行政院國家科學委員會專題研究計畫　期中進度報告

以生物共振音頻檢測機制探討禪定效能(1/2)

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計畫主持人： 羅佩禎

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行政院國家科學委員會補助專題研究計畫 期中報告

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以生物共振音頻檢測機制探討禪定效能（1/2）

Investigation of the Effect of Zen Meditation based on Bio-Resonance Sound Diagnostic Mechanism (1/2)

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計畫類別：■個別型計畫　　□整合型計畫

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共同主持人：

本成果報告包括以下應繳交之附件：

□赴國外出差或研習心得報告一份

□赴大陸地區出差或研習心得報告一份

□出席國際學術會議心得報告及發表之論文各一份

□國際合作研究計畫國外研究報告書一份

執行單位：國立交通大學　電機與控制工程學系

中　華　民　國　95 年　5　月　31　日

一、中文摘要：

過去一年多的『禪定腦電波』研究，已觀察到不同禪定劇本，我們以不同方法進行多通道腦電波分析與詮釋，包括小波分析、參數模型、分頻量化、模糊理論分類、非線性動態分析…等，並依據其空間－時間－頻域之特性變化，歸納出幾種不同的禪定腦電波變化劇本，並已將結果撰寫成三篇學術論文投稿於國際期刊，目前正在審查中。

關鍵字：禪定腦電波、禪定劇本、小波分析、參數模型、分頻量化、模糊理論分類、非線性動態分析、空間－時間－頻域之特性

二、英文摘要：

Three manuscripts reporting our research work have been submitted to the international journals.

Keywords: Meditation EEG (electroencephalogram), meditation scenario, wavelet analysis, parametric modeling, subband spectral quantification, fuzzy clustering, nonlinear dynamical analysis, spatio-temporal-spectral characteristics.

三、前言：

Due to the therapeutic effectiveness, the new area *CAM* (*complementary and alternative medicine*) has drawn the attention of researchers and medical professionals in the past decades. Researches in biomedical engineering and life sciences have thus developed a number of CAM instruments. Scientists of the West have been reporting substantial findings of the effectiveness of meditation practice in CAM not only on improving the physiological and mental health but on treating a number of diseases. Accordingly, the investigator has been devoted to the study of Zen-Buddhist meditation for the past years. We investigate, from the viewpoint of biomedical engineering, phenomena of the human life system under the orthodox Zen meditation practice. We study the time-varying characteristics and dynamic mechanism during meditation course in order to further establish the correlation among different electrophysiological signals and parameters.

At the end of the twentieth century, life science and clinical medicine have begun striding into the new, insubstantial realm of research --- bio-energetic medicine. It states that all the living beings and the minerals consist of energy expressed in the form of various frequencies or rhythms. Our body is the simultaneous, integrating function of numerous rhythmic fields. According to the theory

of bio-rhythmics, diseases may be re-defined as the weakness or deficiency of certain rhythmic frequencies.

During the past five years, the principal investigator has been actively engaged in the research study on the Zen-meditation physiological signals, with the focus mainly on EEG (electroencephalograph), ECG (electrocardiograph), VEP (visual evoked potential), etc. Although we have achieved some results of significance, data provided by these mainstream medical instruments are limited to the physical quantities reflecting the global variation of electrical potentials. In this research, we thus hope to inspect the physiological, spiritual, mood, …, or even conscious and super-conscious states based on the rhythmic concept of bio-energetic medicine. CAM instruments developed for measuring bio-energetic parameters have caught our attention. We began from the ARDK (evaluating the meridian energy) and Sound Analyzer (evaluating the voice print for bio-sound diagnostics). Significance of this research work is at its prospect of providing scientific evidence and academic interpretation for the human life characteristics under Zen meditation as well as the mechanism of health promotion by the Zen practice.

Zen-Buddhist meditation originated more than 2,500 years ago, and had been proved to benefit the health while on the way toward the ultimate “Buddhahood” state. Meditation process reflects a brain state completely differing from the normal consciousness or the sleep states. Different meditating techniques have been studied for several decades [1]-[14]. They are mostly the TM (transcendental meditation), Yoga, and Japanese Zen meditation, with the focus mainly on the physiological and psychological effects of meditation. This work firstly reports the results of investigating bio-rhythmic phenomena of the orthodox Zen-Buddhist practitioners. The following section presents our preliminary results in the order of (Part A) ARDK, and (Part B) Sound Analyzer.

四、研究方法：

Part A. ARDK (Automatic Reflective Diagnosis System)

1. Meridian Energy Test

- Ryodoraku theory

The Ryodoraku theory was developed by a research group lead by Dr. Yoshio Nakatani in Japan since 1949 to 1957. They fed a current into some specific acupoints and measured the electrical value reflected to investigate the meridian electrical properties corresponding to these acupoints. They found that the measured electrical value will reflect the human body health condition which matches the Traditional Chinese Medicine theory saying “disease is reflected by the twelve source acupoints”.

- Instrument – ARDK

ARDK (Automatic Reflective Diagnosis System) is a meridian diagnosis system using a combination of Ryodoraku theory, Chinese Meridian theory, western clinic symptoms data and statistical analysis. It was developed by the Russian Central Scientific Research Institute between the years 1978 and 1992. Because of the research on more than 100 thousands of clinical subjects in Russia and more than 5 thousands of clinical subjects in Taiwan, ARDK has the precision up to 90% now. ARDK is a modern assistant tool helpful in detecting some health changes that indicate the risk of disease before it becomes symptomatic.

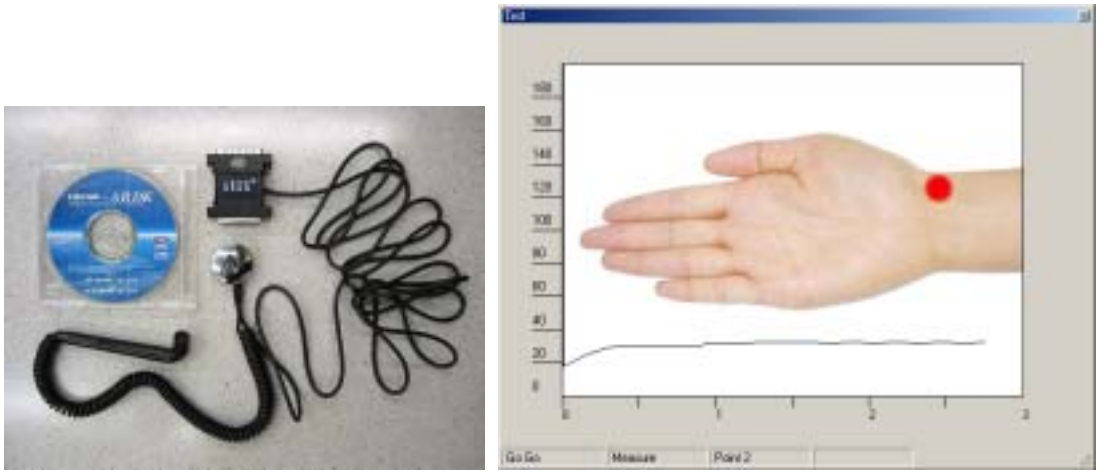


Figure 1. The measurement probe(left) and the measurement window(right) of ARDK

- Recording and analyzing

The ARDK measures each meridian's activity level by applying the probe to a single representative point of that meridian. It reads 24 points in total (12 left meridians + 12 right meridians) and automatically inputs the energy value into the computer. The subject's meridian energy data is collected safely because the maximum detecting current fed into subject's body by ARDK during measurement is 200 μA, which is much lower than a person can feel. The measurement of one diagnostic point takes less than 5 seconds and the entire measurement process will only take about 5 minutes to complete. After the data is collected, the software will analyze the subject's physiological status and then outputs the results on the computer screen. The results we will use for further analysis are as follows :

(1) Meridian Chart

In the Meridian Chart(Figure 2.), the horizontal axis denotes the 24 different meridians and the vertical axis denotes the activity level of meridians. Each symbol "+" in this chart represents one meridian. There are three different colors of horizontal dash lines on this chart. The black dash line represents the mean value for total 24 meridians, the green dash lines represent the upper and lower bound for "Best" value and the red dash lines represent the upper and lower bound for "Good"

value. The value outside the red dash lines denote “too High energy” or “too Low energy” condition.

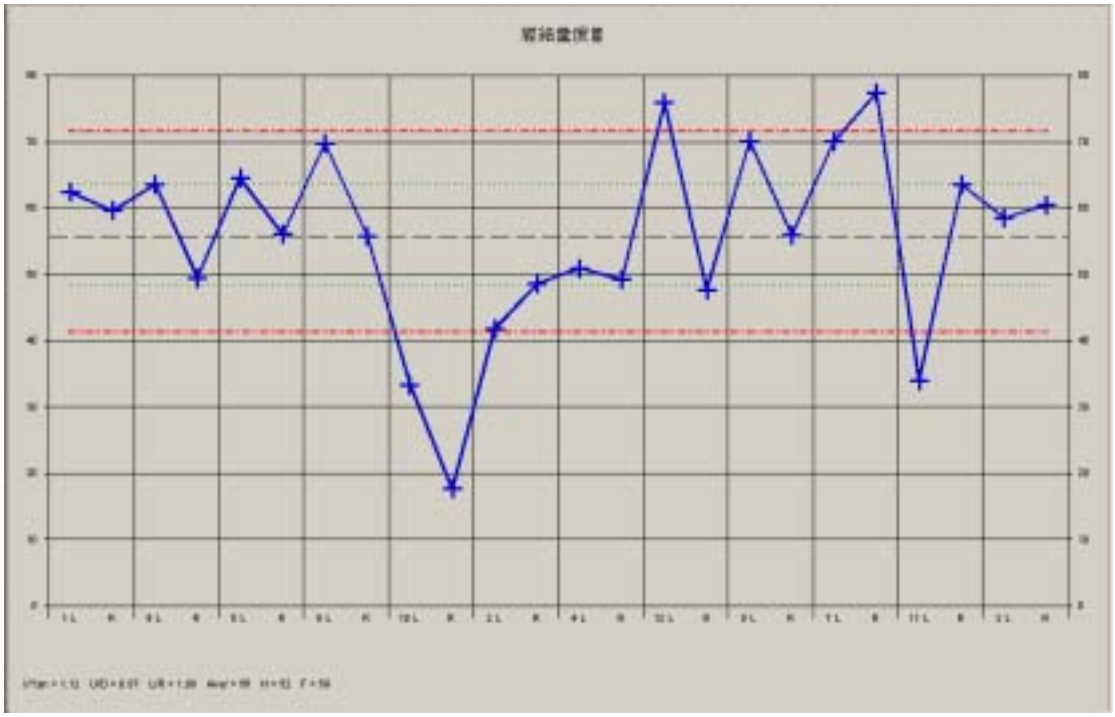


Figure 2. The meridian chart shows the energy value of 24 meridians.

(2) Health Condition Ratio

Table 1. shows 5 health condition parameters and their range of normal values.

“Body Energy” is the average of the measurements from the 24 acupoints. A high average indicates excess Qi and Blood while a low average indicates a deficiency of Qi and Blood.

“Metabolism Function” is determined from the ratio of the total of all Yin meridians divided by the total of all Yang meridians. A high ratio shows that the metabolism of the body is slower than normal while a low ratio shows that the metabolism of the body is faster than normal.

“Mental State” is determined from the ratio of the total of all hands meridians divided by the total of all feet meridians. A high ratio indicates an increase in mental activities, the subject has higher mental stress and may have anxiety, anger and halitosis. A low ratio indicates a decrease in mental activities, the subject gets drowsy, their attention is not focused, their memory is poor, and their response time slows down, etc.

“Musculoskeletal System” is determined from the ratio of the total of all left meridians divided by the total of all right meridians. The degree of balance between the Qi and Blood in the right side and left side of body affects the function of the musculoskeletal system. When the musculoskeletal system is unbalanced, there will be obstacles. The subject will feel pain or soreness in his body.

“Autonomic Nervous System” indicates the balance condition of the autonomic nervous system, the higher the ratio the more unbalance the autonomic nervous systems is. There are many factors that may result in an imbalance in the autonomic nervous system. Generally, this is divided into internal causes (for example, diseases of the internal organs, endocrine disorders) and external factors (for example, mental stresses, pressure from work, and fatigue). Based on Traditional Chinese Medicine theory, this results from an imbalance of Qi and Blood in part or all of the body. An abnormality of the subject’s autonomic nerves possibly results in difficulty sleeping or pain.

Table 1. The items of Health Condition Ratio

Item	Normal
Body Energy	25≤ Value ≤55
Metabolism Function	0.8≤ Ratio ≤1.2
Mental State	0.8≤ Ratio ≤1.2
Musculoskeletal System	0.8≤ Ratio ≤1.2
Autonomic Nervous System	Ratio ≤2

(3) System Reports

Table 2. shows the condition of human body systems and their standard range of values. The unit of each item is percentage, the higher the value the higher the probability to get problems in that system. The last item “System Reports” is the rough value representing the overall items.

Table 2. The items of System Reports

Item	Standard
Body energy (BE)	Value ≤25% : Normal →Best Value ≤50% : Normal →Good 50 < Value ≤75% : Abnormal →Not bad Value >75% : Subhealth(not feel good but haven’t been sick) → Caution
Mental state (MS)	
Autonomic Nervous System (ANS)	
Thyroid Gland Function (TGF)	
Musculoskeletal System (MS)	
Liver Function (LS)	
Digestive System (DS)	
Respiratory System (RS)	
Endocrine System (ES)	
Immune System (IS)	
Cardiovascular System(CS)	
Reproductive System(Rp)	
Kidney Function(KF)	
Urinary System(US)	
Metabolism Function(MF)	
System reports(SR)	

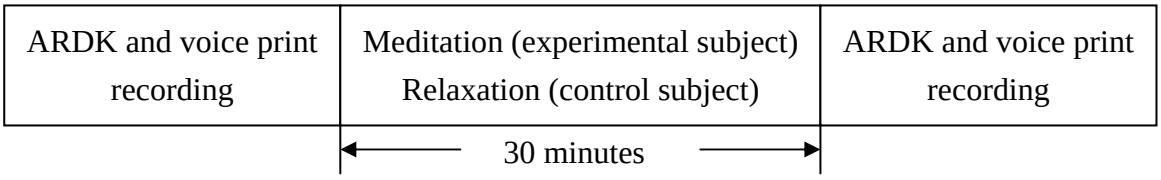
2. Method

- **Subjects**

The experimental group consists of 6 subjects (4 males and 2 females, mean age 26.5 years with S.D. 3.8 years). They have been practicing Zen-Buddhist meditation for an average of 5.9 years. The control group consists of 9 subjects (8 males and 1 female, mean age 25.2 years with S. D. 3.9 years). All of them have no chronic disease according to their medical history.

- **Procedure**

We collected the ARDK parameters for the subjects before and after meditation/relaxation. The procedure of recording is shown below.



3. Result

(1) Health Condition Ratio

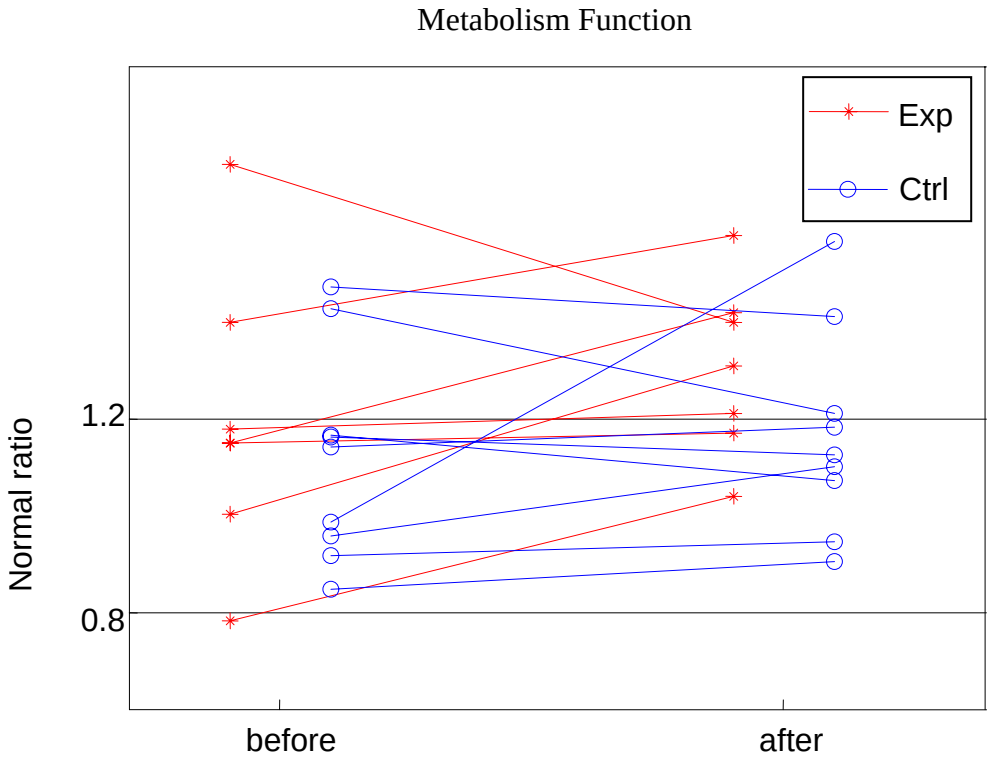
Table 3 shows the number of subjects whose 5 health condition parameters are within the range of normal values. More meditators exhibited a better performance in the “Body Energy” while the control group has an average of lower value after the rest. A low average indicates a deficiency of Qi and Blood.

As showed in Figure. 3, the experimental subjects have an increase ratio of “Metabolism Function” after meditation while the control subjects remain about the same after the rest. A higher ratio shows that the metabolism of the body is slower than normal after meditating activity. Many studies have showed meditation to be a wakeful state accompanied by a decreased metabolism. There are many characteristics in body metabolism. The generalized metabolic decrease due to meditation manifests with a decreased breathing pattern, decreased blood pressure (Wallace et al 1971, Wallace et al 1983, Delmonte 1984, Sudsuang et al 1991, Schneider et al 1995), and decreased heart rate (Wallace 1970, Wallace et al 1971, Delmonte 1984, Zeier 1984, Sudsuang et al 1991, Telles et al 1995). There is also a marked decrease in the level of oxygen utilization (Wallace 1970, Allison 1970, Wallace et al 1971, Hirai 1974, Fenwick et al 1977, Zeier 1984, Wilson et al 1987, Benson et al 1990) and carbon dioxide elimination by muscle (Wallace 1970, Wallace et al 1971, Wilson et al 1987, Jevning et al 1992). The ARDK parameter “Metabolism Function” is a general idea of the metabolism of the body. Our results imply that meditation may slow down the

body metabolism which is consistent with earlier findings.

Table 3. Mean, standard deviation and the number of subjects whose 5 health condition parameters are within the range of normal values

	Normal subjects	Body Energy	Metabolism Function	Mental State	Musculoskeletal System	Autonomic Nervous System
Exp Group (7)	before	5	4	4	4	2
	Mean(std)	39.6(11.4)	1.2(0.3)	1.4 (0.6)	0.9(0.2)	3.5(1.9)
	after	6	2	4	2	2
	Mean(std)	36.9(13.2)	1.3(0.2)	1.3(0.6)	0.7 (0.2)	4.5(2.3)
Ctrl Group (9)	before	5	7	5	2	3
	Mean(std)	30.8(14.2)	1.1(0.2)	1.2(0.4)	0.8(0.3)	2.6(0.8)
	after	5	6	5	5	2
	Mean(std)	25.8(12.7)	1.2(0.2)	1.2(0.4)	0.8(0.2)	2.8(1.3)



Figuer 3. The ratio of Metabolism Function for every subject during the two states

The result of “Musculoskeletal System” indicates the balance condition of all left meridians and all right meridians. Measurements showed that meditation increased activity of the Qi and Blood in the right side of body, while the control subjects remain balanced before and after the rest. It is hypothesized that the imbalance of the “Musculoskeletal System” caused by meditation is associated with the posture (left or right lotus posture). Further discussion needs more data and more subjects.

In the current study, the ratio of “Mental State” remains almost unchanged in both groups. The differences of “Autonomic Nervous System” did not reach significance in both groups because of high inter-subject variability.

(2) System Reports

Mean, standard deviation and the number of subjects whose parameters of system reports are within the range of normal values are showed in Table 4. Figure 4 is the mean probabilities of system reports for 7 meditators and 9 control subjects during the two states. In the system reports, the items which are in the range of the normal health for both groups are “Body energy”, “Mental state” and “Metabolism Function”. Control group shows an average of better health condition than the experimental group dose in “Mental state”, “Autonomic Nervous System”, “Thyroid Gland Function” and “Reproductive System”. The probabilities of almost all items are higher after meditation than before meditation (and rest). This tendency means to get problems in that system which is on the contrary of our supposition. The differences of “Liver Function”, “Digestive System”, “Respiratory System”, “System Reports” , “Endocrine System”, “Immune System”, “Musculoskeletal System” and “Urinary System” did not reach significance in both groups because of high inter-subject variability. Further discussion about system reports needs more data and more subjects.

Table 4. Mean, standard deviation and the number of subjects whose parameters of system reports are within the range of normal values

Mean(Std) and Normal subjects		BE	Mt	ANS	TGF	MS	LF	DS	RS	ES	IS	CS	Rp	KF	US	MF	SR
Exp Group (7)	before	7	6	4	5	3	2	1	1	2	0	3	1	**1**	7	3	2
	Mean (std)	29.3 (11.7)	26.9 (29.9)	51.3 (25.8)	40.8 (26.2)	61.4 (13.4)	62.1 (22.3)	66.3 (17.7)	70.7 (19.1)	63.4 (26.6)	70.2 (11.9)	52.5 (34.4)	66.3 (18.2)	70.8 (16.8)	16.1 (13.2)	54.2 (16.7)	63.0 (19.4)
	after	6	5	3	2	1	1	0	0	1	1	3	0	0	7	2	0

Ctrl Group (9)	Mean (std)	34.1 (10.5)	24.0 (26.6)	57.1 (22.6)	63.0 (16.1)	66.6 (14.2)	66.5 (13.8)	71.8 (10.1)	77.5 (11.6)	71.2 (18.1)	66.0 (12.4)	55.7 (26.4)	67.3 (11.0)	72.5 (6.5)	15.7 (8.2)	58.8 (11.0)	71.7 (11.8)
	before	6	9	7	5	6	2	2	0	2	4	6	3	3	9	4	2
	Mean (std)	38.3 (17.0)	15.2 (18.4)	42.0 (12.3)	38.0 (35.9)	53.8 (14.1)	67.7 (14.4)	67.3 (12.9)	78.1 (14.8)	71.2 (17.9)	46.9 (14.5)	24.2 (34.3)	61.3 (24.1)	63.1 (18.9)	12.2 (7.6)	49.9 (12.5)	68.0 (18.9)
	after	5	9	6	5	1	1	2	1	2	2	3	1	0	9	3	2
	Mean (std)	41.4 (22.9)	11.8 (15.7)	45.8 ((21.4)	37.2 (42.1)	65.8 (17.7)	67.8 (17.6)	68.7 (17.9)	83.8 (16.9)	70.6 (20.8)	70.9 (15.2)	49.0 (29.2)	77.1 (13.7)	79.3 (9.2)	11.8 (7.6)	56.9 (12.2)	71.1 (18.6)

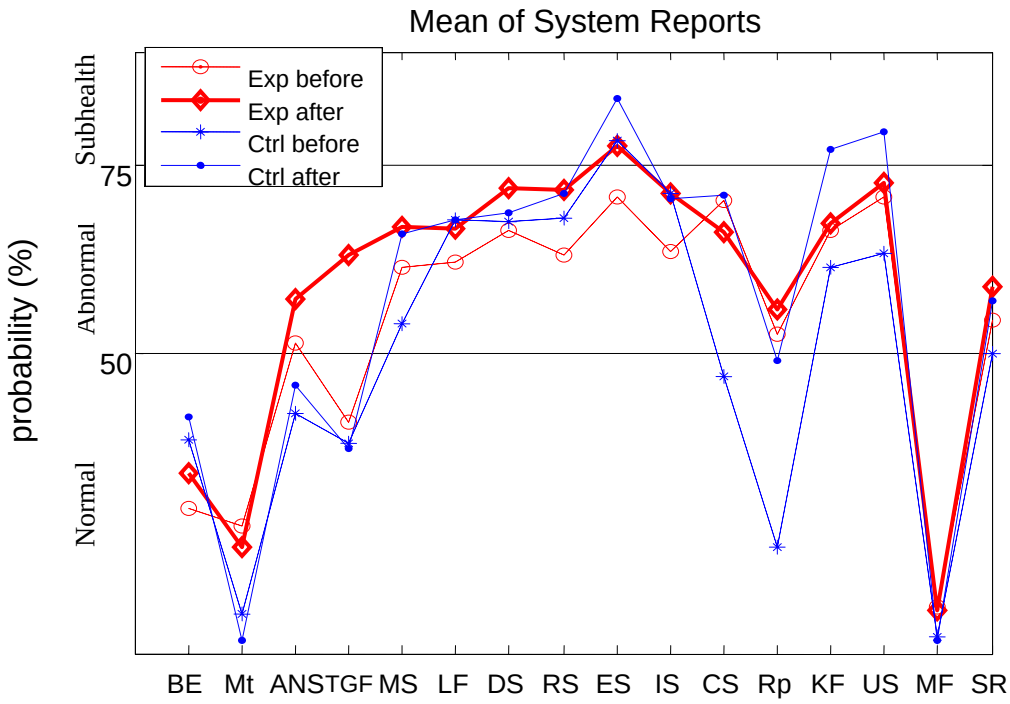


Figure 4. Mean of System reports for 7 meditators and 9 control subjects during the two states

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Part B. Sound Analyzer

- **The spectrum of frequencies**

Everything vibrates. Vibrating atoms are like radio transmitters. Molecules of air and water are also emitting frequencies, as is your liver, heart, pancreas, and every tissue in your body. The

spectrum of frequencies range from 0 cycles per second (no vibration) on up to trillions and trillions of vibrations per second and much more. Brain wave vibrates from about 1/2 cycle per second to 40 cycles per second and human hearing ranges from about 12 cycles per second up to 20,000 cycles per second.

When you speak, air molecules get compressed from the pressure of your voice. Then they transfer that energy to other molecules and it looks much like a Slinky - the “shock waves” from your vibrating vocal cords pushes air particles, which push other air particles, which push other air particles, etc.

The brain produces waveform patterns that can be measured with a variety of instruments. The voice also produces a waveform pattern that contains a great deal of frequency information that seems to relate to the physical and emotional health and balance of the speaker. Since every person's voice is unique, the resulting frequency voice analysis map when recorded and analyzed with The Sound Assistant™ software, may show indications of physical and/or emotional issues at the time of the recording.

The audio waveform is analyzed for frequencies in stress which are then compared to the experimental frequency assignments of vitamins, minerals, amino acids, bones, muscles and all manner of substances, including drugs and toxins.

- **Record a voice print**

Subjects were asked to speak in a normal voice at a normal volume with a headset. The voice records were then analyzed by The Sound Assistant™ software.

Figure 5.

Figure 6 presents the frequencies of the voice on a circle for a more holistic view of the entire system. The overview display allows us to display a single octave or all of the octaves together plotted in a circle.

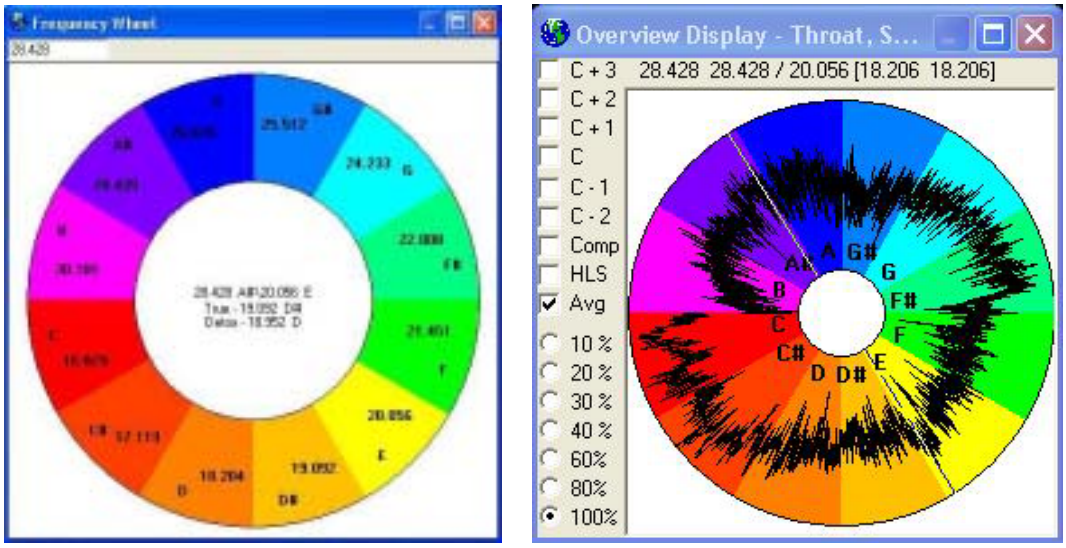


Figure 6 Overview display.

- **Balance in the voice print**

A balanced voice print would theoretically have sufficient energy in ALL note areas, with neither high nor low extremes. There are some areas where there's insufficient energy and other areas of excess energy. When we're looking at a voice print we're not comparing it to another print but mainly looking to see if it's balanced within itself. For example, area of insufficient or low energy areas can sometimes indicate a symptom such as a pain or a missing nutrient.

Figure 7 presents an octaves display of one subject. We can found that there is a low energy area around E.

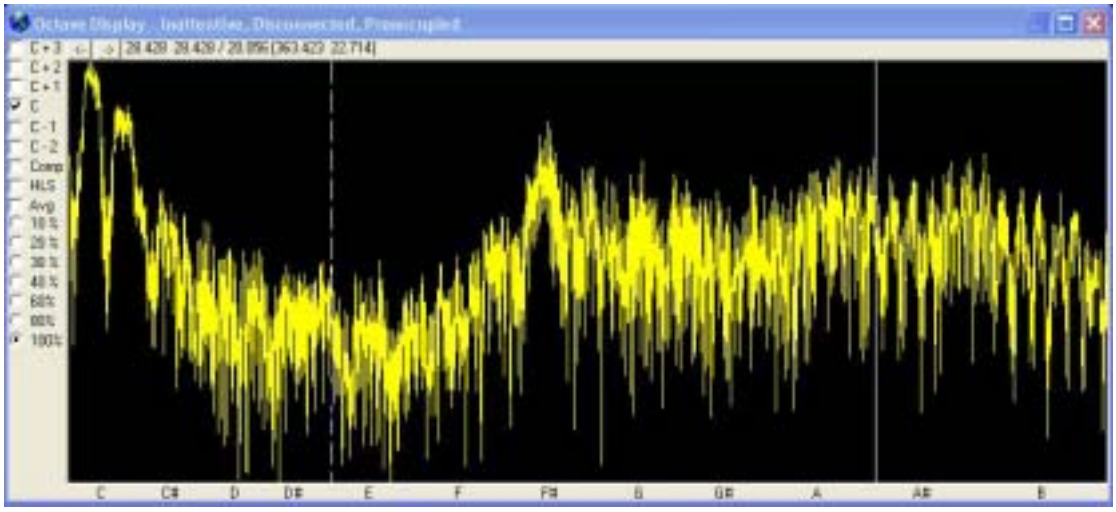


Figure 7 Octaves display.

2. Method

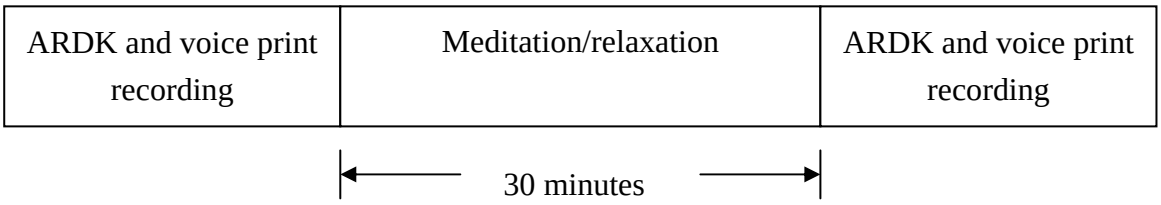
- Subjects

The experimental group consists of 6 subjects (4 males and 2 females, mean age 26.5 years with

S.D. 3.8 years). They have been practicing Zen-Buddhist meditation for an average of 5.9 years. The control group consists of 9 subjects (8 males and 1 female, mean age 25.2 years with S. D. 3.9 years). All they do not have any chronic diseases and their voice is normal.

- Procedure

We recorded the voice of the subjects before and after meditation/relaxation. The procedure of recording is as below.



Each subject is asked to pronounce two sentences: (1) “1, 2, 3, …, 10, A, B, …” (the numbers one to ten is pronounced in Mandarin), (2) narrating themselves the states of their health. Each sentence is 15 seconds long. The sampling rate is 44.1 KHz.

- Data analysis

Here we use Fourier transform to estimate the power spectrum of each sentence. The window size is 3 seconds, moving without overlap (that is, step size: 3 seconds). The power spectrum is derived via averaging. Then we calculate the **variance** of power spectrum in the central-C octave (256 – 512 Hz) to evaluate the balance. The variance is derived using the unbiased formula as below.

$Var = \frac{\sum_{i=1}^{N}\left(s_i - \bar{s}\right)}{N-1}$, where $\bar{s}$ is the mean and N is the number of points in spectrum.

Accordingly, a lower variance reflects a more balancing spectrum.

3. Results

The figure below is the power spectrum in the central-C octave (one experimental subject).

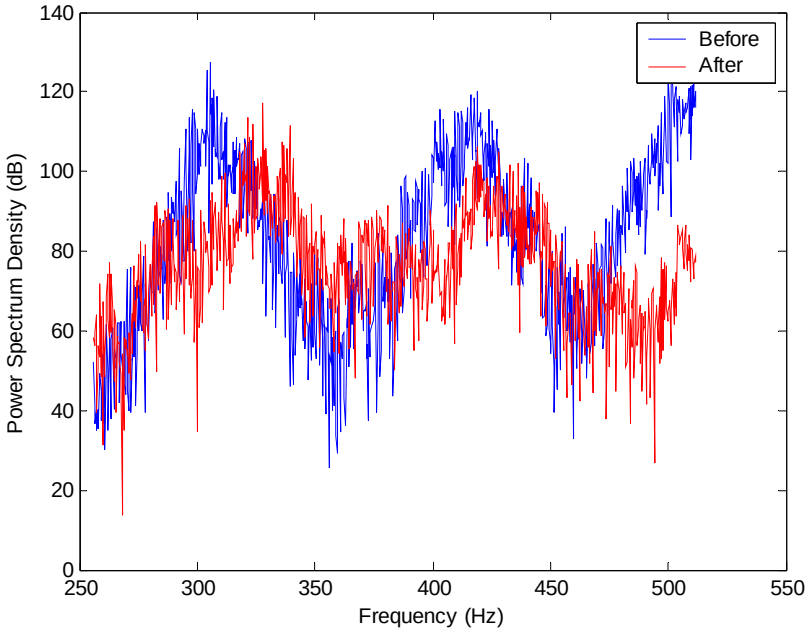


Figure 8 (a) Sentence (1)

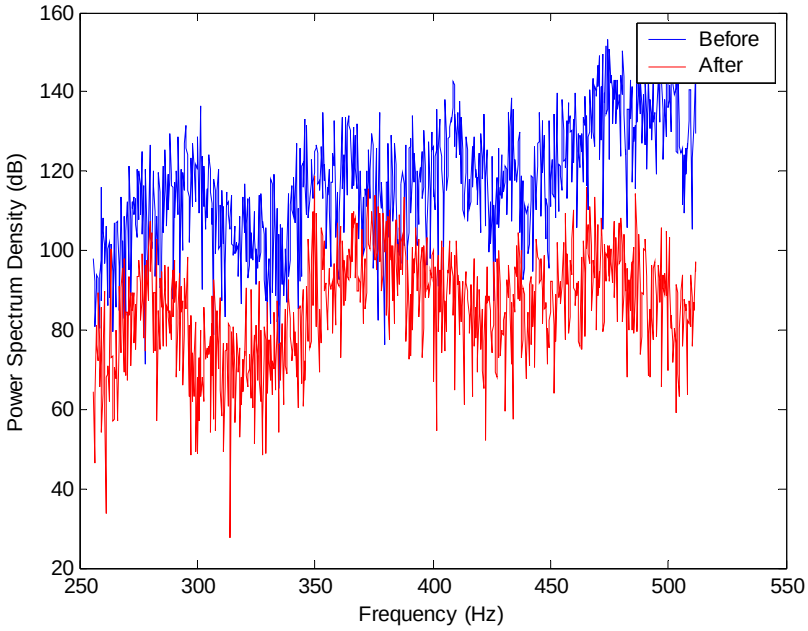


Figure 8 (b) Sentence (2)

From the results we find some unbalancing parts are improved after meditation. For instance, in sentence (1) the deviation between lower energy and higher energy reduces after meditation.

The table below shows the variance of power spectrum estimated from both sentences:

Table 1: The estimated variance.

	Sentence (1)		Sentence (2)	
	Before	After	Before	After
Exp Group	**637.8**	**583.8 (p < 0.07)**	642.9	603.0

Ctrl Group	596.6	572.0	585.9	548.4

Reduction of power-spectrum variance is (8.5%, 6.2%) for experimental group and (4.1%, 6.4%) for control group. Apparently, the experimental group has more *balanced* voice according to the variance of power spectrum after meditation. This result shows that meditation may balance the whole body more effectively.

五、結果與討論：

A. ARDK

The experimental subjects have an increase ratio of " Metabolism Function" after meditation while the control subjects remain about the same after the rest. A higher ratio indicates that the body metabolism is slower than normal after meditating activity. In addition, more meditators exhibited a better performance in the "Body Energy." Measurements show that meditation increased activity of the Qi and Blood of the right side of body, while the control subjects remained balanced before and after the rest session. Note that the "Musculoskeletal System" imbalance was highly probably caused by the half-lotus meditation posture (left or right lotus posture).

B. Sound Analyzer

Reduction of power-spectrum variance is (8.5%, 6.2%) for experimental group and (4.1%, 6.4%) for control group. Apparently, the experimental group has more *balanced* voice according to the variance of power spectrum after meditation. This result shows that meditation may balance the whole body more effectively.

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七、計畫成果自評：

During the past year, results of our research work have been accumulated and more significant. Because this study is still in its infancy, more recordings and observations are required. Nevertheless, we have observed the distinction between two groups based on the measurement of CAM instrumentation. Especially motivated by the multiform benefits of Zen-Buddhist meditation in promoting health, we have the confidence of having the results published in the international journals in the near future. Our recent publications are listed below.

1. Ching-Chuan Wei, Pei-Chen Lo, and Lin-KunWu, 2005, "Spectral Analysis of the Blood Circulation Based on the Viewpoint of Resonance," *Jpn. J. Appl. Phys.* (accepted). SCI, EI
2. Ching-Chuan Wei, Pei-Chen Lo, and Lin-Kun Wu, 2005, "System Analysis of the Blood Circulation Based on the Coherence Power Transfer: from Electrical Driving to Mechanical Vibration," *Jpn. J. Appl. Phys.* (accepted). SCI, EI
3. Kang-Ming Chang and Pei-Chen Lo, 2005, "Meditation EEG Interpretation Based on Novel Fuzzy-Merging Strategies and Wavelet Features," *Biomedical Engineering—Applications, Basis, and Communications*, V.17, No.4, pp.167-175. EI
4. Pei-Chen Lo and Jenq-Shiun Leu, 2005, "Quantification of Pseudo-periodicity of Alpha Rhythm in Meditation EEG," *Journal of Medical and Biological Engineering*, V. 25, No. 1, pp.7-13. EI
5. Kang-Ming Chang and Pei-Chen Lo, 2005, "Hurst exponent and linear regression with an application to low-power beta characterization in meditation EEG," *American Journal of*

Electroneurodiagnostic Technology, V.45, pp130-138. Medline

6. Hsien-Cheng Liao and Pei-Chen Lo, 2005, "Meditation EEG Overview Based on Subband Features Quantified by AR Model," *Journal of International Society of Life Information Science* (ISLIS), in print. PsycINFO (American Psychological Association)
7. Pei-Chen Lo and Hsuan-Yung Huang, 2005, "Investigation of Meditation Scenario by Quantifying the Complexity Index of EEG," submitted to *Journal of the Chinese Institute of Engineers* on June 3.