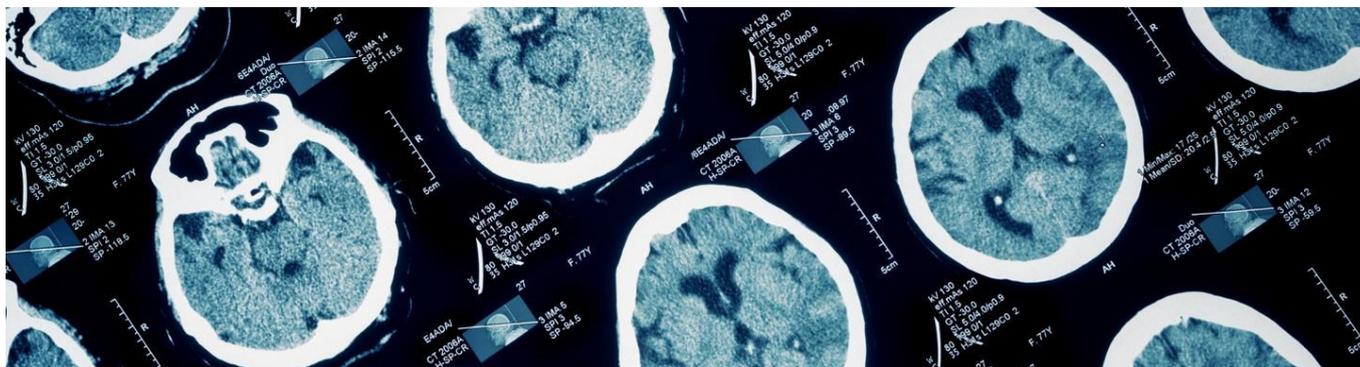


# Sensory-Motor-Integration training in students with attention deficit Hyperactivity Disorder : Positive effects of Neurofeedback on Brain Network Activities



## Original Research Article

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## ABSTRACT

**Purpose:** Function of NeuroFeedBack to minor sign of ADHD. 1980 In cooperation of physical therapists, we started Sensory Integration Therapy in Taiwan on Saturday afternoon for 2 hours; for 1 years without remarkable improvements. As organizer, I decided we have to do intensive courses. We asked mothers of ADHD students let them daily participate 40-minute intensive exercises in the morning. All mothers attended to prevent dangers between the students.

Within 2 weeks, the teachers and parents all reported to us that the ADHD students had become quiet, fully concentrates, and quickly finished homework. These changes indicated brain re-well organized. Notably, all severe symptoms of ADHD had improved in 2 weeks except minor ones and feelings of heat floating in prefrontal area. We have used this exercise for 35 years, with excellent results.

**Methods:** From 2017/03/01 to 2018/02/28, Everspring have 65grade students with ADHD near the end of Sensory-Motor-Integration-Training (male 47-72%), female (18-28%), age ranged from 7.3 to 12.5years. Everspring wanted to know how are diffuse other brain waves conditions, seeking causes of the minor sign origins. We asked parents’ permissions and used EEG fine machine checking all of their brain waves. In normal and health state showing Standard Scores in range (0~±2), all abnormal need special consideration of doing Neurofeedback.

**Results:** ADHD 51 students through Sensory-Motor-Integration-Training and participate Neurofeedback all showed networks z Scours (±2~±3) or worst, and also having frustrations.

**Conclusion** Neurofeedback were near 100% improved to normal range (0~±2).ADHD minor symptoms all improved on neurofeedback return normal z Scours (±2~±0). This is a great success in minor symptoms of ADHD from Nneuro-rehabilitation and Neurofeedback from Neuropsychology.

**Keyword:** ADHD, Brain Waves Networks, Neuro-therapy, LD, NeuroFeedBack, SMI-Tx Training.

## I. INTRODUCTION

For accurate diagnosis of attention deficit/hyperactivity disorder (ADHD) children must exhibit six or more symptoms of inattention and hyperactivity, impulsivity and/or ADHD with six or more symptoms of distraction within the last 6 months. Most children with ADHD exhibit a combination of multiple symptoms that may be occur individually in normal developing children of the same age. Children with ADHD often experience problems with temperament, motor skills, study skills, and social skills, both at home and in the classrooms [1][2][3]. Although the etiology of ADHD is unclear, studies have shown that genetic, physiological, or biochemical disorders, brain damage during pregnancy, and environmental factors (smoking or drinking) can all play a role. In one study regarding the clinical and functional outcome of childhood ADHD, the education level of adults who had been diagnosed with ADHD as children was significantly lower; occupational, economic, and social outcomes were also poor. [4]

As stated by Ayers [5][6], vestibular balance organs help animals to resist the force of gravity and have evolution of lower animals to higher animals. To occupy the prone position is to re-experience the process of speciation and individual oogenesis. Survival activities such as searching for food and avoiding prey are understood to be very focused behaviors, and have been important to animal survival for thousands of years. Assuming the prone position may also allow individuals to re-experience the sensation of being a human infant 6–12 months old. At this age, the prone position is a common body posture, and some research has indicated that time spent in this position is associated with the development of nerve pathways in the prefrontal and somatic areas. Sensory-Motor-Integration Training, abbreviated as SMI-Tx, uses the prone posture and requires the participant to work against gravity. At the Everspring center, we have found that after intensive SMI-Tx treatment, students with ADHD reported mild heating and floating sensations in their foreheads, followed by a lack of impulsive behavior, increased concentration, more stable mood, and progress in homework. When exercising in the prone extension position on the scooter board, the muscles and bones move vigorously, generating a large number of kinesthetic and vestibular impulses.[5] These are quickly transmitted to the entire body, as well as the whole brain and the prefrontal area of the cerebral cortex. The increased brain activity, as well as the kinesthetic and vestibular sensations, may increase behavioral control of thoughts and activities executed by the frontal and prefrontal lobes, which are implicated in impulsive behavior. This could improve mental focus and physical dexterity, and thus schoolwork and interpersonal relationships.

## II. OBSERVATIONS

Electroencephalography (EEG) was developed in 1929 by the German psychiatric scientist Dr. Freda, who found that the human brain has a "current ripple". Brain waves reflect the electrical pulse caused by the release of current from nerve cells in the brain, and can have different frequencies that reflect different behaviors or phenomenon. For example, excessive discharges may reflect epilepsy. Brain waves can be modulated by factors in the external environment such as light and sound stimulation.

Brain waves are divided into five bands:

$\delta$  (Delta Wave 0.5–4 Hz) slow, high amplitude brain waves, deep sleep, no dreams, good sleep quality;

$\theta$  (Theta Wave 4–8Hz), main subconscious state, slow wave that reflects the second phase of sleep, is related to hypnosis and meditation;

$\alpha$  (Alpha Wave 8–12Hz), dominant wave, reflects a conscious and relaxed state, present during learning and calculation, associated with decreases in anxiety;

$\beta$  (Beta Wave 12–35Hz), Fast, low amplitude waves, reflect an awake state, present during thinking, anxiety, calculation, high attentional state;

$\gamma$  (Gamma Wave 40 Hz and above), fast eye movement (REM), high frequency factor, people in this state will be full of energy and remain highly alert and thinking.

Brain waves have historically been used to diagnose epilepsy (e.g., Grand mal seizure, Focal seizure, Petit mal seizure), intracranial blood clots and/or diffuse edema, and to determine the size and position of tumors. They are also used to perform tomography scans for neurosurgery treatment and for continuous tracking of brain state.

Over the past 30–40 years, many European and American psychologists have devoted themselves to the study of brain waves. Above-or below-average distributions of brain waves can indicate abnormal brain function. Specifically, abnormal brain waves may indicate impaired thinking, learning, expression, emotion, or judgment. The US Food and Drug Administration (US FDA) certified normative database for brainwave data was collected from 727 healthy individuals ranging in age from 2 months to 82 years old. All participants had no history of neurological disease or behavioral disorders, and most of the school-age participants completed extensive neuropsychological tests. The criteria for screening brainwave norms have included demographics, neuropsychological tests, Gaussian distribution tests, and cross-validation tests in several peer-reviewed publications. [8]

Brain wave abnormalities alone cannot be used as a basis for diagnosis or treatment. Clinicians must refer to case history along with observations from neurologists and psychiatrists. With an objective diagnosis, it is possible to develop tailor-made cranial neurofeedback [9] training session that are 1 hour in length, and are completed 10 times per treatment course. If the course does not provide the desired effect, it can be supplemented with one or more additional neurofeedback trainings sessions and brainwave reports.

Neuroplasticity[10] was first characterized more than 40 years ago, and since then, many European and American psychologists have been focused on ways to use neuroplasticity to enhance brain function. The standard z-Score of an individual can be compared with that of individuals who are the same age, and then compared with neurofeedback. Participants are able to receive the feedback, generally through a visual display, and are encouraged to modulate their brainwaves to match an idea network. Neurofeedback is thought to have potential in improving dysmotility, impulsivity, uses brain full-scale Scores (z-Scores), abnormal brain waves (such as a depression network), and brainwave training to correct the size of other brain networks.

Figure 1

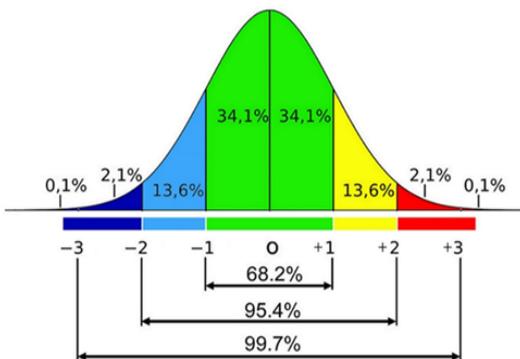


Three chief prone extension exercises. The mild heat and floating sensation in the forehead (when it work, the impulses, shaking restless disappeared, and more focusing.)

[Figure 1]

Figure 2

qEEG shows in standard (Z) Scores



Z Scores of (0 ± 2) indicate normal brainwave data. Z Scores of (± 2 to ± 3 and ± 4, ± 5, ± 6, ± 7 or higher) are considered to be abnormal. The deep blue color indicates a very weak signal (-2--3 & smaller negative numbers), and deep red indicates that the signals are not differentiated (-2--3 & positive bigger numbers). Neurofeedback (NFB) can be used for brain waves self-correction.

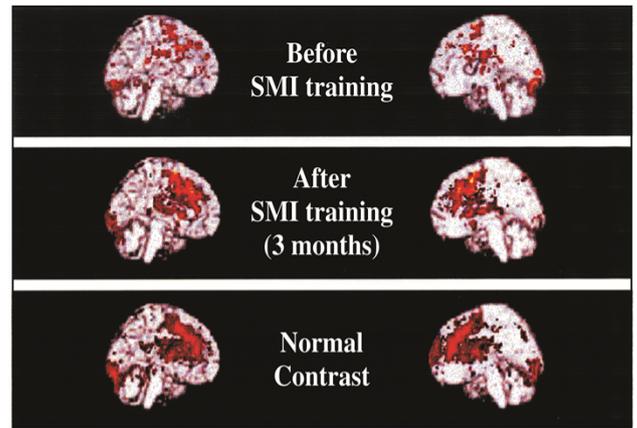
[Figure 2]

(Explanation of special terms:T1 and T2 etc:T1 just indicate first records for later comparisons, what to see brain waves visually, what are your impressions? T2,T3,T4 etc. for comparison with T1 pictures, get smaller or disappear of deep red or deep blue,( if yes, it is normal and good thing. If networks can reach smaller, things are getting better; if networks circles or radar get bigger, conditions get worse or catch cold.)

**Case No 33:** This case was a 12-year-old boy who was restless, impulsive, severely distracted, had an introverted personality, and has well-educated parents. School teachers repeatedly suggested that No. 33 be treated with Ritalin, but his parents were hesitant about pharmacological treatments. Half a year ago, his parents brought No. 33 to the Everspring foundation to complete SMI-Tx training. His parents also ensured that the same exercises were completed at home, and collected weekly records and comments for Everspring records. The boy went to the United States for 2 months during the summer, and returned for NFB (NeuroFeedBack) (see figure 5, 6, 7). (Failure case see Figure 8.)

Figure 3

fMRI BOLD 8 Students with ADHD



Frontal and Prefrontal AREA PALE in fMRI, BOLD DATA

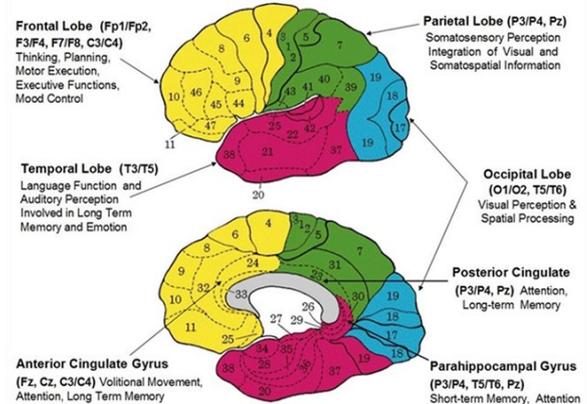
This figure was revised and is published with permission. The image originally appeared in the Taiwan Special Education Quarterly Issue 101 (2006) (3D) SMI-Tx=Sensory-Motor-Integration-Training. Legend Description:

1. The top panel shows average brain images from a group of 8 schoolchildren who were characterized as hyperactive, impulsive, and distracted (symptoms of ADHD), before performing intensive Sensory Motor Integration training (SMI-Tx). As shown, the prefrontal lobe does not appear to be highly activated compared with that in the control group, who are shown in panel 3. These students were distracted, impulsive, sensitive, clumsy, uncoordinated, emotionally unstable, unorganized, and lacking in executive ability. Diagnosed as ADHD. Not yet on SMI-Tx then.
2. The middle panel shows data for the same group of children shown in panel 1 after three months of intensive SMI-Tx. The prefrontal lobes are clearly more activated, which may correspond with reports that the students felt a slight heat and floating sensation after the exercise. These students became quiet and less impulsive in class and showed full concentration, less oversensitivity and clumsiness, good coordination, and increased emotional stability. Under the guidance of their teachers and parents in counselling, getting organization & executive abilities.
3. The bottom panel shows data from a control group of normally developing children. These students showed full concentration, good hand-eye coordination, emotional stability, good organizational skills, and executive ability. They need not do the SMI-Tx.

[Figure 3]

Figure 4

Symptoms, Electrodes, & Brodmann Areas

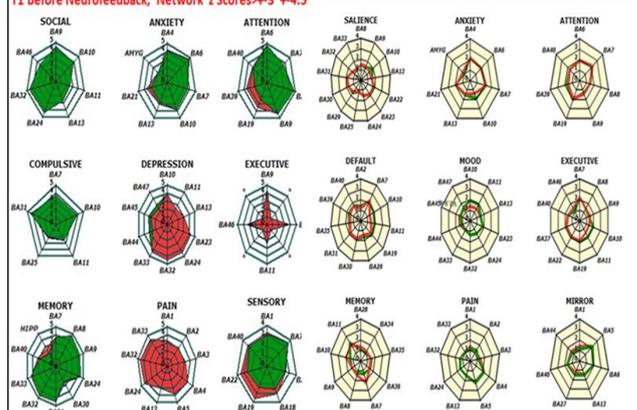


[Figure 4]

Network z-Scores before & after 10 NFB in case no. 33

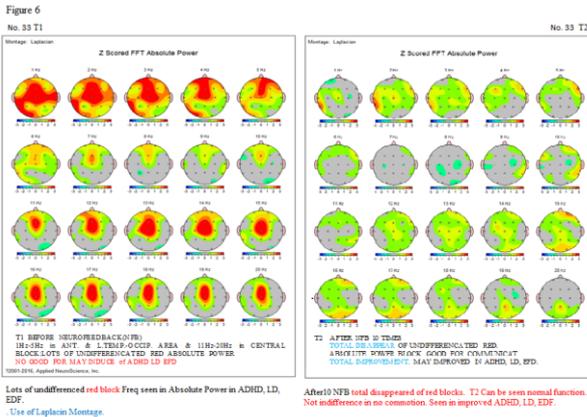
Figure 5

T1 before Neurofeedback, Network z Scores>+3~+4.5 T2 Neurofeedback 10 times, Network z Scores<-1~+2

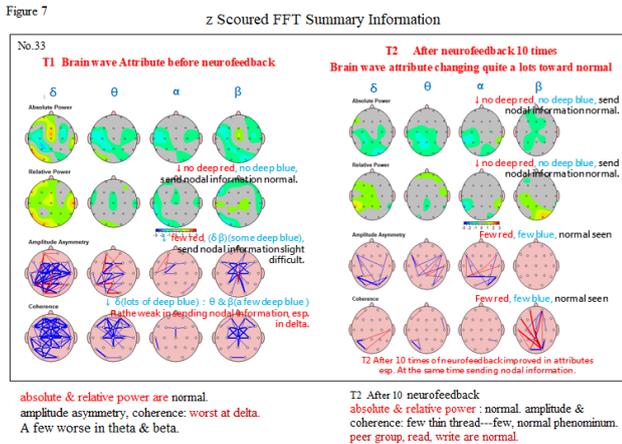


Before Neurofeedback(NFB) network z Scores(±3--±4.5). Bad. After 10 NFB network (±1--±2). Normal. Read, write, expanded network z Score>±3. Bad. (V.2.9.4 old version)

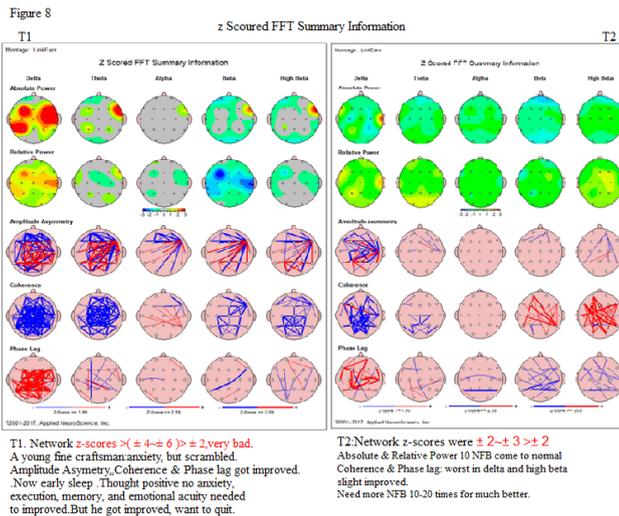
[Figure 5]



[Figure 6]



[Figure 7]



[Figure 8]

III. RESULTS

For students with adhd summary result of smi-tx treatment with neurofeedback.

Diagnosis of ADHD were according to the criteria below the introduction, by Everspring Special Education Teachers observing and later talking to parents.

From 31/03/2017 to 28/02/2018 Everspring Center treated a total of 65 students with ADHD.

Near the end of SMI-Tx training there were still minor symptoms and signs of ADHD. Such as symptoms and signs of ADHD train, such as occasionally forget their homework, daydream during class, act without thinking, or get fidgety at the dinner table.

There were still having some time, after receiving sensory-motor integration training (SMI-Tx). We like to know how are brain wave conditions. We talked to parents and students and got the permissions. Then we did qEEG and T1 brain waves reports, which compared with age match 727 norm, from 2-months infants to 82 years old, certified by US FDA, with rigid criteria and lots of tests. The z Scores networks could see whole brain pictures in terms of age match z Sores, which indicated that z-scores were greater than ( $\pm 2 \sim \pm 3$ ) for all of them. After the detection of brain waves, 14 (22%) of the parents felt that the SMI-Tx had induced substantial improvement, such that there was no need to do NFB. Everspring released these cases from the program and, as there were cold & flu outbreak, advised the parents to see a neurologist or Everspring staff member Dr. Shin-siung Jung if their children experienced flu-like symptoms or pain in the back of the head.

51 cases agreed to complete NFB (Neurofeedback). However, 13(25%) cases developed influenza and severe neuralgia. The z-Scores of T2 for these children ranged from ( $\pm 4$  to  $\pm 5$ ) and formed a curved or (improved major symptom) jumping pattern. The children were slight restless and distracted, and were unable to sit still for 15 minutes.

We informed parents that the participant group appeared to have been affected by a seasonal flu or cold epidemic with severe headache symptoms. All 13 parents were seen neurologists for help with anti-inflammatory, antipyretic medications and mild sedation for children. Symptoms in the 13 patients with influenza and neuralgia improved in 4 to 7 days after taking the medicines. Within another one weeks, the radar network z-scores returned to ( $0 < \pm 2$ )  $< \pm 2$ . This is result of daily take temperature on arrival at waiting room, checking neuralgia and cold sign. On discharge all showed no neurologic or cold signs.

In the other 38 cases, NFB sessions were performed, and homework completion and interpersonal relationships improved by 98%. 20 of the participants had radar networks with z-scores at ( $0 \sim \pm 2$ ). That mean 53% (20 cases) of radar networks with z-Scores at ( $0 \sim \pm 2$ ) within normal rang ( $\pm 2$ ) & contact  $\pm 0$ . These are extremely rare conditions. I believe they will high successful persons, if they get nice guidance.

IV. DISCUSSION

Students with ADHD may not use Ritalin or other stimulants for long time side effects. I just make happy atmosphere daily 40-60 minutes in competitions or games style in 2 weeks to 6 weeks, all major symptoms of ADHD will go away. I have done this way at student home, or school grouping activity, for 35 years. There were not pitfalls, but just for pale frontal and prefrontal area in short of vessels, nerves, and biochemical materiel in frontal and prefrontal area of ADHD students. Short of vessels in exchange to pink color to rich in more arteriole control; rich in nerves and biochemical materiel in behavior control, changing emotion or short of temper, and movement of face, body restlessness, and hand playing; thought will be preceding mouth talking, and hand and emotional gesture. Most important, thought change come from behavior changes.

Students with ADHD still have minor sign. frontal and prefrontal defects of vessels, nerves, dopamine and other biochemical materials. Strenuous exercises on prone extension posture with daily 40-60 minutes, mincing developing posture, can reopened and supplemented of above defects in 2-6 weeks. Some other students finished whole courses in 1.5-2 months included.

V. CONCLUSION

Minor symptoms of ADHD from diffuse z Score ( $\pm 2 \sim \pm 3$ ) or much worse, improved within normal range of ( $0 \sim \pm 2$ ). This is a great success in combination of treatments of Sensory-Motor-Integration-Training from Neuro-Rehabilitation and Neurofeedback from Neuro-Psychology.

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**VI. ACKNOWLEDGEMENTS**

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**VII. ETHICAL STATEMENT**

The treatment ethics committee of the Everspring Culture and Education Foundation approved the protocol for the SMI-Tx study as well as the EEG diagnosis and neurofeedback training. We obtained verbal informed consent from the parents of each participants.

**VIII. CONFLICTS OF INTEREST**

The authors declare no conflicts of interest.

**IX. FUNDING STATEMENT**

The Everspring Foundation does not receive financial assistance.

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