Neurofeedback training to improve neuronal regulation in ADD: A case report

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Abstract

This report details the use of Neurofeedback training (NFT) on a 15 years old girl with Attention Deficit Disorder. The child’s mother reported a history of hyperactivity, inability to self-regulate/focus attention, impulsivity, self injury and behaviorally disinhibition. The goal was to enable the child to achieve a better brain regulation, leading to improvements in attention, mood, and social behavior. The sensors were placed on the scalp and connected to the computer software that detects specific neuronal activity. The subject showed an improvement in emotional reaction, a reduction in self injuries and oppositional behavior, and a better social relationship.

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1. Introduction

Neurofeedback training (NFT) is a direct training of the efficient functioning of the brain. It is a technique that gives user actual or real-time feedback of the brain performance. The activity is measured by sensors on the scalp and visual displays. Dysregulation is the problem that is dealt with NFT. The purpose of NFT in this case study is to train an individual’s brain and enable the individual, who in this case is a 15 year-old girl, to achieve better brain regulation leading to improvements in attention, mood, and social behavior. NFT was conducted in 25 sessions over a three-month period on the teenage girl, who was diagnosed as having attention deficit disorders (ADD). ADD and attention deficit hyperactivity disorder (ADHD) are characterized by the inability to self-regulate/focus attention, distractibility, hyperactivity and impulsive behavior. The basis of this neurological disorder may be decreased arousal and is associated with decreased noradrenergic activity (Zametkin et al., 1990), increased slow 4–8 hz, theta activity in frontal and central cortical regions (Mann, Lubar, Zimmerman, Miller, & Muenchen, 1992) and decreased glucose metabolism in both frontal cortical and certain subcortical regions (Zametkin et al., 1990). This biologically-based behavioral disability has a pervasive negative impact on a wide range of adaptive functioning and most

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neurophysiological studies have identified faulty regulation of certain key aspects of attention and nervous system arousal as being central to the understanding of this disorder.

In this research, a dysregulation model (Steinberd & Siegfeied, 2004) is used for understanding and simplifying ADD in a manner consistent with and true to its essential characteristics. Dysregulation is the touchstone for the relevant and distinguishing characteristics of ADD and ADHD. It is the fundamental underlying mechanism by which we can control and improve mental functioning and behavior. ADD is characterized by dysregulation in brain activation, often reflected in the inefficient activation management of the EEG. The EEGs of ADD people are often less differentiated, less activated and less responsive to internal and external cues requiring shifts in activation states.

The core characteristics of ADD/ADHD (underpinned by dysregulation) can be relieved with the use of NFT in managing the dysregulation of the arousal system. Arousal refers to states of excitation and relaxation that are in constant relationship with each other. The arousal system manages or regulates a person’s appetites, perceptions and abilities to control, soothe, gear up and modulate oneself (Steinberd & Siegfeied, 2004). The irregular management of arousal results in a variety of behavioral, emotional and physical symptoms such as anger, moodiness, inattention, anxiety and insomnia.

2. Case history

Lina (Not her real name), was born in February 1996. She was diagnosed with Attention deficit disorders by a child psychologist in University of Malaysia Sarawak when she was three years old. Her mother reported that she was very active but did not vocalize until the age of three, when she began to babble. Her mother brought Lina to meet the NFT experts at the Faculty of Cognitive Sciences and Human Development in September 2009 for observation and discussion related to her medical history and NFT. Observation made before the treatment showed that the girl was characterized with symptoms of distraction, anxiety, impulsivity, frustration, anger, tantrums, mood swings, obsessive worries, inflexibility, insensitivity, and oppositionality. Additional observation showed that there were cuts and scars due to self injuries. The mother reported that Lina did not reveal any signs of pain when she used the nail clipper to clip and hurt her arms. Parental ratings using mental fitness evaluation scale screening profile (0-4) showed a very high rating from 3-4 on worries, concentration, learning, mood and tantrum.

3. Intervention/training procedures

To ascertain the child’s behavioral pattern, preliminary interview was carried out with the parents and siblings based on the medical and school records. In addition, Mental Fitness Screening Profile was used to observe the major problems faced by the client in relation to emotions, cognitive and social relationship, before commencing the training. The changes were observed along with the changes in the EEG pattern of the child obtained as a result of the training. Interview and observations showed better social relationships and improved self-esteem after NFT.

During the training, sensors were placed on the scalp and connected to sensitive electronic device and computer software that detected and recorded specific neuronal activity. EEG responses to stimuli displayed on a computer screen are analyzed in real time for frequency, amplitude and artifact characteristics. The computer provided feedback information in the form of visual displays showing how well the subject was doing. The resulting information was fed back to the trainee to indicate the trainee’s brain activity which was within the designated range.

The objectives of the training were to increase the EEG rhythm called the sensorimotor rhythm (SMR) on a location over the frontal lobe and, at the same time, training to inhibit (decrease) slow activity in the range from 4-8 Hz over the same area. This protocol was primarily used for the hyperactive or impulsive component of ADD. Then, training with focusing of attention was performed, and it aimed at increasing higher frequency beta activity in the range between 15 and 20 Hz. Training was performed twice a week (30 minutes per session) beginning October, 2009. The subject in our case study took 25 sessions (30-40 minutes each) for NFT to produce clinical changes in the brain wave patterns and behavior.
4. Results and Discussion

The changes in the EEG pattern of the child obtained from the training were obvious. Interview and observations showed better social relationships and improved self-esteem after the treatment. EEG recordings were obtained from electrodes situated active at the frontal and cortical regions, reference electrode on the right or left ear with the ground on the opposite ear, using the 10-20 International System. NuPrep and ten20 conductive paste was used to connect the electrodes to the skin.

Initially, the subject was quite reluctant with the placement of the 2 electrodes on her frontal cortex. It took quite some time to get her into sitting on the relaxation sofa in the counseling laboratory. After the third session, observation showed a reduction of oppositional behavior and self injuries. In one occasion, the mother narrated that the subject showed her emotional reaction (sadness) upon listening to the news of her aunt’s death. The NFT training might have implicated on the specific part of the brain responsible for the emotions (amgydala). However, there were no signs of reduction in other symptoms such as language and thinking problem, behavior problems, habits and health. Observations done by the siblings and parents showed a reduction in self injuries (using nail clippers to cut her hands). The researchers were also informed that she was always ready for the NFT sessions and looking forward to the video games that she called as “BubblePopper”. She showed her excitement and confidence for the next sessions. She seemed to enjoy her increment in the scores earned from the games.

In the eighth session, the researcher tried to ask Lina to read and spell her name. She responded and tried to spell her name. Memory test was conducted and showed that she lacks working memory and utterance. In the ninth session (Figure 2), Lina showed her courtesy and confidence before the session began. She looked happier, and more interactive and sociable. The average games scores earned during the NFT were about 940, and her reward frequency achieved above the range, showing that the training achieved its objectives. Figure 1 below shows the reward frequency during the first session and the improvement achieved at the 25th session (Figure 3).

![Figure 1. 1st session](image)

![Figure 2. 9th Session](image)

![Figure 3. 25th session](image)

Surprisingly, after the ninth session, the researchers were told that Lina had requested to go to school. The parents decided to send her to the nearest school. Lina now enjoys the school and has since been the first person to wake up in the morning to get ready for school. Over the course of training, Lina’s behavior continued to change. At the 19th and 20th sessions, she looked tired and less enthusiastic during the training. The researcher decided to give her another five booster sessions to establish the learning of the brain. After 25 sessions of training, she was quite independent and was able to cook her own meal.

5. Conclusion

NFT operant conditioning is a good choice for treatment of ADD children. Praising and rewarding a child when he/she steps up production of beta waves by concentrating on the game or movie should therefore teach her/him how to focus at will in other settings, such as doing homework assignments or cleaning his/her room. And at least in this case study, that seems to have happened.
References

