

## Study of Brain Activity Analysis of Deep Breathing

Wanee Rojviroj<sup>1</sup>

Professor Dr. Vichit Punyahotra<sup>2</sup>

Assistant Professor Dr. Wichian Sittiprapaporn<sup>3</sup>

Dr. Ariya Sarikaphuti<sup>4</sup>

### Abstract

Study of Brain Activity Analysis of Deep Breathing was examined in sixteen healthy participants on stress level, and each type of brainwaves related to deep breathing. All brainwaves were recorded by electroencephalogram (EEG). Deep breathing rate was at six breaths per minute: four seconds for inhalation, two seconds for holding the air, and four seconds for exhalation, respectively. The study found that deep breathing induced relaxation and improved mental health as confirmed by Thai Stress Test. In addition, deep breathing affected to both Theta and Delta brainwaves during resting state as in eyes-closed trial. The deep breathing at trial 2 and 3, ranging approximately four to six minutes might be the most appropriate time for the participants to successfully accumulate alpha brainwave.

**Keywords:** Deep Breathing/Brain/Brainwaves/Stress/Relaxation

- 
1. Graduate Student, Master of Science in Anti-Aging and Regenerative Science, School of Anti-Aging and Regenerative Medicine, Mae Fah Luang University e-mail:wanee\_oon@hotmail.com
  2. Major Advisor, Department of Anti-Aging and Regenerative Science, School of Anti-Aging and Regenerative Medicine, Mae Fah Luang University e-mail:prof.dr.vichit@hotmail.com
  3. Co-advisor, Department of Anti-Aging and Regenerative Science, School of Anti-Aging and Regenerative Medicine, Mae Fah Luang University e-mail:drwichian.s@gmail.com
  4. Co-advisor, Department of Anti-Aging and Regenerative Science, School of Anti-Aging and Regenerative Medicine, Mae Fah Luang University e-mail:unique21th@hotmail.com

### 1. Introduction

Most people are hardly able to avoid confronting frustrated situations; as it is inevitable to encounter with stress. Stress is a response mechanism to stressor such as workload, lifestyle, environment, physical, emotions and so on. Stress is categorized as one of the most toxic substance to human body. It is one of the brain activities that is opposite to relaxation. It greatly reduces overall quality of life and accelerates body aging processes. There are many attempts to discover techniques to counter stress by invention of new products and adaptation to the environment. Moreover, most techniques needed special equipment which are costly and require time-consuming procedure. Therefore, there is a need to look back to the basic of life support that can be utilized from nothing. The vital activity which humans have subconsciously done is "Breathing". In fact, human will not be alive without breathing. Breathing is special in several aspects. It is the only function that can be performed consciously as well as unconsciously, and it can be completely voluntary or involuntary. Breathing is the bridge between mind and body, the connection between consciousness and unconsciousness. It is the key to health and wellness, a function we can learn to regulate and develop in order to improve our physical, mental and spiritual well-being (Weil, 2012). However, most people do not know that they can make use of breathing. In fact, breathing is voluntary and controllable either with respect to rate or type of respiration. Knowing how to perform simple breathing techniques can reduce stress, lower blood pressure, calm a racing heart, and help many systems in the body without taking drugs. Breathing has direct connections to emotional states and moods. We can control or practice our breathing to be deep, slow, quiet and consistent (Weil, 2012).

Diaphragmatic breathing, abdominal breathing, belly breathing are also known as deep breathing and can be controlled. Deep breathing is an excellent tool to stimulate the relaxation

response that results in less tension and overall sense of well-being. (The Benefits of Abdominal breathing, n.d.) It can effectively counter stress, and is considered as one of relaxation techniques. Deep breathing breaks the cycle of stress and also promotes alpha which is the band that is related to body and mind relaxation. Alpha is defined as brainwaves that cycle between the frequencies of 8-12 Hz, which is classified as a state of relaxation. Alpha is the dominant brainwave activity when the body and mind are relaxed. Alpha wave activity is common among highly creative individuals who have a clear mind or are experiencing relaxation (Alpha Brain Waves, n.d.). Deep breathing can also promote Theta, which occur during extreme mind relaxation, and Delta, the deepest state of complete relaxation. It should be a great benefit if a person can integrate all knowledge and demonstrate the correlation between deep breathing and relaxation. Certainly, if deep breathing is to create Alpha, Theta, and Delta, it should be valuable to human well-being. In terms of practice, deep breathing can be performed with no cost, no equipment, no membership required – in fact, deep breathing can be done by anyone, anywhere and at any time. Deep breathing definitely promotes health and is acknowledged as one of the most effective anti-aging methods. Therefore, the research hypothesis were deep breathing may improve mental health, may induce relaxation and may affect Alpha, Theta, Delta.

## **2. Objectives**

The objectives of the research were to study the effect of deep breathing on stress level and to analyze brain activity resulting from deep breathing as a whole and to analyze brain activity resulting from deep breathing particularly on relaxation bands including Alpha, Theta, and Delta, respectively.

## **3. Materials and methods**

### **3.1 Participants**

Sixteen participants, age ranged from 25-55 years, twelve females and four males, volunteered for this study. All participants were healthy and carefully screened according to the inclusion and exclusion criteria. The screening was to exclude those with current diseases, history of mental illness or intake of medication that may have affected EEG recording. Inform consent was obtained from all participants and all procedures were conducted in accordance with the ethical standards of the Mae Fah Luang Ethical Committee.

### **3.2 Research Instrumentations**

#### **3.2.1 Personal profiles recording**

The personal profiles included gender, age, nationality, weight, height, and personal health history.

#### **3.2.2 Electroencephalography (EEG) Recording**

The 2-channels EEG was used to record the brainwave activities. Silver-silver chloride electrodes were fixed at two areas of the brain, Frontal (Fz) and Central (Cz) electrode sites. The ground was fixed at the Front-polar (Fp) electrode site while the left and right ear lobe were used as references according to the international 10/20 system and study of Fumoto *et al.* (2004).

#### **3.2.3 Stress Level Evaluation**

Thai Stress Test (TST) developed by Phatthaayuttawat (2000) was used to evaluate stress level. The test was a two dimensional rating scales which each scale composed of twelve index items. The total of both parts were composed of twenty four questions. The first twelve questions represented negative feeling while the latter denoted positive one. The test was characterized in 3 levels as Likert. The sum of rating scale was grouped by the standard scale from the matrix table. Participants answered questions in both negative and positive feelings by rating them on computer by Super Lab Pro Version 2.0.4 before and after deep breathing. Results of Thai Stress

Test after grouping were interpreted into 4 levels: Excellent mental health, normal mental health, mild stress, and stressful.

### 3.2.4 Procedures

Prior to the experimental trials, participants would be instructed to train deep breathing. First, to confirm that a participant was doing deep breathing by asking the participant placed one hand on the chest and the other on the abdomen. While taking a deep breath in, the hand on the abdomen should rise higher than the one on the chest. This insured that the diaphragm was pulling air into the bases of the lungs. Second, taking a slow deep breath in through the nose imagining that all the air in the room was sucked for a count of four ( four seconds). Holding the air that sucking in for a count of two (two seconds). Third, slowly exhaled through the mouth for a count of four (four seconds). As all the air was released with relaxation, gently contracted the abdominal muscles to completely evacuate the remaining air from the lungs. Last, repeated the cycle five more times for a total of six deep breaths and tried to breathe at a rate of one breath every ten seconds (six breaths per minute). The participant would be given a practice session for several times to become familiar with deep breathing.

### 3.3 Experimental paradigm

The experiment consisted of three main sections – pre-test normal breathing, deep breathing, and post-test normal breathing. In the first section, participants were asked to perform three short trials, comprising one-minute normal breathing with eyes-open, one-minute normal breathing with eyes-closed, and Thai Stress Test evaluation. The following section was made up of five identical trials; in each trial, the participant was asked to perform deep breathing for two minutes. The final trials were similar to the first except the order of the tasks was reversed. After deep breathing trials, Thai Stress Test was taken followed by one-minute eyes-closed normal breathing and one-minute eyes-open normal breathing. During each trial, data were collected in separated files. The whole experiment was expected to last about half an hour.

### 3.4 Statistical analysis

Paired sample t-test was used to analyze the Thai Stress Test (TST) scores and Electrophysiological data. The results were considered to be statistically significant when p-values were less than 0.05.

## 4. Result

### 4.1 Demographical Data

**Table 4.1** Demographical Data

<b>Variable</b>	<b>n</b>	<b>Variable</b>	<b>n</b>
Age (years)		Weight (kg)	
20 - 29	9	45 - 54	7
30 - 39	4	55 - 64	2
40 - 49	0	65 - 74	3
50 - 59	3	75 - 84	4
<b>Occupation</b>		<b>Height (cm)</b>	
Freelance	4	150 - 159	6
Self-employed	4	160 - 169	6
Office worker	3	170 - 179	4
Civil servant	1		
Doctor	1	<b>Total</b>	<b>16</b>
Housewife	1		
Teacher	1		

## 4.2 Analyzing of deep breathing assessed by the Thai Stress Test

The study after being analyzed by Thai Stress Test found that deep breathing created relaxation and improved mental health. These conclusions were confirmed by the data of stress evaluation in negative and positive feeling and stress level interpretation as shown below.

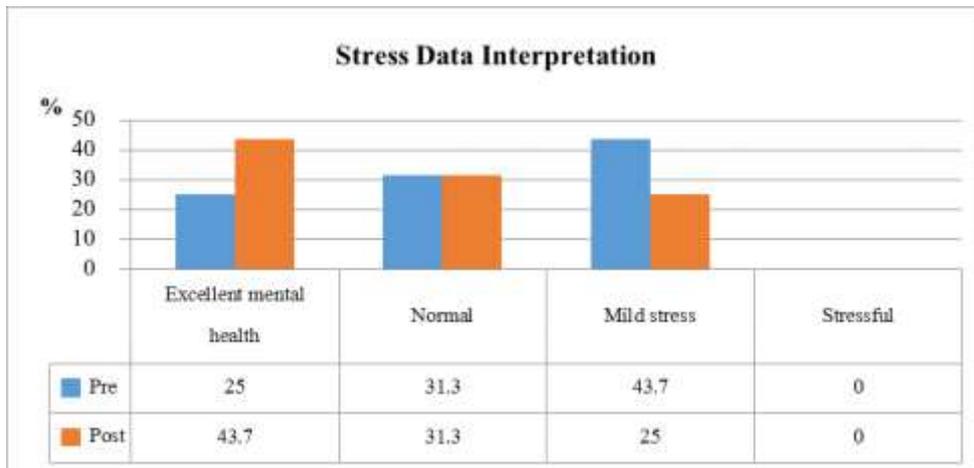
**Table 4.2** Stress evaluation in negative and positive feeling before and after deep breathing

Stress Evaluation	$\bar{x}$	SD	$\bar{d}$	SD	t	p
Negative feeling before deep breathing	6.0	5.3				
Negative feeling after deep breathing	4.3	4.4	1.7	2.4	2.941	0.010*
Positive feeling before deep breathing	27.2	4.6				
Positive feeling after deep breathing	29.5	4.8	-2.3	4.2	-2.191	0.045*

\*  $p < 0.05$

**Table 4.3** Stress level interpretation before and after deep breathing task in number

Stress Level Interpretation	Pre	Post
	Number	Number
Excellent mental health	4	7
Normal	5	5
Mild stress	7	4
Stressful	0	0
<b>Total</b>	<b>16</b>	<b>16</b>



**Figure 4.1** Stress level interpretation

## 4.3 Electrophysiological data

**4.3.1 Comparison of trial pairs** (three pairs: eyes-open before and after deep breathing, eyes-closed before and after deep breathing and Thai Stress Test before and after deep breathing)

1) There was no significance in the comparison of eyes-open before and after deep breathing:

2) The statistic expressed the significance at the level 0.05 of eyes-closed before and after deep breathing in Beta, Theta, and Delta but not included Alpha.

3) There was no statistically significant difference in the trial pair of Thai Stress Test before and after deep breathing.

### 4.3.2 Brainwave activities

1) Gamma brainwave: there was no significance in three comparison trial pairs

2)Beta brainwave: the study found the significance at level 0.05 in twelve trial pairs. The outcome expressed in frequency and number of waves both in Fz and Cz electrode sites. There was also have a significance in comparison trial pair, eyes-closed before and after deep breathing

3)Alpha brainwave: since Alpha brainwave is a state of relaxation band. The analysis found the significance at 0.05 in four trial pairs. The result expressed in the number of waves at the same area (Fz) and, as shown in the following table. There was no significance found in all comparison trial pairs in this band.

**Table 4.4** Alpha brainwave experimental data at Fz electrode site

				$\bar{x}$	SD	d	SD	t	p
Pair 1	deep breathing trial 2			14.88	8.48	2.50	3.72	2.69	0.017*
	eyes-open before deep breathing			12.38	7.17				
Pair 2	deep breathing trial 3			14.44	8.29	2.06	3.86	2.14	0.049*
	eyes-open before deep breathing			12.38	7.17				
Pair 3	deep breathing trial 2			14.88	8.48	3.31	3.57	3.71	0.002**
	eyes-open after deep breathing			11.56	6.398				
Pair 4	deep breathing trial 3			14.44	8.294	2.88	5.00	2.298	0.036*
	eyes-open after deep breathing			11.56	6.398				

\*  $p < 0.05$ ; \*\*  $p < 0.01$

4) Theta brainwave: the study found the significance at the level 0.05 in one trial pair in frequency at Cz electrode site

**Table 4.5** Theta brainwave experimental data

				$\bar{x}$	SD	d	SD	t	p
Pair 1	eyes-closed before deep breathing			5.28	0.87				
	eyes-closed after deep breathing			5.73	0.82	-0.45	0.78	-2.32	0.035*

\*  $p < 0.05$

5) Delta brain wave: the study found the significance at the level 0.05 in three trial pairs. The result expressed in the number of waves and frequency at the same Cz electrode site (Table 4.6). There were two pairs that had significances in comparison trials including eyes-closed before and after deep breathing.

**Table 4.6** Delta brain wave experimental data at Cz electrode site

				$\bar{x}$	SD	d	SD	t	p
Pair 1	eyes-closed before deep breathing			2.56	0.33	0.41	0.61	2.656	0.018*
	eyes-closed after deep breathing			2.16	0.57				
Pair 2	eyes-closed before deep breathing			6.19	2.07	-0.81	1.22	-2.657	0.018*

	eyes-closed breathing	after	deep	7.00	2.76				
Pair 3	deep breathing trial 1			2.38	0.38	0.37	0.64	2.299	0.036*
	eyes-open breathing	before	deep	2.01	0.68				

\*  $p < 0.05$

## 5. Conclusion and Recommendations

### 5.1 Conclusion

The study found that deep breathing induced relaxation and improved mental health as confirmed by Thai Stress Test. In addition, deep breathing affected to both Theta and Delta brainwaves during resting state as in eyes-closed trial. The deep breathing at trial 2 and 3, ranging approximately four to six minutes might be the most appropriate time for the participants to successfully accumulate Alpha brainwave.

### 5.2 Recommendations

This study could truly serve as the fundamental case for future related studies. They could vary in a number of ways: various sample groups, types of breathing, and brainwaves in depth, for example. Referring to the results of this study, deep breathing can be beneficial a better-quality health. Particularly, deep breathing gives benefits to human body and is the best practice in anti-aging.

### Acknowledgement

We would like to express our sincere appreciation to the staff of School of Anti-Aging and Regenerative Medicine, Mae Fah Luang University for their professionalism in handling their work. In particular, our sincere gratitude extends to all my colleagues and others who have provided helpful opinions and suggestions at various occasions.

### References

- Alpha Brain Waves. (n.d.). *Definition, Functions & Benefits*. Retrieved September 28, 2013, from <http://www.brainwavesblog.com/alpha-brain-waves/#sthash.Eu1lxN1J.dpuf>
- Brain Actor 2-channel EEG. (n.d.). Retrieved October 17, 2013, from [http://www.microsofttranslator.com/bv.aspx?ref=SERP&br=ro&mkt=en-ww&dl=en&lp=DE\\_EN&a=http%3a%2f%2fwww.shift-academy.com%2fProdukte%2fdetails%2fBrainActor-2-Channel-EEG-1](http://www.microsofttranslator.com/bv.aspx?ref=SERP&br=ro&mkt=en-ww&dl=en&lp=DE_EN&a=http%3a%2f%2fwww.shift-academy.com%2fProdukte%2fdetails%2fBrainActor-2-Channel-EEG-1)
- Fumoto, M., Sato-Suzuki, I., Seki, Y., Mohri, Y. & Arita, H.. (2004). Appearance of high-frequency alpha band with disappearance of low-frequency alpha band in EEG is produced during voluntary abdominal breathing in an eyes-closed condition. *Neuroscience Research*, 50(3), 307-317.
- Phattharayuttawat, S. (2000). The Development of the Thai Stress Test. *Psychiatry Journal*, 45(3), 237-250.
- The Benefits of Abdominal breathing*. (n.d.). Retrieved June 16, 2014, from <http://www.amsa.org/healingthehealer/breathing.cfm>
- Weil, A. (2012). *Spirit and Inspiration*. Retrieved November 5, 2013, from <http://www.drweil.com/drw/u/ART00519/An-Introduction-to-Breathing.html>