

# The Study of Eucalyptus Essential Oil Wave Inhalation on Brain Activities, Working Memory and Reaction Time

Sukhumaln Santaphongse<sup>1</sup>

Dr. Werner Kurotschka<sup>2</sup>

Dr. Ariya Sarikaphuti<sup>3</sup>

Assistant Professor Dr. Wichian Sittiprapaporn<sup>4</sup>

## Abstract

The purpose of this study was to investigate the effects of eucalyptus essential oil inhalation on the brainwaves changes, working memory performance and the speed of reaction times by testing on subjects' age group between 20 – 60 years old. Brainwaves changes were detected by BrainActor 2-channels EEG. Matching Parts and Figures Test was chosen for the working memory performance evaluation and SuperLab Pro was the program that determines the speed of reaction time. Results showed that when subjects were asked to complete Matching Parts and Figures Test before and after inhaled eucalyptus essential oil (20 ppm), performance of working memory was not significant difference, whereas speeds of reaction times were significantly increased. Brainwaves changes detected from BrainActor 2-channels EEG showed that during subjects inhaling eucalyptus essential oil (20 ppm), intensities of theta and alpha brainwave spectra were increased, but showed no significant change on theta, alpha and beta spectra after stop eucalyptus essential oil inhalation.

**Keywords:** Eucalyptus essential oil/Working memory/Reaction Time/Brainwaves

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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: [ks2\\_158@hotmail.com](mailto:ks2_158@hotmail.com)

2. Major Advisor, Department of Anti-Aging and Regenerative Science, School of Anti-Aging and Regenerative Medicine, Mae Fah Luang University email: [drkuro@aol.com](mailto:drkuro@aol.com)

3. 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](mailto:unique21th@hotmail.com)

4 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](mailto:drwichian.s@gmail.com)

## Introduction

Humans have been plagued by illness since the beginning of time. Physical disorders not only hamper a patient's work performance but can lead to disabilities or death, bringing grief and hardship to families. At a macro level, death means the loss of resources for a country that values its human capital for continued progress and development. The state spends a fortune on prevention, treatment and rehabilitation programs for patients who are sick or disabled, causing economic and social issues for families and the nation. Certain types of illnesses and disorders cause severe imbalances in the body's essential make-up, resulting in negative changes to neurotransmission, loss of concentration, slower reaction time, impaired memories and decreased thinking ability. These conditions affect the body's ability to perform routine activities efficiently.

Electroencephalography (EEG) is a method to measure the electrical activity of the brain that occurs during neurotransmission, when information is transmitted between the brain's neurons. This reflects brain performance in terms of reaction time and brain wave frequencies. These frequencies depend on various factors such as pathology of the brain, emotion and concentration at a time. Many researches have been conducted by stimulating the brain for medical benefit, such as musical sounds that helps autistic children to speak and scents to reduce clinical depression. The use of aromas in medicine to cure disorders is known as aromatherapy.

Aromatherapy has been known for about for 6,000 years, with historical records suggesting it was first used in ancient Egypt in rituals that pay homage to their gods. Aromatherapy was initially used for medically treating illnesses by Greek physician, Pedanius

Dioscorides. Essential oils have also been used in aromatherapy for beauty treatments, healing scalded wounds, sterilization and relieving inflammation. The oils have been used as mind-soothing agents that help to adjust balance in the body and they have been known to effectively enhance performance, boosting reaction time of a brain that has been initially slowed down by exhaustion. They also enhance the efficiency of short-term memory and long-term memory, as well as working memory.

Propose of this study is to initiated the use of plant scents that are grown in Thailand to enhance memory functions or reaction time while working, enabling improved performance among users who live hectic lives and who are prone to stress. This research benefits users in accordance with anti-aging and regenerative principles with the purpose of enhancing quality of life and health. Users can effectively perform their duties and make meaningful contributions with utmost efficiency.

### **Objectives of the Study**

1. To study the effects of Eucalyptus essential oil inhalation on Theta, Alpha and Beta brainwaves activities.
2. To study the effects of Eucalyptus essential oil inhalation on working memory.
3. To study the effects of Eucalyptus essential oil inhalation on reaction time.

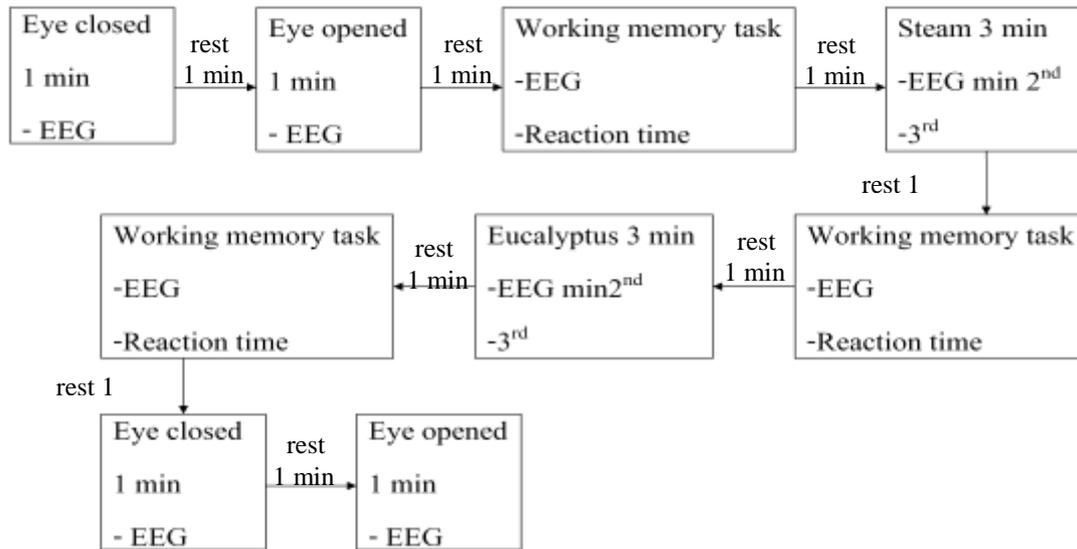
### **Methodology**

Subjects in this study include 7 male and female volunteers whose ages range between 20 – 60 years old . The subjects had no underlying diseases or disorders that may affect the research procedures . The subjects were acknowledge this fact and accepted to join the research . The equipments and tests used in this study were an odor familiarity test (Winai Sayorwan, 2011), BrainActor 2-channels EEG, Matching Parts and Figures test(Levy J. U. & Levy N., 1992), Oxygen Concentrator, a mask and 20 ppm. eucalyptus essential oil in sterile water.

The volunteers were asked to complete the odor familiarity test (Winai Sayorwan, 2554). The subjects who give highest or lowest scores in the evaluation were deselected from the next steps of the research. Electrode pads will be attached to volunteers' scalp at the F3 and F4 position in accordance with the International 10/20 system to evaluate brain wave activities. The research was proceeded in accordance with the experimental paradigm. Collected data was analyzed by calculating the quantity of each type of brain waves with the following formular

$$\frac{\text{The length of the longest spectrum in each brainwave type} \times 100}{\text{Total length of spectrum}}$$

The analysis of the subjects were conducted upon age, speed of reaction, scores from the working memory test , and quantity of each type of brain waves with the mean , percentage and standard deviation (SD). It will be analyzed and compared with the Student T Test or Paired T- Test. The confidence level was analyzed at  $p\text{value} \leq 0.05$ .



**Picture 1** Experimental Paradigm.

## Results

The average age of selected 20 subjects was 32.2 ( $\pm 9.77$ ) years old. Six subjects were male which was 30% from the whole subjects and 14 others were female which was 70% of the subjects.

The study on the effects of Eucalyptus essential oil inhalation on working memory, the result showed that the accuracy of the evaluation prior to inhalation of the vapor (50.58) and the post vapor inhalation (55.54) was not significantly difference ( $p = 0.243$ ). The accuracy of the test results prior to the vapor inhalation (50.58) and the post inhalation of the Eucalyptus essential oil (52.41) also showed no significantly difference ( $p = 0.69$ ). The accuracy of the test results conducted after the vapor inhalation (55.54) and after the inhalation of the Eucalyptus essential oil (52.41) also showed no significantly difference ( $p = 0.44$ ).

The study on the effects of Eucalyptus essential oil on the reaction time, the result showed that the reaction time prior to the vapor inhalation (53.95 seconds) and after the vapor inhalation (46.66 seconds) was not significant difference ( $p = 0.07$ ). Meanwhile, the reaction time after the inhalation of the Eucalyptus essential oil (41.80 seconds), Thus, the reaction time between before the vapor inhalation and after the inhalation of Eucalyptus essential oil appeared significantly different at .01 ( $p < .01$ ), and the reaction time after the vapor inhalation comparing to after the inhalation of the Eucalyptus essential oil also showed significantly different at .01 ( $p < .01$ ). The effects of the inhalation of Eucalyptus essential oil on brain waves, the result showed as follows:

**Theta Brainwave:** Changes that were found in the left hemisphere of the brain wave as follows:

1. While resting and eyes opened 1 minute prior to the experiment, the theta brainwave was at 8.61%, comparing to the during vapor inhalation that was at 11.42%, showed significantly different at .05 ( $p = .02$ ).
2. While resting and eye opened 1 minute prior to the experiment, the Theta brainwave was at 8.61%, comparing to the during inhalation of Eucalyptus essential oil that was at 10.38%, showed significantly different at .05 ( $p = 0.02$ ).
3. While inhaling the vapor, the theta brainwave was at 11.42%, comparing to when resting and eye opened 1 minute before ending the experiment that was at 8.55%, showed significantly different at .05 ( $p = 0.04$ ).

4. During performed the spatial test after the vapor inhalation, the Theta brainwave was at 12.70%, comparing to during the inhalation of the Eucalyptus essential oil that was at 10.38%, showed significantly different at .05 ( $p = 0.02$ ).
5. While inhaling the Eucalyptus essential oil, the Theta brainwave was at 10.38%, comparing to performing the spatial test after the inhalation of the Eucalyptus essential oil was at 12.63%, showed significantly different at .05 ( $p = 0.01$ ).
6. While inhaling the Eucalyptus essential oil, the Theta brainwave was at 10.38%, comparing to during resting and eye opened 1 minute prior to the termination of the experiment was at 8.66%, showed significantly different at .05 ( $p = 0.01$ ).

**Changes that were found in the right hemisphere of the brain wave as follows.**

1. While resting and eyes opened 1 minute prior to the experiment, the brain wave was at 9.37%, comparing to during the vapor inhalation was at 12.02%, showed significantly different at .05 ( $p = 0.05$ ).
2. During the vapor inhalation, the brain wave was at 12.02%, comparing to during resting and eyes opened prior to the termination of the experiment was at 9.19%, showed significantly different at .05 ( $p = 0.03$ ).
3. While inhalation of the Eucalyptus essential oil, the brain wave was at 10.81%, comparing to during resting and eyes opened 1 minute prior to the termination of the experiment was at 9.19%, showed significantly different at .05 ( $p = 0.02$ ).

The result showed no changes of Theta brainwave from both lobes of the brain in term of statistical different.

**Alpha Brainwave:**

Changes that were found in the left hemisphere of the brain wave as follows:

During the Eucalyptus essential oil inhalation, the Alpha brainwave was at 10.23%, comparing to during resting and eyes opened 1 minute prior to the termination of the experiment was at 8.13%, showed significantly different at 0.01 ( $p = 0.001$ ).

Changes that were found in the right hemisphere of the brain wave as follows:

1. While resting and eyes opened 1 minute prior to the experiment, the Alpha brainwave was at 11.82%, comparing to during inhaling the Eucalyptus essential oil that was at 14.14%, showed significantly different at .05 ( $p = 0.05$ ).

The result showed no changes of alpha brainwave from both lobes of the brain in term of statistical different

**Beta Brainwave**

When the experiments were conducted in different period of time and with both lobes, the result showed no changes of Beta brainwave in terms of statistical significance.

**Discussion**

There are not many reports on the Eucalyptus essential oil and changes of the brainwave; moreover, there have never been reports on studies on the Eucalyptus essential oil that 1,8-cineole is a major chemical constituent. According to a study on 1,8-cineole as a major substance, just like the Eucalyptus essential oil, only rosemary essential oil has 16%-55% 1,8-cineole (British Pharmacopeia Online 2012, 2011). From the previous studies, rosemary essential oil enhances memory and decrease reaction time (Moss *et al.*, 2003) which is different from the latter experiment that is conducted with the same scent and result shows reaction time improvement. Its enhancement depends on the concentration of 1,8-cineole substance in the increasing blood flow (Moss and Oliver, 2012), which may result from its ability to inhibit

Acetylcholinesterase enzyme and enable Acetylcholine to work more effectively. This study on the Eucalyptus essential oil by using Matching Parts and Figures Test (Levy J. U. & Levy N., 1992), which is a spatial test, examines working memory and reaction time. It is found that the inhalation of the Eucalyptus essential oil with 20 ppm concentration has no effects on working memory, but enhances the reaction time. This result is different from the research on rosemary essential oil. The both research on the rosemary essential oil and this study on eucalyptus essential oil give different results may due to the difference in the concentration of both oils, the concentration of 1,8-cineole that the subjects got in their blood circulation, period of inhalation time and experimental procedure. The study on changes of brainwave spectra, the increase of Theta, Alpha and Beta brainwaves have not yet been found while conducting the spatial test after the inhalation of the Eucalyptus essential oil. Although the Eucalyptus essential oil can help increase the Theta and Alpha brainwaves spectra while inhaling. Theta and Alpha brainwaves are essential for concentration and analytical thinking, and enhance working memory (Zaehle *et al.*, 2011). As the subjects get the low concentration of the Eucalyptus essential oil, the short inhalation time result in no effect on brainwaves during the working memory test. While Acetylcholinesterase inhibition ability remains unchanged and results in improve reaction time (Moss & Oliver, 2012) without changes of Alpha brainwave spectrum, which is consistent to this study.

This study employed different test, equipments and methodology that have been employed with the earlier research on rosemary essential oil. Both research remain unclear on indicating that rosemary oil has a n ability to enhance working memory. Likewise, this study on the Eucalyptus essential oil has not yet answered the question whether or not the oil enhances the efficiency of working memory. Recommendation for further study is that the concentration of the oil and period of the inhalation can be varied in order to support the hypothesis that the Eucalyptus essential oil with 1,8-cineole as a major substance affects the efficiency of working memory.

## Conclusion

The study on the effects of Eucalyptus essential oil inhalation on working memory, the accuracy of the evaluation prior to inhalation of the vapor, the post vapor inhalation and after the Eucalyptus essential oil inhalation showed no significantly difference. The study of the effects of Eucalyptus essential oil inhalation on the reaction time, the reaction time prior to the vapor inhalation and after the vapor inhalation showed no significantly difference. Meanwhile, the reaction time after the Eucalyptus essential oil inhalation, the reaction time was lesser than prior to the vapor inhalation and after the vapor inhalation with statistical significance at .01.

## 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.

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