Chapter 7
Studies on Five Senses Treatment

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Abstract. There were studies on uses of complementary and alternative medicine therapy to treat mental disorder like anxiety, depression, and adjustment disorder, whereas there was no effective method to treat such mental disorders. This study proposed a therapy from complementary and alternative medicine to treat mental disorder by through interactions of five senses between therapist and patient. In this method sounding a certain six voices play an important role in healing and recovery. By applying chaos theory, we investigated time series of six vocal sounds consisted of six syllables that have been used in the therapy. On the basis of the reconstructed phase space trajectory for the subject’s voices, we found chaos features in the six vocal sounds with correlation dimension of \( D_2 = 3.02 \pm 0.8 \). Further, we studied the effect of spoken six voices on human status. A measure from RQA, diagonal length \( L_{\text{max}} \), was computed for the records of start and end of voices during consecutively spoken the voices lasting 1min long. The mean value of \( L_{\text{max}} \) increased from 6.4 to 7.9, giving nearly 20% increase in the end of voice in relate to start. Wilcoxon test showed the significant changes in \( L_{\text{max}} \) with \( p = 0.019 \). Our results implied that the six vocal sounds induce a decrease of divergence in pulsation waves, leading to a formation of order out of chaos in human body. The proposed five sense therapy is a noninvasive intervention that can be used to reduce anxiety levels and improvement of mental health. First, we studied effects of speaking using scalp-EEG measurement. Chaos analysis of EEG showed a largely enhanced largest Lyapunov exponent (LLE) during the speaking. In addition, EEG power spectrum showed an increase over most frequencies. Second, we performed case studies on mental disorder using the therapy. Running power spectrum of EEG of patients indicated decreasing power at end of treatment, implying five senses therapy induced relaxed and lowered energy in central neural system. The results agreed with patient’s reports that there were considerable decline in anxiety and improvements in mood.

Keywords: Chaos, EEG, mental disorder, depression, therapy, voices, five senses, plethysmogram.

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1 Introduction

In the last years, there were widely studies on uses of complementary and alternative medicine therapy to treat mental disorder like anxiety, depression, and adjustment disorder. Music therapy is one of methods that have been used in a range of ways in the treatment of many mental disorders including depression [1]. Whereas effectiveness on those with depression is unclear [2]. Recently a new study showed usefulness of yoga as a potential therapy for mental disorder [3]. They reported that yoga might be superior to other forms of exercise, with regard to its positive effect on mood and anxiety.

In the other hand, mental disorder/illness is a common problem affecting about 121 million people world-wide. It is characterized by persistent low mood, which leads to changes in appetite, sleep pattern and overall functioning. Especially, depression is projected to become the leading cause of disability and the second leading contributor to the global burden of disease by the year 2020 (WHO 2000, Moussavi 2007). Anxiety is associated with increases in heart rate and blood pressure and other changes that can have a negative impact preoperatively. In addition, anxiety may also be related to the symptoms of an underlying disease, the lack of knowledge regarding a diagnosis, uncertainty of the chain of events to occur, and fear of unknown or unexpected findings [4]. Feelings of anxiety are unpleasant for the patient. In regard some alternative approaches having a long history, many remain controversial. This is because of complexity of mental disorder that is associated with many aspects concerning psychology and physiology. Recent studies have shown that music can actually calm patients, improve vital signs, and increase patients’ overall levels of comfort [5-8]. Music therapy is a noninvasive intervention that can be used to reduce anxiety levels and improvement of mental health.

We proposed a five senses therapy in treatment of mental disorders, which emphasized the interrelationship between mind, body, and spirit in recovery and healing mental disorder by combined uses of five senses of human being. Smell, Taste, Touch, Sound, and Sight are our God given gifts to help heal our bodies. Humans use their five senses of sight, hearing, smell, touch, and taste as a means of acquiring information from the outside world. The senses bring into the brain information or (vibrations) that are then broken down into signals by the brain to stimulate healing. As Diane Ackerman writes in books “A Natural History of the Senses” [9]: "Most people think of the mind as located in the head, but the latest findings in physiology suggest that the mind doesn't really dwell in the brain but travels the whole body on caravans of hormones and enzymes, busily making sense of the compound wonders we catalogue as touch, taste, smell, hearing, and vision."

In our five senses therapy, sounding certain voices play an important role in our method, since of these five, humans mainly rely on their senses of sight and hearing to live. Many observations in both vocal folds model and experiments have established the existence of chaos in human voice production, which stimulated an extensive study on nonlinear dynamic analysis of the sounding voices [10] [11]. As noted by many researchers, investigations of chaotic activities of voices might indicate states of pathological and physiological functions, and therefore, might potentially useful for applying to diagnose and evaluate the effects of clinical treatments. We analyzed the six vocal sounds, called universal voice, which have been extensively used for pathological treatment and therapy in Holistic Health Science Institute. We firstly
apply chaos theory method to study of time series of the six vocal sounds. Then we investigate the effect of spoken the six voices on human status. We employ finger plethysmogram to observe changes of physiological parameters in response to the vocal sound. Finger plethysmogram was found having complexity and chaotic dynamics. It has been used to characterize the changes in physical/physiological status when performing a variety of mental tasks [12-15].

In final, we studied the effect of speaking on human status to understanding interactions between therapist and patient by through touching and communications, where therapist status play central role. We used measurement of scalp-EEG (Electroencephalogram) and chaos analysis. Then, we report some case studies on therapy of mental disorder. Finally, there are discussions and conclusions.

2 Experiment Method

2.1 Experiment 1

In the experiment 1 for the purpose of study of sounding effects in the five sense therapy, we had subjects who were mainly female and participated in the experiment. All of the 11 subjects have received a training program based on spoken the six voice for many years in the Holistic Health Science Institute, Kanazawa, Japan. Table 1 listed the subject characters and the years they received for the trainings. Age range was from 33-60, with mean 42. All subjects were informed of the purpose and procedures of the study and signed an informed consent.

Subjects were seated comfortably in a chair. After some simple questionnaires have been answered and relaxed for about 3min, subjects were instructed to speak six voices consecutively, continuously, and naturally. The vocal sound, called universal voice, consists of six syllables of Japanese vowels /a/, /o/, /u/, /e/, and /i/. The six vocal sounds have been used for pathological treatment and mental/physical trainings in Holistic Health Science Institute. All participants performed a practice session that contained 1 minute speaking trials before the experiment. We recorded time series of the vocal sound spoken by participates in sound proofed laboratory. The voices were recorded by digital audio recorder using an electric condenser microphone, with sampling rate of 44 kHz.

Since duration changed with spoken speed, whereas data sampling frequency remained fixed, a dilemma arises with respect to the proper way to compare data collected at different spoken speeds. Data were time-normalized in such a way to compare results, that each data set of six syllables (a set of universal voices) was re-sampled to be 12000 data points long, i.e. approximately 2000 data points per syllable. This permits enough temporal variation while normalizing the data such that the average number of data points per vocal sound was similar for each spoken speed condition.

In the experiments, physiological changes induced due to spoken six voices were measured by finger plethysmograms using a sensor attached to a right index finger by a device of BACS Advance (2002). The signals were A/D digitized and converted into a PC with resolution 12 bit and sampling frequency 200Hz.

Each test lasted about 1 min. Each subject was instructed to complete the spoken six voices consecutively, continuously, and naturally. The first set of the six syllables recorded was taken for chaos and nonlinear dynamics analysis.
The first and last portion of 10 sec, denoted as start and end of voice, respectively, were taken from the 1 min record of finger plethysmograms to perform RQA analysis, pointing to study the voice effect on human status.

<table>
<thead>
<tr>
<th>Subject No.</th>
<th>Sex</th>
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### 2.2 Experiment 2

In this experiment 2, we focused on studies on two subjects who were mastered therapists from the Holistic Health Science Institute, Kanazawa, Japan. The subject was seated comfortably in a chair in all of experiment. All subjects were informed of the purpose and procedures of the study and signed an informed consent. As shown in Fig.1 of experiment setup, subjects were seated comfortably in a chair in all of experiments conducted by two tasks.

Task 1 is a speaking task. After having a brief rest, subjects were instructed to speaking certain of six voices consecutively, continuously, and naturally. The vocal sound consists of six syllables of Japanese vowels /a/, /o/, /u/, /e/, and /i/.

Task 2 is a listening task. Subjects were instructed to listening classic music for a period of time. The music was taken from Mozart collections having slowly and peaceful melodies.

Each experiment had 2 min rest and following 2 min task. Before and during the tasks, physiological changes were measured by finger plethysmography and scalp-EEG recorder. The plethysmogram was recorded by a device (BACS Advance, CCI 2002) consisting of a sensor attached to a right index finger.

The scalp-EEG was recorded using a multi-channel EEG recorder (Neurofax EEG-1200, Nihon Kohden) with 14 active electrodes (Fp1, Fp2, C3, C4, A1 A2, P3, P4, Fz, Cz, Pz). The EEG electrodes were installed according to internal standard (10/20). All signals were A/D digitized and converted into a PC for analysis with sampling frequency of 200 Hz for finger plethysmogram and 500 Hz for scalp EEG.
3 Analysis Method

3.1 Chaos Analysis of Time Series

To understand chaos analysis methods, the concept of phase space needs to be described. A phase space is a space defined by multiple dynamic variables composed of generalized positions and velocities. The signals of a dynamical system such as vocal sound can be demonstrated as a trajectory in phase space with time evolution. The trajectory in phase space qualitatively displays the dynamics of underlying system. That is, periodic signals produce a closed trajectory, whereas aperiodic signals produce an irregular trajectory. When multiple dynamic variables cannot be assessed, it is useful to reconstruct the phase space of a voice signal by plotting a single time series $x(i), \text{ with } i=1,..., N$. We can create the reconstructed phase space with the following $d$-dimensional time delay vector

$$x(i) = (x(i),..., x(i-(d-1)\tau)) = \{x_k(i)\}$$

using $\tau$ constant time delay (time lag) and $d$ the embedding dimension, and $x_k(i) = x(i-(k-1)\tau), \text{ with } k=1,..., d$.

In order to correctly reconstruct the phase space, the parameters of time delay and embedding dimension should be chosen optimally. Because of the finite length and finite precision of voice data, the time delay is an important parameter in the reconstruction of a phase space. The time delay can be estimated with the mutual information method proposed by Fraser and Swinney [16]. Mutual information measures the general dependence of two variables. Fraser and Swinney found that the first minimum value in the curve of mutual information versus time delay provides an effective criterion for choosing the proper time delay, which will ensure that the variable and lagged variables are generally independent.

The correlation dimension $D_2$ proposed by Grassberger and Procaccia [17] is a geometric measure of a trajectory in phase space that describes how strongly two points on the trajectory are correlated. The correlation dimension quantifies the complexity or irregularity of a trajectory in phase space, which can be classified as a zero-dimensional fixed point, a one-dimensional limit cycle, quasi-periodic torus or a
fractal dimensional chaotic trajectory. A system with a higher correlation dimension may require more variables to describe its behavior. After reconstructing the phase space of a time series, the Grassberger–Procaccia algorithm is firstly to calculate the correlation integral \( C(r) \), where \( r \) is the radius around \( x(i) \). For small \( r \), \( C(r) \) shows a power law behavior in equation (2), which reveals the geometrical scaling property of the trajectory in phase space.

\[
C(r) \propto r^{D_2}
\]  

(2)

Based on \( C(r) \), we estimated the correlation dimension \( D_2 \) in the scaling region of the radius \( r \) with the increase of the embedding dimension \( d \).

We also estimated the largest Lyapunov exponent (LLE) using improved Rosenstein algorithm that was able to compute LLE in short and noise data [18, 19]. In this method, with \( \tau \) time delay and \( d \) the embedding dimension, with \( k=1,\ldots, d \), the phase space was reconstructed using time delay coordinate as in equation (1). An embedding dimension \( d=6 \) was used for time series of scalp-EEG, based on false nearest neighbor analysis. Time delay was determined using the first minimum of the average mutual information function.

From the constructed attractor in phase space, Euclidean distances between neighboring trajectories in state space were calculated as a function of time and averaged over all original nearest neighbor pairs to obtain the average logarithmic rate of divergence:

\[
y(i) = \frac{1}{\Delta t} < \ln (d_j(i)) >
\]  

(3)

where \( d_j(i) \) represents the Euclidean distance between \( j \)-th pair of nearest neighbors after \( i \) discrete time steps, \( < \rightarrow > \) denote the average over all values of \( j \). The slope of the resulting divergence curves provides an estimate of LLE.

### 3.2 Recurrence Quantitative Analysis

Recurrence plots proposed originally by Eckmann et al [20], describe the recurrence feature of a deterministic dynamics system by visualizing the time dependent behavior of trajectory in a phase space. Assume a dynamical system governed by \( \dot{x} = F(x) \), \( x \in \mathbb{R}^n \). \( N \) discrete points recorded in time are \( x(i), i=1,\ldots,N \). A threshold recurrence plot is constructed by forming the matrix

\[
R_{ij} = \Theta(\varepsilon - \| x(i) - x(j) \|)
\]  

(4)

where \( \varepsilon \) is a threshold parameter and \( \| \cdot \| \) takes Euclidean norm of the \( m \)-dimensional distance vector. \( \Theta(\cdot) \) is Heaviside function. The values of \( R_{ij} \) are 1 or 0 depending on whether the distance between points \( i \) and \( j \) is less than or greater than \( \varepsilon \). The binary values of \( R_{ij} \) can be simply visualized with black (1) and white (0). Thereby the visualized plots can be considered as an inspection of a high-dimensional phase space trajectory. Based on a single measured variable, the phase space vector \( x(i) \) can be reconstructed by using the Taken's time delay method as formulated in equation (1).
The recurrence quantitative analysis (RQA) was proposed in Webber and Zbilut [21] to measure the visualized recurrence plots of \( R_y \). In measures of RQA, a diagonal line of length \( l \) means that a segment of the trajectory is rather close during \( l \) time steps to another segment of the trajectory at a different time. The length \( L_{\text{max}} \) of the longest diagonal line found in the recurrent plot. We used \( L_{\text{max}} \) as an important measure. This measure gives a hint about the divergence of the trajectory segments. Many studies suggested that the diagonal line length could inversely estimate the largest positive Lyapunov exponent. One marker of nonlinear dynamics that we consider as the most important is the Lyapunov exponent. The dynamics have the property of “sensitivity to initial conditions.” Starting from two similar values, the systems may generate two sequences that quickly (exponentially) diverge one from the other. The direct calculation of the Lyapunov exponent from an experimental time series is complicated and requires very long and stationary series [22][23].

4   Results

4.1   Results of Chaos Analysis of Voice

The voice data re-sampled to be 12000 data points long contains a set of six syllables (a universal voice). The parameter of time delay used to reconstruct phase space was estimated with the mutual information method proposed by Fraser and Swinney. Fig.2 shows a signal from a set of six syllables vocal sound.

Grassberger–Procaccia algorithm calculated the correlation integral \( C(r) \). From curve \( C(r) \) for a sound, we estimate the correlation dimension \( D_2 \) in the scaling region of the radius \( r \) with the increase of the embedding dimension. As illustrated in Fig.3, the correlation dimension was obtained when the embedding dimension is sufficiently large.

In result, Fig.4 shows the estimated correlation dimension \( D_2 \) for subject from No.1 to 11. Mean and SD is \( D_2=3.02\pm0.8 \). The result means there are nonlinear dynamics and underlying chaotic activities in human six voices production. The system has low dimensional and determinate characters.
Fig. 3. Correlation dimension was estimated when the embedding dimension is sufficiently large.

Fig. 4. Correlation dimension for subject from No.1 to 11.

4.2 Results of RQA Analysis

To study the voice effect on human status, we calculated a measure of RQA corresponding to the first and last portion of 10sec taken from the finger plethysmograms recorded during continuously spoken voices. The embedding dimension to reconstruct phase space of plethysmogram was 4 according to a method of false nearest neighbors. Time delay used 10 determined by initial minimum points in mutual information function. The parameter of threshold $E$ was 5% of the maximum phase space diameter to make recurrence point density approximately 1%.
Fig. 5 illustrates calculations of measure $L_{\text{max}}$ in start voice and end voice, respectively, corresponding to the first and last portion of 10sec taken from the finger plethysmograms recorded during continuously spoken voices. Although there were largely individual differences, mean of $L_{\text{max}}$ increased from 6.4 to 7.9. In relation to relative changes, there was an increase of 20% in the end of voice than start.

Wilcoxon test performed a paired, two-sided signed rank test. The test showed the value of $L_{\text{max}}$ in the last 10sec (Start voice) significantly larger than the first 10sec ($p = 0.019$). Since Eckmann et al. have stated that “the length of the diagonal lines is related to the largest positive Lyapunov exponent”, it means there was lower in divergence in the last 10 sec than the first one.

**Fig. 5.** $L_{\text{max}}$ in start voice and end voice, respectively, corresponding to the first and last portion of 10sec of plethysmograms during continuously spoken the voices with six syllables.

### 4.3 Chaos and Power Spectrum in Scalp EEG

In analysis of time series of scalp EEG, time length of 8s was used taken from both the rest and task periods.

For sake of simple, Fig.6 shows reconstructed chaos attractors in phase space for only first 3-channels (Fp1, Fp2, C3). The row 1 in Fig.6 corresponds ones of the 3-channels at rest period before speaking. The row 2 is ones during the task. It is clear there is an increase in complexity of attractor observed due to speaking.

In most left of Fig.7, it shows a computation of LLE by equation (3), where we plot divergence curve (above) and slope (below). According to computations on scalp-EEG, the topographical 2-D scalp map in Fig.8 shows map changes due to speaking in a distribution of LLE on cerebral scalp. There is largely enhanced LLE during speaking as shown in 2D map.
Fig. 6. Reconstructed chaos attractors in phase space for first 3-channels. Row 1 and 2 correspond to before and during speaking.

Fig. 7. Most left is divergence and slope in computation LLE
Fig. 8. Scalp LLE maps before and during Speaking

(a) before speaking

(b) during speaking

Fig. 9. Power spectrum before (a) and during speaking (b). 2-D map show scalp power maps at positions of 4.9Hz, 11.7Hz, and 19.5Hz.
Fig. 9 shows a change in power spectrum before (a) and during speaking (b). The power spectrum was calculated according to FFT method, where scalp power maps indicated power distribution on map at positions of 4.9Hz, 11.7H, and 19.5Hz, respectively. In comparing (a) and (b), we found that speaking caused increasing effect of EEG spectral power.

4.4 Lyapunov Exponent Distribution over Scalp EEG

Fig.10 and 11 show the largest Lyapunov exponent (LLE) estimated for scalp EEG before and during Task 1 (speaking task), with respect with subject 1 and subject 2. As shown in above part in Fig.10 and 11, most of channels (ordered 1-14) show an increase tendency of LLE during Speaking Task in comparison with Before (rest period). Topographical 2-D scalp map in Fig.10 and 11 are distributions of LLE on cerebral scalp map. Especially LLE around occipital and right cerebral area reveal enhanced increase during Speaking. Frontier cerebral area shows small or little changes.

Fig. 10. LLE of scalp-EEG before and during Speaking for subject 1. Scalp map is a distribution of LLE on brain scalp.
Fig. 11. LLE of scalp-EEG before and during Speaking for subject 2. Scalp map is a distribution of LLE on brain scalp.

Fig. 12. LLE of scalp-EEG before and during Listening music for subject 2. Scalp map is a distribution of LLE on brain scalp.
Fig. 13. LLE of scalp-EEG before and during Listening music for subject 2. Scalp map is a distribution of LLE on brain scalp.

Fig.12 and 13 show LLE estimated for scalp EEG before and during Task 2 (listening music task) for subject 1 and subject 2. As shown in above part in Fig.12 and 13, there is a decreasing tendency of LLE during Listening Task in comparison with Before (rest period). Topographical 2-D scalp map of distribution of LLE show a drop around center cerebral area.

4.5 Changes of Plethysmogram in Relation to EEG

LLE obtained based analysis of finger plethysmogram are shown in Fig.14 under Task 1 (Speaking) and Task 2 (Listening music) in Fig.15. Both subjects indicate increasing values during Task 1 (Speaking). Whereas, there is decreasing LLE during Task 2 (Listening).

Finally, in comparison of Fig.14 with Fig.10-11, it is clear that the increasing LLE of plethysmogram correspond the same increasing tendency for ones of EEG during Speaking Task. Similarly, there is the same decrease in LLE for both plethysmogram and EEG during Listening Task when comparison of Fig.15 with Fig.12-13.
Fig. 14. Results of finger plethysmogram in experiments conducted by speaking Task

Fig. 15. Results of finger plethysmogram in experiments conducted by Listening Task

5 Case Study

5.1 Method of Five Senses Therapy

In our five senses therapy from complementary and alternative medicine, we emphasized the interrelationship between mind, body, and spirit in healing mental disorder by through interactions between therapist and patient. Smell, Taste, Touch, Sound, and Sight are our God given gifts to help heal our bodies. Humans use their five senses of sight, hearing, smell, touch, and taste as a means of acquiring information from the outside world. The five senses are the doorways to our internal physiology. The five senses therapy is so easy and pleasurable for her patients to use—and because of its speedy effect.
We developed therapy program outlined here having direct health benefits. They also prime your sense to absorb all forms of sensual pleasures. This can be a source used for inspiration, and information on everyday ways to enrich the life.

**Smell (Aromatherapy)**  
There is a certain kind of aroma smell used during therapy-Aromatherapy. A smell has the power to take a person to another place and time in her life. Olfactory priming through food, perfumes or commercial items of a specific era can greatly enhance recall and prompt the patient to open discussion with her therapist or group members. Autobiographical stories surrounding a certain smell, such as a bouquet of flowers or a peach pie, can create emotional contact with a patient and group cohesion within a care facility.

In our aromatherapy, we used a specific essential aromatic oils made in our Institute from combinations of herbs, traditional medicine, and natural oils. The treatment using the oil corrected imbalances in the mind-body system. This therapy works by penetrating into the memory and breaking the pattern of imbalance that lives there. In this way aromatherapy heals the memory of mental disorder, quickly, effortlessly, and pleasurably.

**Taste**  
Taste is importance in the human mind-body interaction. Each smell used in our therapy an energetic bundle of information. Gustatory priming can include era-appropriate recipes, soft drinks and spices. We researched the significant historical and demographic trends of a patient's life. Recipes and spices unique to the region and time of a patient's youth can be highly effective in prompting memories and stories. There are nine thousand taste buds, and when stimulated they trigger nerve impulses to special taste centers in the brain’s cortex and thalamus. We used natural "feel good" chemicals. This stimulation resulted in improved blood flow, blood pressure, pulse rate, breathing, and posture changes [6, 7].

**Touch (Massage therapy)**  
Items that engage the patient's tactile sense can include clothing, blankets, fabric swatches and fur, as well as occupation-specific items. Our therapist touches patient naturally and softly according to a rhythm by through certain kind of oil. Particularly, therapist uses clinical techniques to connect with the patient by speaking the six voices, which can act to emotional awareness. We found that such sounding voices stimulated the body's natural chemicals. This stimulation is important, leading to significantly improved blood flow, blood pressure, pulse rate, and the other physiological parameters [7].

**Sight (Image therapy)**  
All objects absorb some of the light waves. Our eye picks up the light waves that bounce from the object’s surface and sends them to the brain, which interprets them as certain colors underlying the brain, particularly the area of the brain known as the hypothalamus. The hypothalamus regulates and controls the adrenals, pituitary, thymus, and entire endocrine system. The color sent by light waves affect mental and physical activities and hence the mind-body health.
In this method and the color therapy, we employed fractal images and movies in sense of sight of patient who simultaneously hearing certain resonance voices. We found that certain colors have specific benefits.

Red color builds blood, improves red blood cell production, improves circulation, and inspires the creative process.

Yellow color stimulates and increases assimilation, and raises consciousness.

Orange color fights bacteria, strengthens the immune system.

Blue color is cooling, enhances perception, and reduces pain.

Green color is calming, refreshing, and energizing.

**Sound (Hearing therapy)**

Studies found that recordings of sounds and voices with personal, historical, occupational or geographic significance to the patient could be a powerful memory cue. Also Carefully select musical cues that are chronologically appropriate to the patient is important in healing processes. Sound plays a key role in the spiritual and religious’ rituals of many cultures. Music has been found to enhance immune function; improve thinking ability; improve sleep; exercise, and work performance; help speed recovery from heart attacks and strokes; reduce side effects of chemotherapy; ease chronic pain; reduce the amount of anesthesia required during surgery; and reduce the amount of pain-killer required during childbirth.

In this method, we instructed patient to listening certain resonance voices having six syllables of Japanese vowels /a/, /o/, /u/, /e/, and /i/ in /n/, spoken by a therapist.

Accordingly in our clinical practice, five senses therapy has been used to treat generally mental disorders such as stress, grief, depression, schizophrenia, and autism, and to diagnose mental health needs.

### 5.2 Patients and Study Design

We had three patients having mental disorder as follows.

P1: age 41, female. Earthquake in Kobe of Japan caused agoraphobia (adjustment disorder) 14 years ago.

P2: age 44, female. Depression due a trouble with persons in work 9 years ago.

P3: age 51, female. A mentally shock caused schizophrenia 7 years ago.

All patients were characterized by a marked lowering of self-esteem and feelings of worthlessness and guilt, having common characters of mental disorder (WHO 1992).

In study design, we treat each patient for about 30min by using five senses therapy. Before and after the therapy, physical examinations, including blood pressure, pulse and weight measurements were performed together with EEG measurement, neurological, and psychiatric examinations. EEG recorded by a device (Brain Builder) developed in Brain Function Research Center.

Left picture of Fig.16 shows therapy processes. Right one is a patient doing EEG measurement.
5.3 Result of Therapy

At the end of therapy, we found that those patients received the therapy reported considerable decline in anxiety and greater improvements in mood and anxiety status in agreement with observations on physiological measurements.

P1:

![Graph of EEG analysis for P1 before and after therapy](image)

P2:

![Graph of EEG analysis for P2 before and after therapy](image)

P3:

![Graph of EEG analysis for P3 before and after therapy](image)

Fig. 17. Analysis of running power spectrum of EEG before (Left column) and after therapy (Right column) for all three patients (P1, P2, P3)
Analysis of running power spectrum of EEG was performed to examine effects on central neural system (CNS). Fig.17 shows the results before (Left column) and after therapy (Right column) for all three patients (P1, P2, and P3). Generally there are decreasing powers over majority frequencies after treatment, implying five senses therapy induced relaxed and lowered energy in CNS.

6 Discussion and Conclusion

Mental disorder/illness is a common problem becoming the leading cause of disability and the global burden of disease. In regard some alternative approaches having a long history, many remain controversial, we proposed five senses therapy to treat mental disorder by through interactions of five senses between therapist and patient. In our method speaking a certain voices play an important in healing and recovery by considering that humans mainly rely on their senses of sight and hearing to live. In particularly, therapist uses clinical techniques to connect with the patient by speaking the six voices, which can act to emotional awareness. Since sounding voices may give an arising vital energy underlying human body in therapist, that in turn inducing patient having body's natural "feel good" chemicals.

We accordingly studied the effect of speaking voice on human status and on central nervous system (CNS) using scalp-EEG (Electroencephalogram). Chaos analysis of EEG shows the changes due to speaking on a distribution of EEL on brain scalp. We found there was largely enhanced LLE during speaking. To investigate neural activities of brain, the power spectrum was calculated according to FFT method, where the speaking caused increasing effect of EEG spectral powers. These imply that speaking six voices increased complexity and processing processes in human brain, along with an increase of power spectrum over most neural activities (vibrations) underlying cerebral scalp.

We studied six vocal sounds, denoted as universal voice, consisted of six syllables that have been used for mental/physical training and treatment. By applying chaos theory to study of time series of the six voices, we have investigate the complexity activities underlying physiologic systems that responsible for generation chaos in vocal sound, suggesting that changes in nonlinear dynamic measures may indicate pathological and physiological states. Further studies should explore into the relationship between the voice chaos feature of various voice and mental/physical status by employing various sound protocols by we-designed approaches. We found chaos features in the six vocal sounds with correlation dimension of D2=3.02±0.8, implying emergence of low dimensional and deterministic chaos [21].

To investigate the effect of spoken the six voices on human status. We employed finger plethysmogram to observe changes in physiological parameters in response to the vocal sound. Finger plethysmogram showed having complexity and chaotic dynamics. It has been used to characterize the changes in physical/physiological status under a variety of mental tasks and conditions. A method of recurrence quantification analysis (RQA) was used to analysis the recorded finger plethysmograms. Based on recurrence plots from start voice to end of voices, we computed a measure of max diagonal length Lmax associated with the start and end of voices during consecutively spoken the six voices lasting 1min long. The mean value of Lmax increased from 6.4
to 7.9. In relation to relative changes, there was an increase of 20% in the end of voice than start. Wilcoxon test showed the significant changes in measure Lmax with $p=0.019$, implying there was low divergence in response to spoken the six voices. It is well-known that pulsation of human capillary vessel has chaotic and fluctuation characters [23]. Our results mean that the six vocal sounds induce a decrease in fluctuation and divergence in pulsation waves, leading to a formation of order out of chaos in homodynamic system of human body.

We found that scalp-EEG showed an increase of LLE during Speaking Task in comparison with Before (rest period). Topographical scalp map showed that LLE around occipital and right cerebral area had a largely increase during Speaking. Changes in frontier cerebral area were small. In Task 2, scalp-EEG showed decreasing tendency of LLE during Listening Task in comparison with Before (rest period). Topographical scalp map of LLE revealed a drop around center cerebral area. As illustrated in analysis of finger plethysmogram, it is clear that the increasing LLE of plethysmogram correspond the same increasing tendency for ones of EEG during Speaking Task. Similarly, there is the same decrease in LLE for both plethysmogram and EEG during Listening Task.

In relation to clinical practice, we performed three case studies on mental disorder. Analysis of running power spectrum of EEG was performed to examine effects on central neural system (CNS). It shows there may be decreasing power spectrum over all frequencies, implying five senses therapy induced relaxed and lowered energy in CNS. This agree with reports from those patients received the five senses therapy that there were considerable decline in anxiety and greater improvements in mood status.

More detailed studies are needed to understanding the mechanism of the therapy. We are expected to have an effective use of the method to treat disorders such as stress, grief, depression, schizophrenia, and autism in children, and to diagnose mental health needs in clinical practice in the future.

References


