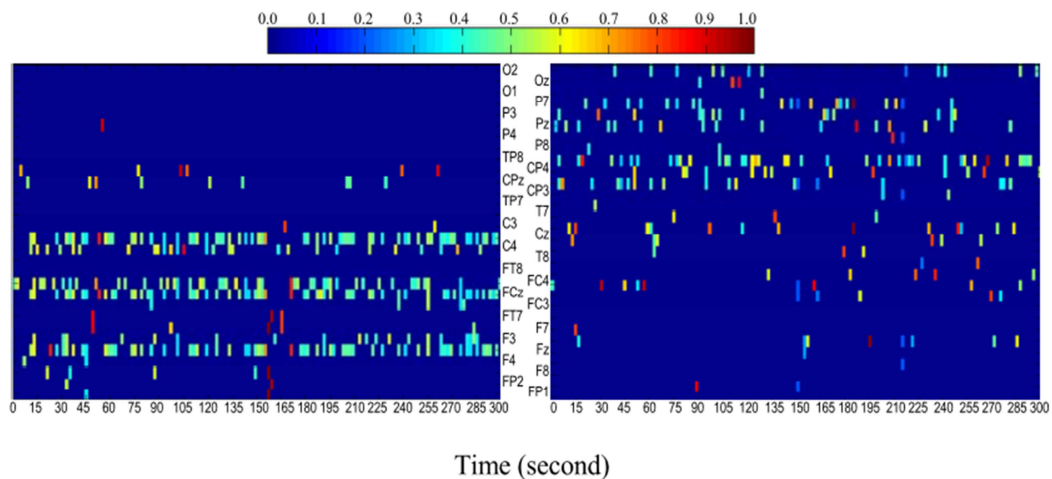
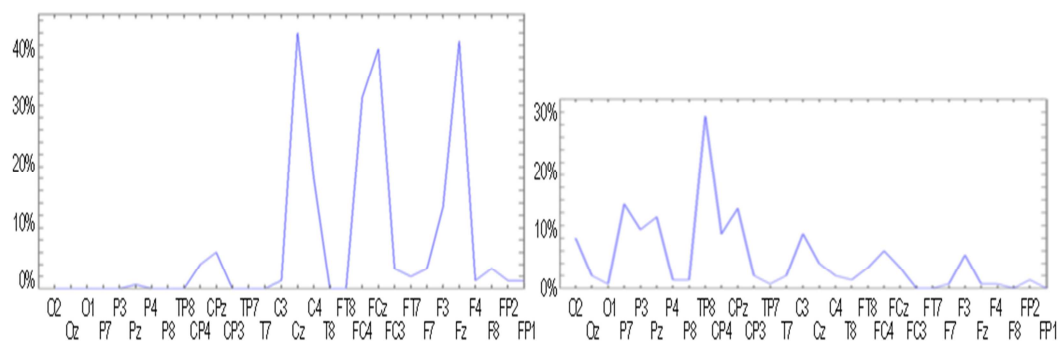


Figure 3: Active Brain Mappings for 11 Source Locations (Fz, Cz, Pz, F3, F4, C3, C4, P3, P4, O1, and O2) by Analyzing 30-Channel Chan-Ding EEG (Left) and Resting EEG (Right), Analyzed with Embedding Dimension: 8, Time Delay: 6 Samples, K : 5 – 7, and Epoch Duration: 2 Seconds (400 Samples)

To investigate the time-varying focalization behaviors, Figure 4(a) illustrates the time evolution of dominant EEG electrodes analyzed for a 5-minute EEG record. For a given source channel Y , the maximum percentage of number of EEG channels ($= 30$) with $S(\mathbf{X}|\mathbf{Y}) \geq 0.5$ is encoded by the color from blue (0%) to red (100%). For example, light blue of 40% indicates that 12 channels (\mathbf{X} 's) are effectively driven by the source channel Y . For a given 2-second epoch, there might be more than one channel with the same (maximum) percentage.



(a)



(b)

Figure 4: Dominant EEG Channels for (left) Chan-Ding Practitioner and (right) Normal Volunteer. (a) Time Evolution of Percentages of EEG Channels Governed by the Dominant Channel in Each Two-Second Epoch, and (b) Probability Histogram of Each EEG Channel Being Dominant in the 5-Minute Segment (totally, 150 epochs)

Apparently, Chan-Ding EEG exhibits persistent Fz-FCz-Cz(-CPz) midline dominant, as illustrated by the color blocks aligned orderly in three rows corresponding to channels Cz, FCz, and Fz in Figure 4(a) (left profile) as well as the three distinctive peaks in Figure 4(b). The probability of CPz dominating over the others is comparably smaller. On the other hand, the right profile in Figure 4(a) for non-Chan-Ding EEG reflects a more scattering distribution mainly in the posterior regions. Channel TP8 has the highest probability of acting as the dominant source (Figure 4(b)).

Proposition 3: The Pleasure Center is Converted to Blissful Center by Purifying all the Subliminal Interference and Past Karmas

Tri-mailuns resonance can effectively reform the brain into a detached one by changing the hypothalamus, hippocampus, amygdala and limbic system to realize all the brain characteristics described in *Diamond Sutra*. In the process of purifying karma and manas, the pleasure center in the brain is converted into *blissful* center. The reward circuit involving nucleus accumbens (NAs), ventral tegmental area (VTA), prefrontal cortex (pFC), amygdale, and septum, after being modulated by tri-mailuns resonance with ChI light, is converted into compassionate circuit. This scheme of thoroughly eradicating the subliminal contamination, interference and addicted traits provides the most fundamental and scientific treatment for such problems as the substance addiction (including drug, alcohol, tobacco, etc.), PTSD (post-traumatic stress disorder), and many mental, psychological, and spiritual disorders.

Figure 5 displays two five-second Chan-Ding EEG segments recorded from two advanced practitioners. Both consist of remarkable amount of gamma waves (35 – 50 Hz) that might correlate with the unique brain plasticity in the process of purifying the subliminal (manas) consciousness and past karma. Gradually, the brain is regenerated for Prajñāpāramitā (the Pure realm of grand, eternal wisdom) by 1) releasing from ego consciousness, 2) transcending time-space functioning, and 3) accomplishing detachment and *five-skandhas* emptiness.

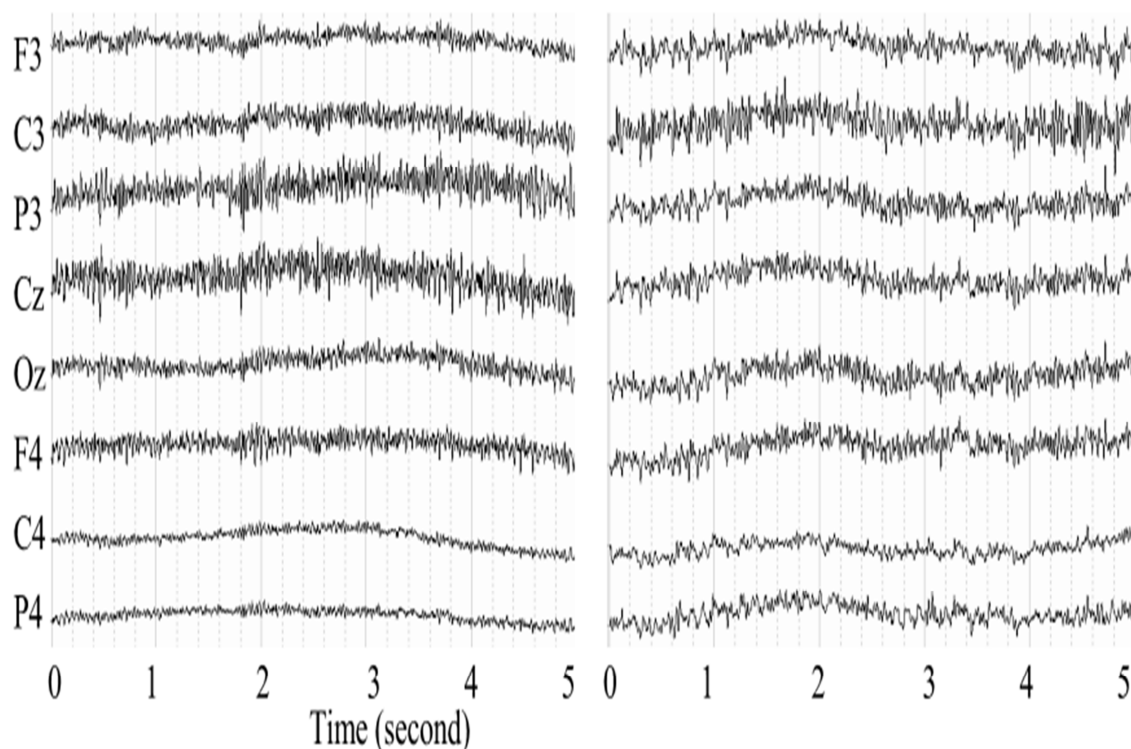


Figure 5: Remarkable High-Frequency Gamma Activities in Chan-Ding EEG

In our previous study on Chan-Ding EEG, almost all the advanced practitioners exhibited extraordinarily high-frequency global gamma rhythms with frequency higher than 30 Hz. A number of papers reported the observation of gamma EEG associated with various pathological [25], mental [26], or consciousness [27] conditions. These gamma activities were reported either to emerge in paroxysmal manner in some active regions of the brain or to be induced by some mental processing or training scheme. Nevertheless, EEGs of many Chan-Ding practitioners exhibit constant, global gamma activities that might be hypothetically correlated with the reformation of brain functions and neuronal networking.

Proposition 4: FaYan mailun at Hypothalamus Acts as Nature's Endoscope

Human eyes serve for the visualization of material, physical phenomenon, while FaYan mailun images the formless, energy spectrum of internal organs. FaYan mailun locates at hypothalamus with the optic nerves and optic chiasm locating immediately below (Figure6). FaYan functions as the nature's endoscope capable of scanning the (formless) energy images of Zang organs through the meridian system. According to *Huang Di Nei Jing*, various parts of eyes reflect *qi* energy of different Zang organs as: iris for liver, canthi for heart, upper/ lower eyelids for spleen, conjunctiva for lung, and pupil for kidney. Advanced Chan-Ding practitioners have enabled the formless-energy vision of FaYan mailun to image the energy states of Zang organs. Brighter (duller) light perceived by FaYan means healthier (poorer) condition of that organ. In addition, optic nerves becoming the formless-to-form transducers can transmit not only electric pulses but formless *qi*-to-light energy for Chan-Ding practitioners in the course of realizing physical-nature wisdom.

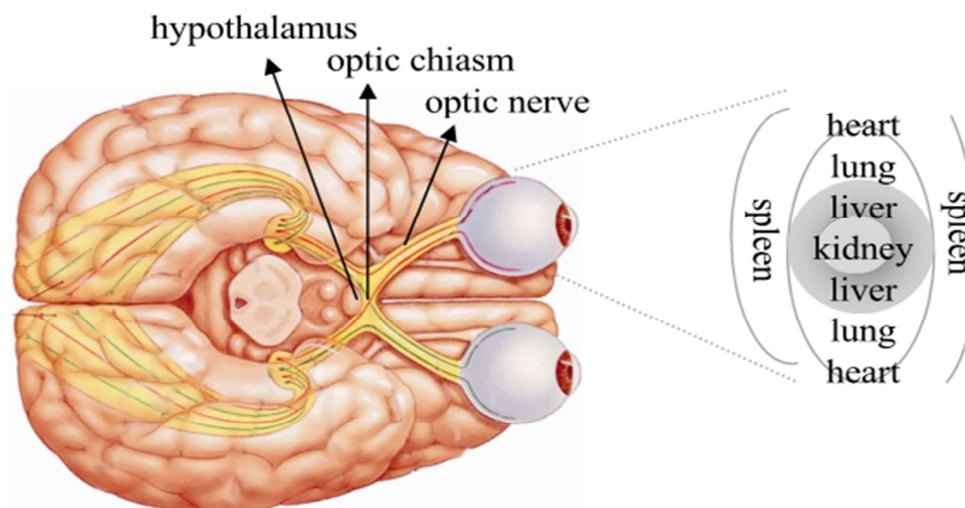


Figure 6: Ventral View of Hypothalamus, Optic Chiasm, and Optic Nerves Connected to Eyes

Characteristics and capacities of sensory organs (eyes, ears, nose, tongue, and body) are expanded and reformed by years of Chan-Ding practice that enable the practitioners to attain higher spiritual realm. As reported in [22], our study on F-VEP (flashed visual evoked potential) demonstrated that amplitudes of P1-N2 and N2-P2 particularly on Cz and Fz increased significantly during Chan Ding, yet, decreased during relaxation rest in the control group. F-VEP amplitudes on Cz and Fz varied in opposite directions for both groups (with no significant difference of latencies between two groups). We thus suggested that Chan Ding results in acute response on primary visual cortex and the associated parts.

Proposition 5: Chan-Ding Neurons Possess Photoelectric Properties

Chan Ding with ChanXin-FaYan-ZhiHui tri-mailun resonance makes electrical pulses fast transmit down the entire nervous system from diencephalon through spinal cord and reach all peripheral nervous fibres, interestingly, that induces intense sensation of *electricity-energy* on the acupoints (Lao-gong and Yong-quan) at the palm centres and sole centres, similar to qigong practice. Long-term Chan Ding practice evokes the interactions between ten-mailuns system and nervous system. Under such metamorphosis process, all the physical and spiritual entities can be thoroughly vitalized and reformed to realize the principle manifested in Section III of *Diamond Sutra*: a cleansed and tranquil mind with no ego-entity can only be disclosed when all living creatures of whatever class inside our body and mind, form or formless, with or without thinking, are ferried to the pure land of *Nirvana* (heavenly, blissful realm) which, in fact, has been implemented in ChanXin mailun of orthodox Chan-Ding practitioners. This provides a complete and logical basis for the proposition's claim on how practitioners maintain a healthy and peaceful body, mind, and spirit. As reported in [14], the frequency of hospital outpatient visits evaluated by the average number of using the healthcare card was reduced with the number of years of Chan-Ding practice as follows: 8.95 (0 – 1 year), 5.8 (2 – 3 years), 4.60 (4 – 5 years), 2.22 (6 – 7 years), down to 2.17 (> 7 years), based on the pool of 193 voluntary Chan-Ding practitioners.

HHIS Chan Ding remarkably expands the scope of all sensations and instinctive capabilities of the body, mind, and spirit. Ten-mailuns system enables the autonomous nervous system (ANS) to better regulate the Yin-Yang balance and five-element harmony, following the basic principle in TCM. Advanced practitioners may experience the interactions with nature more substantially as the brain becomes more detached and egoless. Analogy to the photosynthesis of plants, neurons behave like the photoelectric elements capable of converting the formless light energy into electricity-form vital

energy that transmits throughout the body via meridian network, nervous system, and blood vessels.

Proposition 6: A Detached, Chan-Ding Brain Driven by True Heart Leads to the Most Healthy and Blissful Body, Mind, Spirit State

Human knowledge is still very limited to the materialistic understanding of brain particularly in the scope of anatomy and physiology. Such characteristics as cognition, mind and consciousness make the brain different from the other organs. What would be the core scheme of all these activities through the complicated interweaving of brain (hardware) and mind (software)? What is the role of the heart? Despite rapid scientific progress, much about how the brain works remains unknown. Nonetheless, *Diamond Sutra* has already conveyed the most advanced knowledge of how to explore the intrinsically ultimate capability of the brain.

Detachment provides a unique way for liberating the brain and mind from being hijacked by sensory organs and, accordingly, external stimuli and for being immune to the controlling ties of all internal consciousness states with different layers of deepness. Detachment can relieve and even cure physical, psychological, mental, and spiritual ailments, as manifested in *Heart Sutra* (referred as the abstract of *Diamond Sutra*) and proved by many Chan-Ding practitioners. Countless facts having ever existed in nature yet cannot all be proved by scientific study. Scientific method may be insufficient for interpreting the phenomena explored by Chan Ding. Nevertheless, for thousands of years, ancient Chan-Ding practitioners have been validating the core principles in *Diamond Sutra* and *Heart Sutra*. Through the disclosure of ten-mailuns system by current Chan patriarch, thousands of practitioners in this era are proving the miraculous capability of mailun, the versatile formless vital energy, and the new life with a *heart-driven* brain through their Chan Ding practices – the scientific, empirical experiments conducted directly in their body, mind, and spirit. The so-called “heart-driven” brain refers to the fact that advanced Chan practitioners can perceive and interpret the wisdom emerging from true heart.

On the way towards the disclosure of true nature, brain reformation is a crucial step in preparation for true Chan Ding. On the other hand, Chan Ding effectively promotes the brain reformation. As mentioned previously, major difference between meditation [1–12] and Chan Ding is reflected in the scheme of “with-mind versus without-mind” and “heart-irrelevant versus heart-dominant.” Chan Ding accordingly induces quite different brain changes advocated in the core doctrine of *Diamond Sutra*.

Based on the cosmological theory of “the harmonious relationship between humans and nature” advocated in *YiJing*, the climate system of the earth is affected by the ensemble harmony or disharmony with respect to the four cosmic elements (earth, water, fire, and air) of human beings. Earth-element disharmony causes earthquake. Water-element disharmony causes flood or tsunami. Fire-element disharmony causes drought and fire. Air-element disharmony causes hurricane, tornado, typhoon, etc. According to Chan patriarch’s saying, increasing the number of Chan-Ding practitioners can harmonize the climate patterns on earth and further reduce the natural hazards.

DISCUSSIONS

To the practitioners, Chan Ding is undoubtedly a scientific scheme for cultivating the spiritual entity in that all doctrines conveyed by Chan patriarchs are not merely beliefs or ideology infeasible, instead, those can be realizable and experienced in the whole body, mind, and spirit through Chan-Ding reformation mechanisms.

Scientific exploration of Chan Ding is still in its infancy as little is known in regard to the states and characteristics of detachment, *Wu-Ji*, *five-skandhas emptiness*, ten-mailuns system, true heart, etc. Nevertheless, the wisdom of *Diamond Sutra*, the most important doctrine in Chan Sect, could pioneer the study in brain science. In addition to describing how to disclose true nature in the heart, *Diamond Sutra* provides the most profound, perspective reality and illustration for preparing the unique brain for probing and realizing the intrinsic creativity of eternal universe. HHIS Chan Ding is the way to realize the *detachment* and *five-skandhas emptiness*, the core principles of *Diamond Sutra*.

With a *detached* brain, practitioners may enter into the righteous Chan Ding. At this stage, the brain neural networking is optimally rewired for entering and probing the hyper-dimensional universe with unlimited wisdom and vitality. In addition, practitioners begin realizing the state of egolessness or oneness as manifested in Section III “The real teaching of the Great Way” of *Diamond Sutra*— with limitless compassion, accommodating all living creatures of whatever classes, whether with form or without form, whether with thought or without thought, and ferrying them all to the unbounded liberation *Nirvana*. Chan-Ding practitioners secure the key to healthy and blissful life upon the purification and liberation of such immense, infinite numbers of beings that cause all kinds of suffering in our lives. In this way, bacteria, virus, or other pathogens can turn into totally harmless beings residing together in our body. As a consequence, Chan-Ding practice of ancient doctrine in *Diamond Sutra* brings forth new insights for modern medical problems since coexistence and co-prosperity might be superior to attacking or killing pathogens.

ACKNOWLEDGEMENTS

Chan-Ding practitioners of the Shakyamuni Buddhist Foundation are gratefully acknowledged for their enthusiastic participation in this research as volunteers. This research was supported by the grants from the Ministry of Science and Technology of Taiwan (Grant No.: NSC 102-2221-E-009- 020-MY2).

REFERENCES

1. Cahn BR, Polich J. Meditation states and traits: EEG, ERP, and neuroimaging studies. *Psychol Bull.* 2006;132(2):180-211.
2. Travis F, Shear J. Focused attention, open monitoring and automatic self-transcending: Categories to organize meditations from Vedic, Buddhist and Chinese traditions. *Conscious Cogn.*2010;19(4):1110-8.
3. Goleman D. *Destructive Emotions: A Scientific Dialogue with the Dalai Lama*. Bantam Books, N.Y., 2003.
4. Aftanas LI, Golosheikine SA. Human anterior and frontal midline theta and lower alpha reflect emotionally positive state and internalized attention: high-resolution EEG investigation of meditation. *Neurosci Lett.*2001;310(1):57-60.
5. Khoury B, Lecomte T, Fortin G, et al. Mindfulness-based therapy: A comprehensive meta-analysis. *Clin Psychol Rev.* 2013;33(6):763-71. doi: 10.1016/j.cpr.2013.05.005.
6. Vestergaard-Poulsen P, van Beek M, Skewes J, et al. Long-term meditation is associated with increased gray matter density in the brain stem. *Neuroreport.*2009;20(2):170-4.
7. Luders E, Toga AW, Lepore N, Gaser C. The underlying anatomical correlates of long-term meditation: larger hippocampal and frontal volumes of gray matter. *Neuroimage.*2009;45(3):672-8.

8. Lazar SW, Kerr CE, Wasserman RH, et al. Meditation experience is associated with increased cortical thickness. *Neuroreport*.2005;16(17):1893-7.
9. Hölzel BK, Carmody J, Vangel M, et al. Mindfulness practice leads to increases in regional brain gray matter density. *Psychiatry Res*.2011;191(1):36-43.
10. Brewer JA, Worhunsky PD, Gray JR, Tang YY, Weber J, Kober H. Meditation experience is associated with differences in default mode network activity and connectivity. *Proc Natl Acad Sci. USA* 2011;108(50):20254–20259.
11. Lutz A, Brefczynski-Lewis J, Johnstone T, Davidson RJ. Regulation of the neural circuitry of emotion by compassion meditation: Effects of meditative expertise. *PLoS ONE*. 2008; 3(3):e1897. doi: 10.1371/journal.pone.0001897.
12. HagertyMR, Isaacs J, Brasington L, Shupe L, Fetz EE, Cramer SC. Case study of ecstatic meditation: fMRI and EEG evidence of self-stimulating a reward system. *Neural Plasticity*.2013; Article ID 653572. dx.doi.org/10.1155/2013/653572.
13. Yu T, Tsai HL, Hwang ML. Suppressing tumor progression of in vitro prostate cancer cells by emitted psychosomatic power through Zen meditation. *Am J Chin Med*. 2003;31(3):499-507.
14. Lo PC, Huang ML, Chang KM. EEG alpha blocking correlated with perception of inner light during Zen meditation. *Am J Chin Med*. 2003;31(4):629-642.
15. Liao HC, Lo PC. Investigation on spatiotemporal characteristics of Zen-meditation EEG rhythms. *J Int Soc Life Inform Sci*. 2007; 25(1):63-71.
16. Huang HY, Lo PC. EEG nonlinear interdependence measure of brain interactions under Zen meditation. *J Biomed Eng Res*. 2008;29(4):286-294.
17. Huang HY, Lo PC. EEG dynamics of experienced Zen-meditation practitioners probed by complexity index and spectral measure. *J Med Eng Technol*. 2009;33(4):314-321.
18. Lo PC, Chang CH. Spatially nonlinear interdependence of alpha-oscillatory neural networks under Chan meditation. *Evid-based Complement Alternat Med*. 2013;360371. doi: 10.1155/2013/360371.
19. Chang KM, Huang CL, Sheu JC, Huang ML, Lo PC. Chan-Ding for drug rehabilitation and its brain-basis hypothesis. *2nd Int Conf Exh Traditional & Alternat Med*. August 25-26, 2014, Beijing, China.
20. Chan Master Wu Jue Miao Tian, *Chan Master Miao Tian's Book of Wisdom and the Guide to Heart Chan Meditation*, Publisher: lulu.com, USA, January, 2010.
21. Chang CH, Lo PC. Effects of long-term Dharma-Chan meditation on cardiorespiratory synchronization and heart rate variability behavior. *Rejuvenation Res*. 2013;16(2):115-123. Doi: 10.1089/rej.2012.1363.
22. Liao HC, Liu CY, Lo PC. Investigation of visual perception under Zen-meditation based on alpha-dependent F-VEPs. *J Biomed Eng Res*. 2006;27:386-393.
23. Urgesi C, Aglioti SM, Skrap M, Fabbri F. The spiritual brain: selective cortical lesions modulate human self-

- transcendence. *Neuron*. 2010;65(3):309-319.
24. Tadel F, Baillet S, Mosher JC, Pantazis D, Leahy RM. Brainstorm: A user-friendly application for MEG/EEG analysis. *Computational Intelligence and Neuroscience*, 2011: 879716, 2011.
 25. Katsuhiko K, Kazushi M, Tomoyuki A, et al. Cortical contribution to scalp EEG gamma rhythms associated with epileptic spasms. *Brain Dev-Jpn*. 2013;35(8):pp. 762-770.
 26. Melloni L, Molina C, Pena M, et al. Synchronization of neural activity across cortical areas correlates with conscious perception. *J Neurosci*. 2007;27(11):2858-2865.
 27. Lutz A, Greischar LL, Rawlings NB, et al. Long-term meditators self-induce high-amplitude gamma synchrony during mental practice. *Proc Natl Acad Sci USA*. 2004;101(46):16369-16373.
 28. Takeuchi T, Morris RGM. Neuroscience: Shedding light on a change of mind. *Nature*. 2014;513 (27 August 2014):323-324. doi: 10.1038/nature13745.
 29. Takens F. *Detecting strange attractors in turbulence*. In D.A. Rand and L.-S. Young. *Dynamical Systems and turbulence*. Lecture Notes in Mathematics, vol 898. Springer-Verlag, pp. 366-381, 1981.
 30. Lo PC, Chung WP. An Approach to Quantifying the Multi-Channel EEG Spatial-Temporal Feature. *Biometrical J*. 2000;42(7):21-34.
 31. Pritchard WS, Duke DW. Dimensional analysis of no-task human EEG using the Grassberger-Procaccia method. *Psychophysiology*. 1992;29:182-192.
 32. Liu CY, Lo PC. Spatial Focalization of Zen-Meditation Brain Based on EEG. *J Biomed Eng Res*. 2008;29:17-24.
 33. Bhattacharya J, Petsche H, Pereda E. Interdependencies in the spontaneous EEG while listening to music. *Int J Psychophysiol*. 2001; 42:287–301.
 34. Quiroga RQ, Kraskov A, Kreuz T, Grassberger P. Performance of different synchronization measures in real data: a case study on electroencephalographic signals. *Phys Rev E*. 2002;65:041903.
 35. Stam CJ, Breakspear M, van Cappellen van Walsum AM, van Dijk BW. Nonlinear synchronization in EEG and whole-head MEG recordings of healthy subjects. *Human Brain Mapping*. 2003;19:63-78.
 36. Feldmann U, Bhattacharya J. Predictability improvement as an asymmetrical measure of interdependence in bivariate time series. *Int J Bifurcation and Chaos*. 2004; 14: 505-514.

APPENDICES

Appendix I

Chan Ding originating more than 2,500 years ago has been proved to disclose the true nature (true self, true heart) while on the way toward the ultimate Buddhahood state. Buddha Shakyamuni disclosed the *Nirvana Buddhist Heart* (also called *Chan-heart Imprint* in Chan lineage) in ultimate Chan-Ding state under a linden tree. *Chan-heart Imprint* encompasses the invariant truth, the supreme wisdom, the noumenal energy, the natural powers of creativity of the eternal universe. The orthodox Chan Buddhism was originated by such an exceptional affair, known as the Flower Sermon, that Buddha Shakyamuni transmitted the *Chan-heart Imprint* to the Great Kashyapa (MahaKashyapa, or simply Kashyapa).

Kashyapa smiled when Buddha held up a lotus flower. No one knew what actually happened in the affair except Kashyapa. Kashyapa smiled because he received *Chan-heart imprint* from Buddha. Based on the scientific description, Kashyapa received the mighty power of *Chan-heart Imprint* from Buddha, through wireless communication link, that helped Kashyapa release his own *Chan-heart Imprint* from all body-mind-spirit bindings. Great Kashyapa became the first Chan patriarch. Every Chan patriarch undertakes the most important mission of keeping the *Chan-heart Imprint* transmitted without interruption. This mechanism of Heart-to-heart Imprint Sealing (HHIS) becomes critical and a must for Chan transmission that is referred as “a special transmission outside the scriptures.” For the beginning Chan practitioners, HHIS plays the crucial role of ‘unlocking’ the heart towards true heart and activating the important passages inside the brain in preparation for body-mind-spirit reformation. Without *Chan-heart Imprint* from Chan patriarch, it is almost impossible to achieve the ultimate aim of Chan practice. Due to the utmost incomprehensibility and unintelligibility of “formless and wordless” propagation, currently only a small group of approximately fifteen thousand practitioners are practicing true Chan Ding in connection with orthodox Chan Dharma Lineage. Chan Ding might be exclusively the only scheme for exploring the true nature and forever existence.

The same path towards perfect enlightenment (Buddhahood) by HHIS was promulgated to mainland China in 527 by Bodhidharma, the 28th patriarch. The current patriarch Wu Jue Miao Tian is the 85th patriarch of the orthodox Chan-Buddhism Lineage since the Great Kashyapa. Patriarch Wu Jue Miao Tian developed the innovative approach of Ten-mailuns purification Chan Ding, integrated with Taoist principle of Yin-Yang, Tai-Ji, and Wu-Ji, for disclosing true nature by effectively rejuvenating the body, mind, spirit characteristics. Only spiritual entity can guide one into righteous Chan Ding. Yin-Yang unification, with the aid of *Chan-heart Imprint*, at MingXin inside the heart is the exclusive scheme to liberate spiritual entity. ChanXin is the medium inside our body for receiving Yang energy from the heaven, while WuShi receives Yin energy from the earth. With the catalytic power from *Chan-heart Imprint*, practitioners start to realize the heaven-man-earth *triple-entity unification* by the intercourse of heaven-Yang and earth-Yin in MingXin inside the heart. Upon the accomplishment of triple-entity unification, practitioners may have their heart converted into *Wu-Ji* state besides the liberation of spiritual entity.

Appendix II: Nonlinear Interdependence Measure

The scheme for evaluating the nonlinear interdependence was based on the modified algorithm employed in computing the *similarity index* $S(\mathbf{X}|\mathbf{Y})$ [16, 18]. Major tasks involved in the algorithm are: reconstruction of the m -dimensional phase-space trajectory and computation of the average cloud radius centered at a given state point.

Reconstruction of M-Dimensional Trajectory

Consider the brain as a nonlinear dynamical system. The nonlinear interactions of the local neuronal networks can be assessed by the analysis of the collective dynamics underlying EEG time series simultaneously recorded from different brain regions. Figure A.1 displays the recording montage.

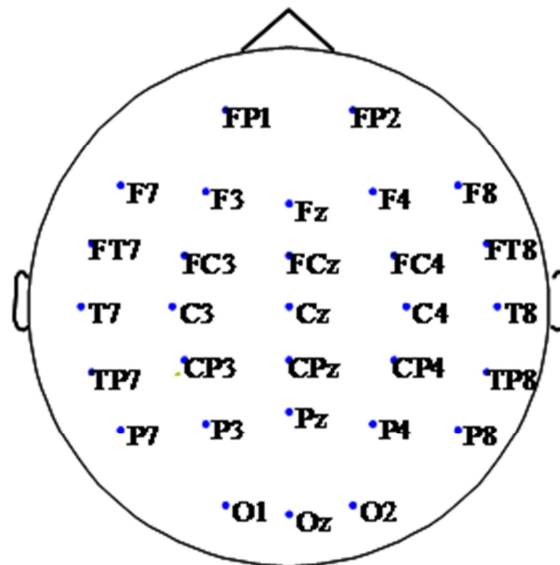


Figure A.1: EEG Electrode Locations of the 30-Channel Recording Montage

The first step is to reconstruct the multidimensional phase-space portrait of the system dynamics \mathbf{X} and \mathbf{Y} respectively from EEG time series $x[i]$ and $y[i]$. According to the Takens embedding theory[29], a smooth map from the EEG time series $\{x[i] \mid i = 1, \dots, N+(m-1)\tau\}$ to the phase-space trajectory $\mathbf{X} = \{X_i \mid X_i = (x[i], x[i+\tau], \dots, x[i+(m-1)\tau])\}_{i=1}^N$ preserves some important topological invariants of the original system. The reconstruction assumes a total number of N system-state points in the m -dimensional phase-space trajectory, utilizing a rational time delay τ (in sample point) [30, 31]. The dimension m indicates the number of degrees of freedom of the nonlinear system and, accordingly, reflects the *complexity* of the system dynamics.

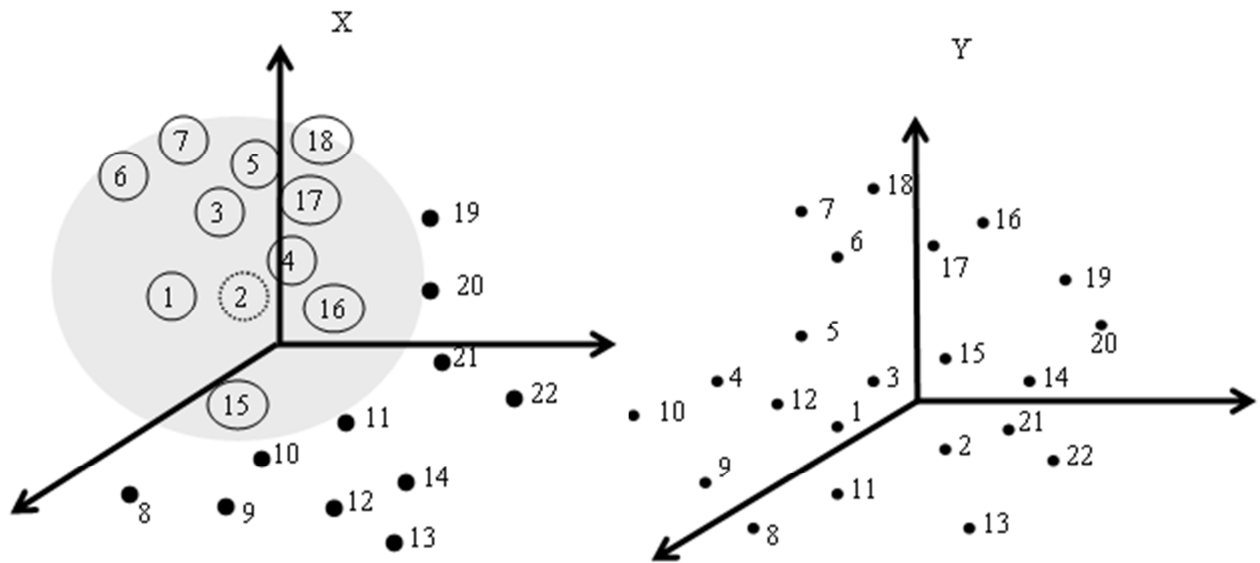
Computation of the Average Cloud Radius

Consider a state point X_i on the m -dimensional phase trajectory. As illustrated in Figure A.2, a KNN hypersphere, formed by the K 's nearest neighboring (KNN) points of X_i , is a cloud composed of Km -dimensional neighboring points around X_i . Let $r_{i,j}$ and $s_{i,j}$, $j=1, \dots, K$, denote the time indices of the KNN points of X_i and Y_i , respectively. Then, the set of state points in the KNN hypersphere centered at X_i is $\{X_{r_{i,j}} \mid j=1, \dots, K\}$. The average square Euclidean distance from X_i to its KNN neighbors (or the average square radius of the cloud centered at X_i) is defined as:

$$R_i^{(K)}(\mathbf{X}) = \frac{1}{K} \sum_{j=1}^K \|X_i - X_{r_{i,j}}\|^2, \quad (1)$$

where $\|\cdot\|$ indicates the operator for calculating the Euclidean distance. Another point cloud around X_i is formed with respect to its *mutual* neighbors $X_{s_{i,j}}$, which share the same temporal indexes of the KNN of Y_i . In this sense, the \mathbf{Y} -conditioned average square Euclidean distance is defined by replacing the true nearest neighbors of X_i by the *mutual* neighbors [32]:

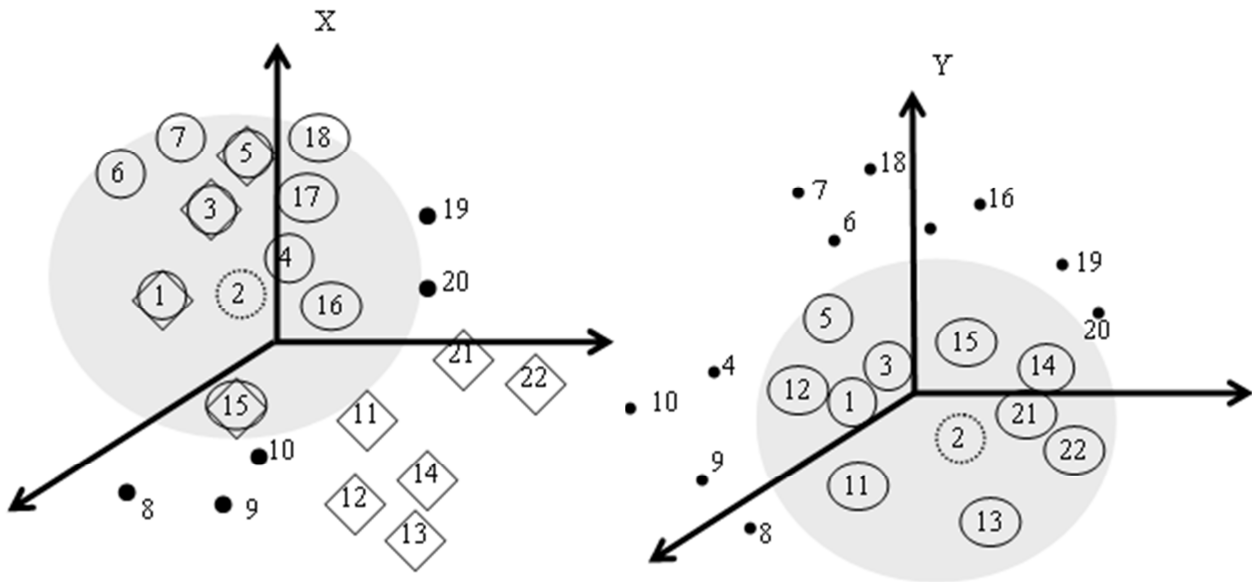
$$R_i^{(K)}(X|Y) = \frac{1}{K} \sum_{j=1}^K \|X_i - X_{s_{i,j}}\|^2 \quad (2)$$



$$r_{2,j} = \{1, 3, 4, 5, 6, 7, 15, 16, 17, 18\}$$

(a)

(b)



$$s_{2,j} = \{1, 3, 5, 11, 12, 13, 14, 15, 21, 22\}$$

(c)

(d)

Figure A.2 Illustration for (a) self neighbors $X_{r_{2,j}}$ (○), (b) state points in Y, (c) mutual neighbors $X_{s_{2,j}}$ (◇) where the indexes $s_{2,j}$ are determined from the indexes of (d) KNN of Y_2 ($K=10$), assuming $m=3$, $K=10$, $i=2$, and $N=22$.

In the extreme case of $K=N$, the average square radius of the trajectory centered at X_i is given by

$$R_i(X) = \frac{1}{N-1} \sum_{j=1, j \neq i}^N \|X_i - X_j\|^2 \quad (3)$$

Then, for two strongly synchronized systems, both self and mutual neighbors mostly coincide so that $R_i^{(K)}(X) \approx R_i^{(K)}(X|Y) \ll R_i(X)$; whereas for independent systems, mutual neighbors are more scattered that leads to $R_i^{(K)}(X) \ll R_i^{(K)}(X|Y) \approx R_i(X)$. Accordingly, the degree of interdependence of these two systems is reflected by the similarities (or dissimilarities) between these two cloud patterns formed by self and mutual neighbors. The strength of similarity between these two point clouds is termed as similarity index S [16, 32] and is defined below:

$$S^{(K)}(X|Y) = \frac{1}{N} \sum_{i=1}^N \frac{R_i^{(K)}(X)}{R_i^{(K)}(X|Y)} \quad (4)$$

$S^{(K)}(X|Y)$ assesses the statistical dependence of the state-space structure of \mathbf{X} on that of \mathbf{Y} in the sense of testifying whether closeness in \mathbf{X} implies closeness in \mathbf{Y} and vice versa. Two identical systems with the same sets of self and mutual neighbors result in the maximum similarity index ($S=1$); whereas the index is close to zero ($S \approx 0$) for completely independent systems. The opposite interdependence ($S^{(K)}(Y|X)$) can be computed analogically. Notice that similarity indexes are in general asymmetric, that is, $S^{(K)}(Y|X) \neq S^{(K)}(X|Y)$. $S^{(K)}(X|Y)$ evaluates the effect of system \mathbf{Y} on system \mathbf{X} . From the point of view of the system theory, signal \mathbf{Y} is regarded as the *source* or the active role in the interaction; while signal \mathbf{X} plays a passive role (a *sink*). On the other hand, $S^{(K)}(Y|X)$ analysis considers \mathbf{Y} as the *sink* that plays the passive role [16, 32].

The asymmetry of S is one of the main advantages over the other nonlinear measures such as the mutual information and the phase synchronizations. By considering each EEG electrode either as a sink or as a source in the nonlinear-interdependence interaction, we may further explore the brain functional topological profile and the direction of interaction among local neuronal networks [33-36]. For example, the condition of $S(Y|X) > S(X|Y)$ indicates that \mathbf{Y} depends more on \mathbf{X} than vice versa. In other words, \mathbf{X} has a greater influence on \mathbf{Y} than vice versa. In such a case, \mathbf{X} is said to be more *active* and \mathbf{Y} is more *passive*.

In order to maximize the sensitivity to the underlying synchronizations and gain the robustness against noise, we proposed a modified version of S measure with an adjustable range of KNN. The final estimate of nonlinear interdependence is the average $S^{(K)}(X|Y)$ over an appropriate range of K 's and is denoted by $S(X|Y)$. In the practical implementation, larger K causes heavy computational load. For long-time EEG monitoring, K ranging from 5 to 7 provides appropriate estimates of S for discriminating various nonlinear-interdependence behaviors of different spatiotemporal properties. Previous studies of dimensional complexity for 9 Hz alpha-dominant EEG have established a moderate choice of parameters: time delay $\tau = 6$ (sample points), embedding dimension $m = 8$ and window length $N = 400$ sample points (2 seconds) for convergent and rational estimates.

