THE EXPLORE OF AROMATHERAPY USING EEG SIGNAL ON THE EMOTIONAL ANALYSIS

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Abstract: The EEG signal was acquired using wireless one-electrode technology by the ThinkGear chip. The signal was filtered and amplified through Bluetooth interface, and then displayed on human-computer interface. We determine two parameters attention and meditation with eSense algorithms on α, β, θ, δ waves. The study survey the variation between attention and meditation after aromatherapy treatment. Simultaneously, use a sphygmomanometer to display the parameters of systolic pressure, diastolic pressure and pulse for verifying the effect. After of four kinds of aromatherapy, we search out the attention parameter had enhanced significantly using bergamot and peppermint oil, and the effect of peppermint oil is more obvious than bergamot oil. On the other hand, the meditation experiment using lavender and ylang-ylang oil also has the relax effect.

Key Words: Brainwave, Aromatherapy, Brain-computer interface

1. INTRODUCTION

The human causes many kinds of diseases of civilization due to busy in a fast-paced life. For instance, the pressure resulted in the brain memory loss, attention distracted, and resulted in melancholy, fidgety, sleep-disorder and another emotional situation. Medicine also confirmed that pressure maybe disturb and destroy the body’s hormone secretion, brain neurotransmitters, immune function and metabolism etc (Hsu, 2009). The body resistance disappeared gradually when bodily function weakened slowly, and drug abuse resulted in side effects increased. Therefore, the biomedical industry research and development constantly with aromatherapy which become one new trend improve bodily function.

Aromatherapy is a form of alternative medicine that uses essential oil extracted from aromatic plant, and via respiratory tract or skin absorption into body using massage, bubble bath, perfume to reach relieve mental stress and improve health. Fragrant volatile oil through the incense to the lung or the brain limbic system and hypothalamus, and Olfactory and brain via brain system convey the message to stimulate various places to reach mental, psychological, physiological and behavioral effect. Therefore, aromatherapy is not only cosmetic or luxury consumption, but also civilians, healthy commodity.

Electroencephalography (EEG) discovered the origin of 1875, England professor of physiology Richard. Canton recorded one electric wave from the rabbit’s brain surface of the cerebral cortex. The wave which was a type of brain physiological effect had nothing to do with breathing or heart. Later, he found that stimulate the animal’s body to make brainwave alteration. He used this alteration to research the relationship
between body and brain surface of the cerebral cortex, and explore the function of brain cortex. The research became the foundation of development for evoked potential of neural diagnostics. The Germany psychiatric Hans Berger recorded the same electrical activity in human skull until 1929, and named electroencephalogram (EEG). (Lin, 2005)

![Figure 1 the relationship between olfactory system and brain](image)

According to the international EEG Association, there are four kinds electroencephalogram in accordance with the different frequency that divided into alpha, beta, theta and delta waves in potential response of the cerebral cortex. And it also found Gamma high frequency wave in recent years. Besides, there are different meaning and characteristics in each different frequency of brain waves. (Table 1)

The object of research explores brainwave signal to analyze the difference between attention and meditation through different kinds of aromatic oils.

<table>
<thead>
<tr>
<th>Brainwave type</th>
<th>Frequency range</th>
<th>Common Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha</td>
<td>8Hz—12Hz</td>
<td>Relaxed, but not drowsy, tranquil, conscious</td>
</tr>
<tr>
<td>Low Beta</td>
<td>12Hz—15Hz</td>
<td>Formerly SMR, relaxed yet focused, integrated</td>
</tr>
<tr>
<td>Midrange Beta</td>
<td>16Hz—20Hz</td>
<td>Thinking, aware of self &amp; surrounding</td>
</tr>
<tr>
<td>High Beta</td>
<td>21Hz—30Hz</td>
<td>Alertness, agitation</td>
</tr>
<tr>
<td>Theta</td>
<td>4Hz—7Hz</td>
<td>Intuitive, creative, recall, fantasy, imaginary, dream</td>
</tr>
<tr>
<td>Delta</td>
<td>0.1Hz—3Hz</td>
<td>Deep, dreamless sleep, non-REM sleep, unconscious</td>
</tr>
</tbody>
</table>

### 2. MATERIALS AND METHODS

#### 2.1 Methods

The research that original EEG signal processed to filter and amplifier, such as interfere with muscle tissue movement (eyeblink signal) using thinkGear™ eSense algorithm technology that Neurosky Company developed. The signal compiled two parameters, included attention and meditation. Attention which indicates the intensity of a user's level of mental "focus" or "attention", and meditation which indicates the level of a user's mental "calmness" or "relaxation".

The EEG device measured raw brainwave and then through the scaling of emotion
equation to get the parameter of attention and meditation after sampling the frequency of $\alpha \cdot \beta \cdot \theta$ and $\delta$ wave crossing power spectrum.

The parameter of meditation meter which indicates the level of a user's mental "calmness" or "relaxation". Its value ranges from 0 to 100. Note that Meditation is a measure of a person's mental levels, not physical levels, so simply relaxing all the muscles of the body may not immediately result in a heightened Meditation level. However, for most people in most normal circumstances, relaxing the body often helps the mind to relax as well. Meditation is related to reduce activity by the active mental processes in the brain, and it has long been an observed effect that closing one's eyes turns off the mental activities which process images from the eyes, so closing the eyes is often an effective method for increasing the Meditation meter level. Distractions, wandering thoughts, anxiety, agitation, and sensory stimuli may lower the Meditation meter levels (Neurosky, 2009).

### 2.2 System Architecture

We use EEG MindBand headset device that Neurosky Company developed captured EEG signal using simple wireless one-electrode technology from system architecture diagram, became attention and meditation after collection with beta, alpha, theta, delta wave through Bluetooth interface deliver signal to PC. The software Neuro View recorded the parameter of attention and mediation each second and transform value to excel file and then data analysis.

<table>
<thead>
<tr>
<th>eSense value</th>
<th>Status Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-20</td>
<td>States of distraction, agitation, or abnormality</td>
</tr>
<tr>
<td>20-40</td>
<td>“Neutral” and is similar in notion to “baseline” that are established in conventional brainwave measurement techniques</td>
</tr>
<tr>
<td>40-60</td>
<td>“Slight elevated” may be interpreted as levels tending to be higher than normal (levels of attention or meditation that may be higher than normal for a given person)</td>
</tr>
<tr>
<td>60-80</td>
<td>“Elevated”, meaning they are strongly indicative of heightened levels of that eSense</td>
</tr>
<tr>
<td>80-100</td>
<td></td>
</tr>
</tbody>
</table>

### 2.3 Essential oils and Devices

Essential oils are the experimental materials that choose Bergamot, Lavender, Peppermint, Ylang Ylang and Eucalyptus. The following is the characteristics of essential oils.

### 2.4 Experiment Device

Design a homemade closed box to incense essential oils, the concentration of diluted is that used a dropper inject 4.5ml of water and 0.5ml of essential oils. So the concentration of essential oils is 10%. The closed box was shown in figure 2. On the other hand, equation (1) and (2) referred as the concentration of essential oils and spatial density.
\[
C(EO) = \frac{EO}{EO + W}
\]

\[
SD = \frac{C(EO)}{L \times W \times H}
\]

where: 
\(C(EO)\) = The concentration of essential oils (%) 
\(EO\) = essential oil (ml) 
\(W\) = water (ml) 
\(SD\) = Spatial density 
\(L\) = Length (cm) 
\(W\) = Wide (cm) 
\(H\) = High (cm)

Table 3 The efficacy of essential oils

<table>
<thead>
<tr>
<th>Essential oils</th>
<th>Efficacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bergamot</td>
<td>Citrus, a little spicy, appease and inspires the mood through the sympathetic nervous system; Appropriate for depression and emotion ups and downs</td>
</tr>
<tr>
<td>Lavender</td>
<td>Most used widely in aromatherapy, The most common usage is that improve insomnia and headaches, ease the mood, stability of neural, also well-known repellents that purify the air.</td>
</tr>
<tr>
<td>Peppermint</td>
<td>Taste strongly, be refreshing, calm and analgesia; Useful for inability to concentrate and the fatigue of physical and mental.</td>
</tr>
<tr>
<td>Ylang Ylang</td>
<td>The fragrance makes people feel warm and happy, and calm effect reduce high blood pressure. In addition, it can balance with skin oils.</td>
</tr>
</tbody>
</table>

2.5 Neurosky MindBand

The research we use EEG MindBand device which use non-invasive Bluetooth technology Neurosky Company developed detected neural electrical triggering activities.

We divided into two parts, one is that recorded the parameter of attention and meditation without aromatherapy situation. Another is that recorded parameter in aromatherapy situation. Compare whether the essential oil achieves the aromatherapy effect after data analysis. As shown in figure 3.

![Figure 2 Experiment Device](image1.png)

![Figure 3 The experimental flowchart](image2.png)
3. RESULTS & DISCUSSION

The experiment that used NeuroView academic software Neurosky Company provided measured the parameter of attention and meditation and recorded each second to excel file and then data analysis. The data rendered as (3) and (4).

\[ A = \frac{S}{t} \]  \hspace{1cm} (3)

\[ P = \frac{AS - NS}{NS} \]  \hspace{1cm} (4)

where:

- \( A \) = The average of data (1/s)
- \( S \) = The sum of the data parameter per second
- \( t \) = Total second(s)
- \( P \) = The percentage of variation (%)
- \( AS \) = Data in aromatherapy situation
- \( NS \) = Data in normal situation

The bergamot has a good effect for improving attention. It strengthened the nervous fatigue in the nervous system according to aromatherapy textbook. (Essential oils book, 2002). So we found out bergamot has nice effect for attention from ten experimenter EEG analysis.

The lavender is one of widespread essential oils. The efficacy is that appease hysteria, improve insomnia or nervous and so on (Essential oils book, 2002). Therefore, the experiment was focused on meditation value. The data showed that the most experiment has to enhance the meditation value after aromatherapy with lavender. Only few experimenters reduced, the reason may be caused by measurement under normal situation, the experimenter in relaxed level has been slightly high, and the aromatherapy situation does not significant enhancement.

The efficacy of mint oils is cool, labor pain effect, also powerful for refreshing. So mint oils have ability to strengthen the attention from ten experimenters EEG analysis. But few experimenters have the opposite effect because of the experimenter thought mint oils helped them fall asleep well.
Ylang Ylang has relaxing effect on the nervous system from essential oils textbook (Essential oils book, 2002). However, it will lead to opposite effect happens if the use of time was too long. The experiment showed that the lavender was much better than Ylang Ylang in meditation level. It caused that the meditation level had no significant effect because of Ylang Ylang incensed too long.

![Graph 6](image6.png)  
**Figure 6** the parameter of attention (Normal and mint)  

![Graph 7](image7.png)  
**Figure 7** the parameter of meditation (Normal and Ylang Ylang)

4. CONCLUSIONS
We found that attention which focus on the experiment with bergamot and mint oil enhanced obviously, and the effective of mint oil was better than bergamot oil. On the other hand, the meditation experiment with lavender and ylang also fit with relaxation. It could not achieve perfect result because of several factors. The reason is our improvement distance in the future. We will increase the number of sample measured and variety of essential oils to confirm the practicality of aromatherapy on brainwave. Finally, we use data analysis to integrate that the proportion of beta, alpha, theta and delta identifying different kind emotion state.

5. REFERENCES
Wei-Chi Lin, 2005, Analysis of the EEG Signals in Response to Musical Signal Stimuli, Taipei: Graduate institute of Biomedical informatics Taipei Medical University, pp 4.