

# Brain exercise in elderly: NeuroSky smarter Kit investigation



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## ABSTRACT

**Background:** The measurement analysis of the brainwaves can show whether or not human's mental or cognitive status is in a sober state. The speed of the computer signal processing technology increased until it could sufficiently process the complex brainwave signals measured in real-time. Therefore, the information about the mental status thus gradually revealed a research in information science called affective computing. **Aims and Objective:** The purpose of this study was to study the use of NeuroSky Smarter Kit in brain exercise training program by Brainwave Cloud Classroom (BCC) system, on both attention and meditation levels' changes in elderly. **Materials and Methods:** The sample of this study were fifteen participants, which were four men and ten women, aged 61-84 years old. All participants were measured their attention and meditation levels by NeuroSky Smarter Kit prior to the brain training program. During the brain exercise training program by Brainwave Cloud Classroom (BCC) system, should any participant could not proceed to the next session, he/she was measured their attention and meditation levels again. They were allowed to break for fifteen to thirty minutes or as much as they needed. Then, the second brain training was done and that participants were measured their attention and meditation levels again. **Results:** The result showed that attention and meditation levels were gradually increased with no statistically significant. Both theta and alpha brainwaves were increased statistically significant. **Conclusion:** The attention level increased while the meditation level was sustained similar to before brain exercise training. Some electroencephalographic activities including theta and alpha brainwaves were gradually increased with statistically significant while gamma brainwave did not change.

**Key words:** Brain Exercise; Brainwave Training; Brainwaves; Elderly People; Neurosky Smarter Kit

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## INTRODUCTION

Lives have prolonged and averaged age of population keeps getting higher. The elderly ratio in Thailand has tendency to continuously rising. With our knowledge, technological advancements in medical field, the widespread of public health care, faster rescue team's transportation, and the swiftness in medical diagnostic and treatment, elder people have all the chances they never have been granted before.<sup>1</sup>

Parts of the brain that control the activities have been defined by experts in the field of science of the nervous system.<sup>2</sup> The top of the brain controls the limbs while the rear of the brain is responsible for the control of force, human emotions, mental state, and state of concentration, respectively.<sup>3</sup>

Human physiological signals and cognitive analysis research were discovered in the 1920s by German

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neurologist, named Berger, starting research on human brainwaves.<sup>4</sup> After decades of research, the results showed that measurement analysis of the brainwaves can show whether or not human's mental/cognitive status is in a sober state.<sup>4</sup> In the recent year, the speed of the computer signal processing technology increased until it could sufficiently process the complex brainwave signals measured in real-time. Information about the mental status thus gradually revealed a research in information science called affective computing.<sup>3-4</sup>

The way we focus on specific task can cause a measurable shock to brainwaves which is recorded by electroencephalogram (EEG).<sup>5</sup> Previous studies reported that different forms of focus could form different brainwave frequencies which are usually recorded in the range of 1 to 50 Hz. The integration of these neurophysiological parameters may contribute to the understanding of electroencephalographic correlates of brain training conditions. The aim of this study thus was to explore the modifications of electroencephalographic activities and Brainwave Cloud Classroom (BCC) training program in elderly. In order to detect modifications of electroencephalographic frequencies, we used the light weight electroencephalographic device, MindWave Mobile, NeuroSky, Inc. for electroencephalographic activity recordings.

## MATERIALS AND METHODS

### Participants

This study was done with fifteen participants, aged between 61-84 years old (mean age:  $68.21 \pm 4.73$ ), who were in good health, no congenital illness, no record of brain surgery, not taking medicines or drugs that affect to nervous system. Participants who had the following criteria were excluded from the study including left handedness; history of medical and neurologic diseases; binge eating disorders and other psychiatric disorders; head trauma; assumption of Central Nervous System active drugs in the two weeks prior to study entry; and presence of electroencephalographic abnormalities at the baseline recording. After receiving information about the aims of the study, all participants provided written consent to participate in the study.

### Tools and equipment

Personal information of all participants including age, gender, nationality, and history of illness were recorded before starting the study. In this study, the electroencephalography (EEG) was applied in order to record the brainwaves of all participants. The effectiveness of commercially available lightweight EEG devices, NeuroSky's Mindwave Mobile, was used in this study. The neuroheadset,

NeuroSky's Mindwave Mobile, was used to display the output, analyze and record electroencephalographic activities. The principles of analytical check were based on the 10-20 system or International 10-20 system by displaying the electroencephalographic output. Mindwave Mobile provided two 100-state outputs operating at 1 Hz via the application of a single electrode and signal-processing unit in a headband arrangement. The principle advantage of the Mindwave Mobile was its unobtrusive nature, which minimizes the aforementioned difficulties in conducting accurate user studies. However, the Mindwave Mobile provided a much coarser picture of brain activity than multi-electrode electroencephalogram (EEG) or other technologies (Figure 1).

According to the lightweight electroencephalographic device, NeuroSky's Mindwave Mobile, the electroencephalogram (EEG) frequency analysis was performed by means of a Fast Fourier Transform (FFT) algorithm, with a 2-second interval on the electroencephalogram (EEG) signal. The following frequency bands were considered: delta (0.1-3.0 Hz); theta (4.0-7.0 Hz); alpha (8.0-13.0 Hz); beta (14.0 – 30.0 Hz); and gamma (31.0 – 60.0 Hz). In 2009, NeuroSky released the first Brain-Computer Interfaces (BCI) control. Neurosky MindSet is different from the past BCI devices. It is a single electroencephalogram (EEG) channel comparing with the traditional multi-channels electroencephalogram (EEG) technology and makes wearing easier and more comfortable with no need of people to help you wear it. The NeuroSky product uses its patented ThinkGear chip that can filter out the noise from the EEG to get eSense.<sup>6</sup>

### Brain exercise training

In brain exercise training, the Brainwave Cloud Classroom (BCC) system developed by Alchemy Technology Company, Taiwan, was used in the study. The brainwave attention lesson was divided into four different core parts. Every part had a plurality of small chapters as follows:

Part I: Meditation Practice: This part aimed to teach the brain the relaxation method by making it recognized and



**Figure 1:** Mindwave mobile electroencephalography device (NeuroSky Inc.)

remembered the state of relaxation through exercises and meditation.

**Part II: Left and Right Brain Harmony:** This section aimed to obtain the best results of brain development in a relaxed state by harmonizing both sides of the brain through different left and right brain exercise.

**Part III: Listening, Speaking and Writing Exercises:** This section aimed to train participants' listening, speaking and writing skills, so that participants could maximize while doing these things in a relaxed state. This was an important skill enhancement exercise.

**Part IV: Thinking Exercise:** This section aimed to train participants to be able to seriously ponder problems, and at the same time meaningfully and effectively solve them while being in a comfortable, open, and relaxed state (Figure 2).

Finally, a single-channel electroencephalogram (EEG) was designed to collect brain activity data from the participants' brain. Simplicity and efficiency were the main reasons for designing a single-channel electroencephalographic monitoring system.

### Statistical analysis

The qualitative data was summarized in term of frequency and percentage whereas the quantitative data was summarized in term of average and standard deviation. Each type of electroencephalographic activities was compared by using inferential statistic, *t*-test. Every test was set to the statistic significant at  $p < 0.05$ .

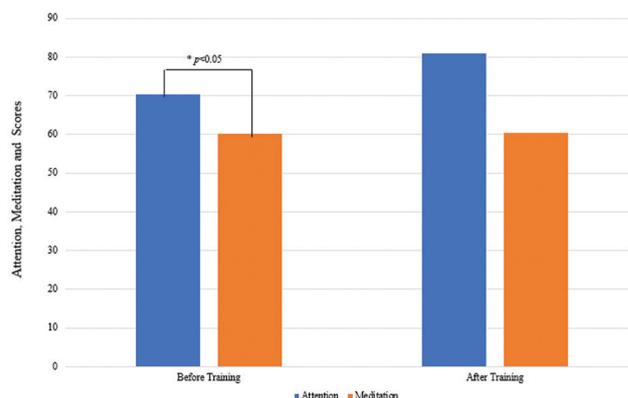
## RESULTS

In this study, the attention and mediation levels were measured both before and after brain exercise training by Brainwave Cloud Classroom (BCC) system. The attention level changed in a statistically significant at 0.05 level ( $p$ -value = 0.04). The average before brain exercise training was 70.34 ( $\pm 2.57$ ) score and the average after brain exercise training was 80.87 ( $\pm 1.51$ ) score. For meditation level, there was no change in a statistically significant at 0.05 level ( $p$ -value = 0.68). The average before brain exercise training was 60.20 ( $\pm 3.13$ ) score and the average after brain exercise training was 60.47 ( $\pm 3.72$ ) score (Figure 3).

Based on Table 1 and Figure 4, it was found that theta and alpha brainwaves gradually increased with statistically significant at 0.05 level while delta and beta brainwaves did not change. On the other hand, gamma brainwave was found to be sustained while performing the brain exercise training program.



**Figure 2:** Brainwave Cloud Classroom (BCC) system with four major core parts



**Figure 3:** Attention and mediation levels were measured both before and after brain exercise training by Brainwave Cloud Classroom (BCC) system in elderly people

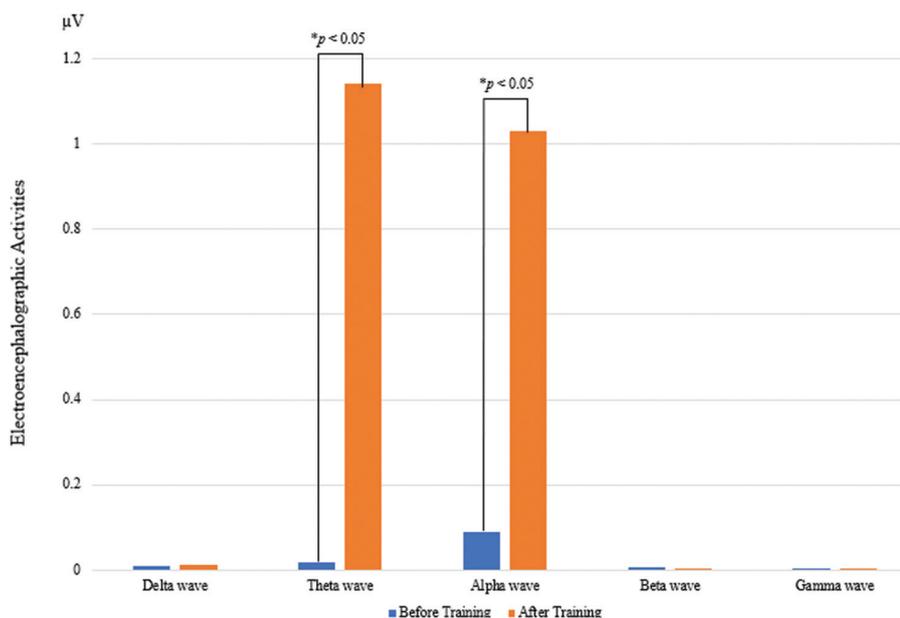
Delta brainwave was gradually increased with no statistically significant while having the brain exercise training program compared to baseline (before training:  $0.011 \pm 0.26 \mu V$ ; after training:  $0.013 \pm 0.02 \mu V$ ;  $t(14) = 0.18$ ;  $p = 0.41$ ). Similar to delta brainwave, theta brainwave was gradually increased with statistically significant at 0.05 level while having the brain exercise training program compared to baseline (before training:  $0.017 \pm 0.24 \mu V$ ; after training:  $1.14 \pm 0.71 \mu V$ ;  $t(14) = 1.23$ ;  $p = 0.04$ ). Moreover, it was found that alpha brainwave was gradually increased with statistically significant at 0.05 level while having the brain exercise training program compared to baseline (before training:  $0.09 \pm 0.31 \mu V$ ; after training:  $1.03 \pm 0.03 \mu V$ ;  $t(14) = 0.97$ ;  $p = 0.5$ ).

On the contrary, it was found that beta brainwave was gradually decreased with no statistically significant while having the brain exercise training program compared to baseline (before training:  $0.008 \pm 0.006 \mu V$ ; after training:  $0.003 \pm 0.010 \mu V$ ;  $t(14) = 1.16$ ;  $p = 0.37$ ) while gamma brainwave was not changed while having the brain exercise training program compared to baseline (before training:  $0.001 \pm 0.026 \mu V$ ; after training:  $0.001 \pm 0.032 \mu V$ ;  $t(14) = 1.12$ ;  $p = 0.29$ ).

**Table 1: Comparison of brain waves between before and after brain exercise training by Brainwave Cloud Classroom (BCC) system in elderly people**

| Electroencephalographic activities | Before training | After training | Paired-test | p-value |
|------------------------------------|-----------------|----------------|-------------|---------|
|                                    | Mean (±SD)      | Mean (±SD)     |             |         |
| Delta brainwave                    | 0.011 (±0.26)   | 0.013 (±0.02)  | 0.18        | 0.41    |
| Theta brainwave                    | 0.017 (±0.24)   | 1.14 (±0.71)   | 1.23        | 0.04*   |
| Alpha brainwave                    | 0.09 (±0.31)    | 1.03 (±0.03)   | 0.97        | 0.05*   |
| Beta brainwave                     | 0.008 (±0.06)   | 0.003 (±0.010) | 0.16        | 0.37    |
| Gamma brainwave                    | 0.001 (±0.026)  | 0.001 (±0.032) | 1.12        | 0.29    |

\*p < 0.05



**Figure 4:** Comparison of brainwaves between before and after brain exercise training by Brainwave Cloud Classroom (BCC) system in elderly people

## DISCUSSION

In the present study, the attention and mediation levels were measured both before and after brain exercise training by Brainwave Cloud Classroom (BCC) system in elderly people. The findings showed that the attention level changed in a statistically significant while the meditation level was not changed. A previous study reported that the brain training program has been shown to be efficient in many different areas including mathematics and engineering education.<sup>7</sup> Moreover, brain and spatial ability trainings were shown to impact capacities in scientific learning.<sup>8</sup> A well-known of mathematics and spatial abilities training was based on the Vanderberg and Kuse<sup>7</sup> who developed the Mental Rotation test. After that Hoyek et al.<sup>9</sup> used a computerized version of this Mental Rotation test to train students' spatial abilities.

As electroencephalography (EEG) is traditionally used to measure the brainwaves, each type of brainwave is associated with one's state of consciousness and different mood state.<sup>10-13</sup> Different neural activities will produce different brainwave

patterns, thus demonstrating a different brain state. Different brainwave patterns make brainwaves of different amplitude and frequency. Beta brainwaves, which are brainwaves between 12 to 30 Hz, mean the brain is in a focused state. Alpha brainwaves, which are brainwaves between 8 to 12 Hz, mean the brain is in a calm, relaxed state. From all types of brainwave, beta brainwave is seen in normal activities as well as stressful conditions or difficulties in mental concentration. On the other hand, alpha brainwaves is seen in wakefulness, relaxed, effortless and alertness condition. Therefore, persons with high alpha brainwaves and low in beta brainwaves could indicate status of relaxation, arousal, less stress and better concentration.<sup>14-18</sup> Several investigators proposed that theta (4-7Hz) brainwave activity correlated positively with the level of meditation experience.<sup>19</sup> Some previous studies found that theta and low alpha brainwaves both increased significantly as subjects were more concentrated in the meditation task.<sup>20-21</sup> As alpha (8-13Hz) brainwave activity was known to be associated with relaxation and a lack of active cognitive processes, initial stages of meditation research focused primarily on alpha brainwave.<sup>20-21</sup>

The finding in the present study also revealed that theta and alpha brainwaves were gradually increased while performing the brain exercise training program of by Brainwave Cloud Classroom (BCC) system. The results of the present study were consistent with previous studies showing that the sensorimotor rhythm related to attention.<sup>18,22</sup> In addition, the increase of both theta and alpha brainwaves in the present study was consistent with previous studies mentioning the increase of theta and alpha powers indicated in the frontal areas.<sup>23-24</sup> In addition, previous studies had shown that both theta and alpha oscillations were known to play an important role in different memory processes and in emotion regulation.<sup>24-25</sup> However, other studies have indicated that theta and alpha brainwaves responded specifically to visual emotional stimulation and to negative emotions, respectively.<sup>26</sup>

## CONCLUSION

This study aimed to study the attention and meditation levels as well as electroencephalographic activities changes during the brain exercise training program of by Brainwave Cloud Classroom (BCC) system in elderly. While performing the brain exercise training program by Brainwave Cloud Classroom (BCC) system, the attention and meditation as well as electroencephalographic activities were recorded by using the lightweight electroencephalographic device, Mindwave Mobile, NeuroSky, Inc. The attention level increased while the meditation level was sustained similar to before brain exercise training by Brainwave Cloud Classroom (BCC) system. Some electroencephalographic activities including theta and alpha brainwaves were gradually increased with statistically significant while gamma brainwave did not change.

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**Authors Contribution:**

**TC-** Concept and design of the study, statistically analyzed and interpreted; **PS-** Concept and design of the study, statistically analyzed and interpreted, manuscript preparation, critical revision of the manuscript.

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