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Neurotechnology for Special Needs Children

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Abstract

This paper highlights the use of neurotechnology to improve the brain dysregulation of special needs children giving an example of a case study on autistic children. Neurofeedback Training (NFT) was preceded by objective assessment of brain activity using Quantitative electroencephalogram (qEEG) to identify the abnormalities of the childrens' brain waves. Neurofeedback training were conducted based on relevant EEG findings in relation to the children's medical history and symptoms. Analysis indicate excessive presence of delta wave at the Frontal lobes and posterior regions. NFT were conducted within three months for more than 25 sessions for each protocol starting with Beta training followed by Delta and Alpha protocols. The observations and assessment showed improvement in terms of social interaction and communication and increased Alpha-beta activity in some parts of the brain suggesting improvement in brain regulation.

Keywords: Neurotechnology, Special needs education, Autism

Introduction

Over the years, various neurotechnologies has been developed to explore more about the mysteries of human brain. It has led to the development and creation of neurofeedback (NFT), quantitative electroencephalogram (Qeeg), magnetic resonance imaging (MRI), functional magnetic resonance imaging (FMRI) and etc. However public awareness about the existence of this technology, particularly among

Malaysians is still at low levels compared with other developing country. In developed country, neurotechnology are widely used in helping children with various neurological disorders such as Autism Spectrum Disorder (ASD), Autism Deficit Hyperactivity Disorder (ADHD), epilepsy, learning disability and etc. In neurofeedback training, participants learn how to alter their own brainwave pattern, producing more normal output. The technique has been successfully used to help people suffering from migraines, sleep problem, anxiety, depression, traimatic brain injury, epilepsy, autism and ADHD. Earlier research revealed that neurofeedback prove to be effective treatment in individual with attention deficits and hyperactivity and those wih neurological disorders compared to medication. Neurofeedback has shown to enhance neuro regulation and metabolic function. Children with autism and Autistic Spectrum Disorder who completed neurofeedback training attained a 26% average reduction in the total ATEC rated autism symptoms in contrast to 3% for the control group. Parents reported improvement in socialization, vocalization, anxiety, schoolwork, tantrums, and sleep while the control group had minimal changes in these domains (Jarusiewicz, 2002). Neurofeedback has no adverse side effects while psychopharmacological interventions, as well as certain vitamin/mineral supplementation and secretin are associated with side effects. In addition, the therapeutic treatment outcomes of neurofeedback training are maintained over time and do not reverse after treatment is withdrawn (Linden, Habib, & Radojevic, 1995) as in drug therapy, diet therapy, and supplementation with vitamins, minerals, and enzymes. Besides, research findings indicated that effects from the medication show temporary response for the autistic children and those having ADD/ADHD. The results are more consistent and permanent than the other traditional therapies.

The Case of Autism Spectrum Disorders

Neurofeedback Training and quantitative Electroencephalogram (qEEG)

Neurofeedback is a non-invasive approach shown to enhance neuroregulation and metabolic function in Autism Spectrum Disorder (ASD) and it is designed to train individuals to enhance poorly regulated brainwave patterns and subsequently implicates on behavioral change through the process of operant conditioning (Coben et. al, 2008). Neurofeedback Training (NFT) was originally pioneered for neurological conditions such as epilepsy and stroke, is now used to treat ADHD, autism, dyspraxia, learning difficulties and health problems. According to Thompson & Thompson (2009), NFT training is targeted to reduce autistic symptoms such as mirroring emotions, poor attention to the outside world, poor self regulation skills, and anxiety.

In NFT, the activity of brain can be observed by researcher while the ASD children doing the game task to trigger the brainwave. According to Coben et. al (2009), information on brainwave activity were fed to a computer that converts this information into game-like displays that can be auditory, visual, or both. According to Fernandez et. al (2007), the EEG signal was obtained from a lead situated at the site with the most abnormal theta/alpha ratio, referred to linked earlobes. Individuals

learn to inhibit brainwave frequencies that are excessively generated (produce negative symptoms); and augment or enhance specific frequencies that are deficient (produce positive results).

Quantitative EEG (qEEG) is the analysis of the digitized EEG sometimes is also called "Brain Mapping". It is an extension of the analysis of the visual EEG interpretation to assist our understanding of the EEG and brain function.

Identification of Brain waves and Neurofeedback Training

Participants

The ASD group composed of 10 participants diagnosed with ASD, ranging in age from 5-18 years were recruited from Kuching Autism Association Sarawak. The normal group consisted of 6 male participants and 4 female aged 7-21 years were volunteers. Inform consent were obtained from the parents and normal young adults above 18 years of age. The normal individual had no history of neurological disorders or mental illness as assessed through the personal interview,self-report and mental fitness screening profile.

Procedures

The procedure begins when the EEG data were recorded by means of the Mitsar amplifier from 19 electrodes (Fp1, Fp2, F7, F3, Fz, F4, F8, T3, C3, Cz, C4, T4, T5, P3, Pz, P4, T6, O1, O2 sites in the International 10-20 system) with 250 Hz sampling rate in 0.3 – 70 Hz frequency range in the resting eyes opened (EO) conditions. During the recording, participants sat comfortably on a reclining leather sofa. The duration of the recording session was approximately from 10-30 minutes.

The EEG is then stored on a computer. The subsequent steps are to visually inspect the data and remove the artifacts (movement, interference, noise, etc) and compute the fast fourier transform (FFT) providing spectral analysis output to examine for peculiar patterns. The output is then displayed as topographical "map" to identify for differences in cerebral functioning using estimates of absolute and total power.

The spectral analysis for the four EEG bands were imported into Microsoft excels for computation of z scores for each of the measurements used in QEEG such as absolute power (uV^2), frequency (Hz) and symmetry. The z scores were computed from the mean of absolute power (uV^2), andto be compared across the different normally distributed sets of data from the international 10/20 system (Fp1,Fp2,Fp3, Fz, Fp4, F7, F8, C3, Cz, C4 ,P3, P4, T3, T4, T5, T6,O1,O2). The z score is the difference between the mean score of a population and the patient's individual score divided by the standard deviation of the population. The Z value indicates how "deviant" an individual's score is from the mean. In the case of qEEG data, the Z-score indicates whether there is deficient or excessive activity in a given frequency for a given electrode (or group of electrodes). The z score graphs were plotted to indicate a

collective impression of the location, degree of deviation and difference of individual's qEEG abnormalities from the normal.

Results and discussion

Findings revealed the presence of excessive slow wave activity (delta and theta) at the prefrontal lobe and Frontal lobe or roughly regions Fp1, Fp2, F7 and F8, and O2 or right posterior regions. The z score graphs for the four EEG bands were plotted to allow visual inspection of QEEG patterns in individuals and children with ASD and compared with normal individuals. (Look at Figure 1(a), (2a), (3a) and (4a) and Figure 1(b), (2b), (3b) and (4b) below)

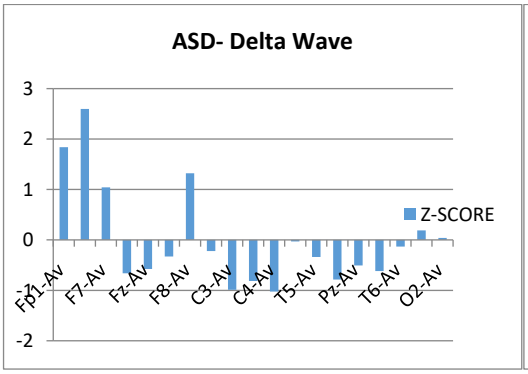


Figure 1 (a)

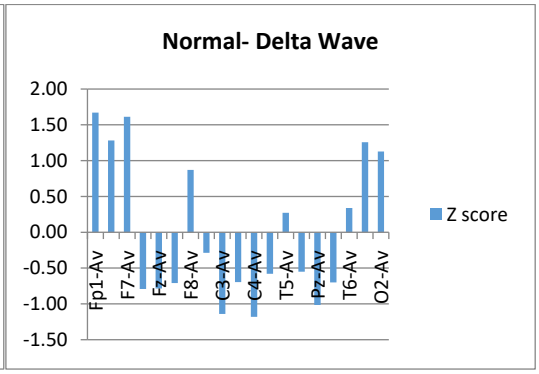


Figure 1 (b)

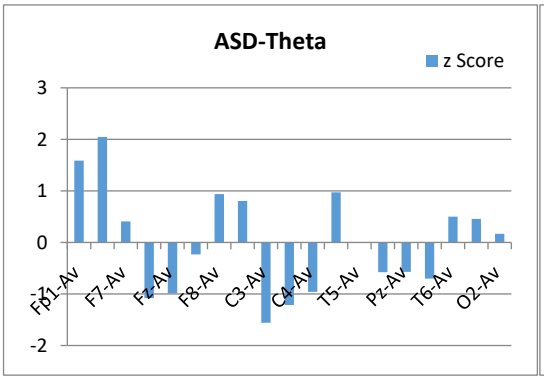


Figure 2 (a)

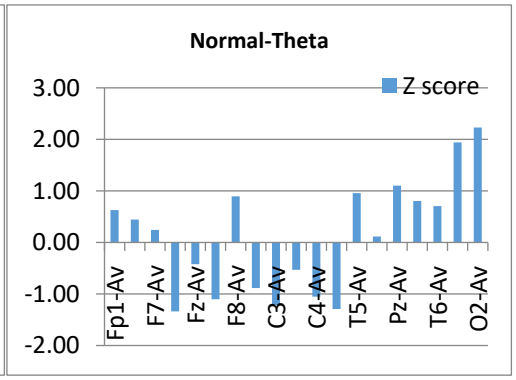


Figure 2 (b)

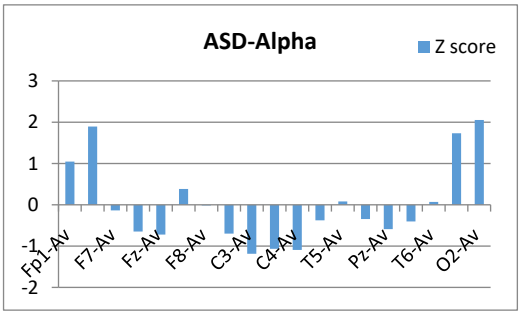


Figure 3(a)

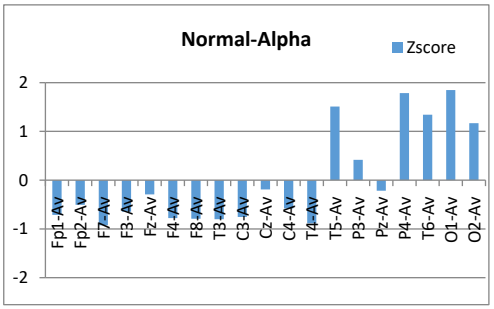


Figure 3 (b)

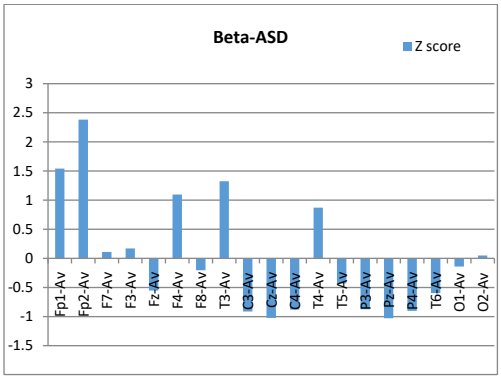


Figure 4 (a)

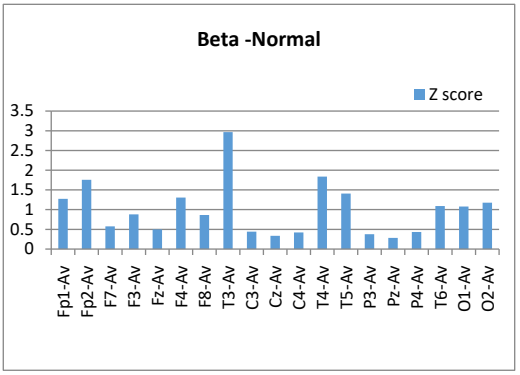


Figure 4 (b)

Figure 1(a), (2a), (3a) and (4a) showed the z scores of ASD children brain waves pattern from each of the points in the international 10/20 system in comparison with the brain waves from Figure 1(b), (2b), (3b) and (4b) from the normal group. Several electrodes are grouped together to designate a region of interest. The regions include electrodes such as ; Left Lateral – F7, T3, T5, Right Lateral – F8, T4, T6, Left Medial – FP1, F3, C3, P3, O1,Right Medial – FP2, F4, C4, P4, O2, Left Anterior (Frontal) – FP1, F7, F3, Right Anterior(Frontal) – FP2, F8, F4 ;Left Central – T3, C3; Right Central – T4, C4 , Left Posterior – T5, P3, O1, Right Posterior – T6, P4, O2, Mid (Midline) – FZ, CZ, PZ.

Below is an example of results from the NFT training from a participant. The participant went through 59 sessions with seven NFT training protocols started with T3-T5 followed by Beta F3-F7, for Alpha CZ-FZ and Alpha P3-P4. ,

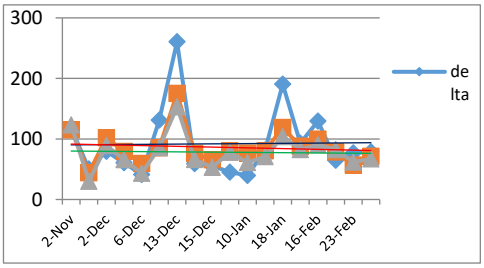


Figure 5 (a) Beta T3-T5 training

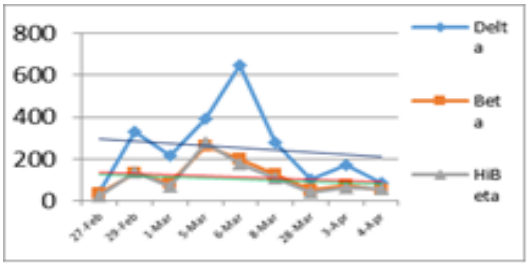


Figure 5 (b) Beta F3-F7 training

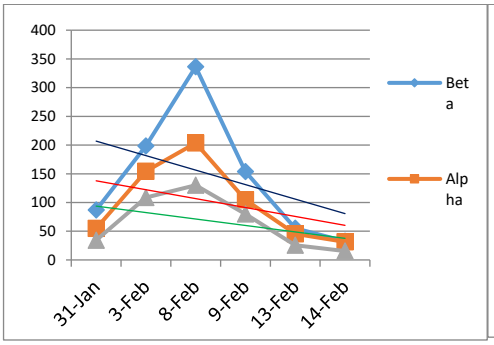


Figure 6(a) Alpha CZ-FZ training

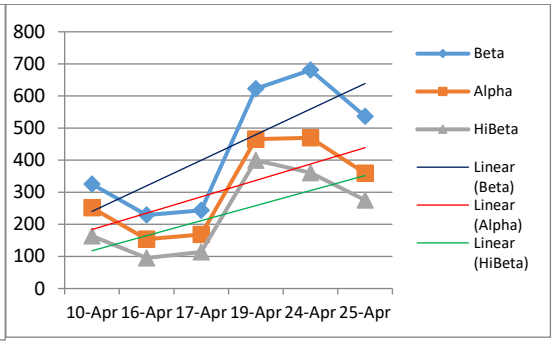


Figure 6 (b) Alpha P3-P4 training

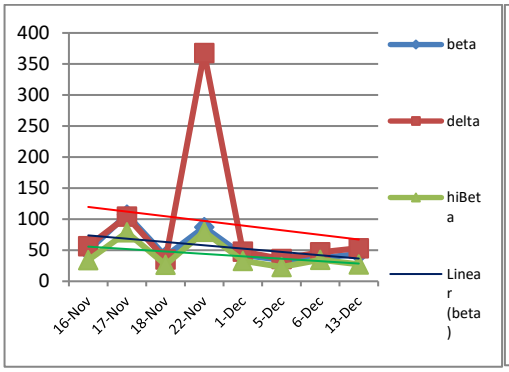


Figure7(a) Average graph for Delta P3-P4 training

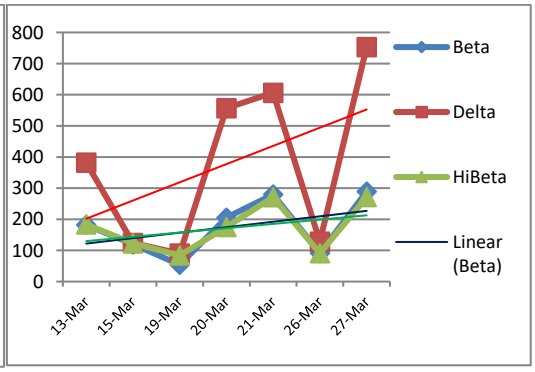
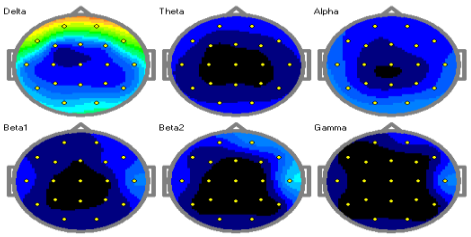


Figure (b) Average graph for Delta T3-T4 training

The first training protocol used was Beta Training using bipolar montage followed by Delta and Alpha training. The protocols were analyzed with the hope that the participant will be able to inhibit both Delta and Hi Beta waves. The participant improved in terms of social interactions and significant improvement in his ability to construct simple sentences. The training helps to improve his mood swings and social behaviors which correlates with the increased in Beta at the posterior region and theta activity at central and parietal area.

Maps of EEG power spectra for bandranges:

First QEEG Second QEEG



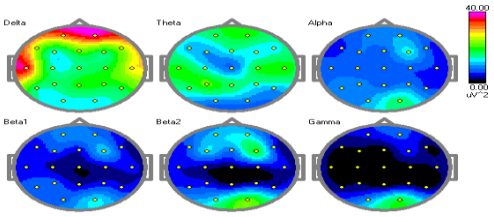


Figure 8 (a) Figure 8 (b)

The above brain topography revealed the increased Alpha-beta activity in most of the brain regions suggesting improvement in the brain regulation,

Conclusion

The purpose of NFT was to improve the brain regulation of children with neurological disorders. The use of NFT with the design of specific training protocol based on relevant EEG findings in relation to the identified symptoms implicates on the brain regulation which may correlates with the improvement in the participants' behavior. Each participant may improved at a different pace depending on the severity of symptoms. Improvement could be seen in terms of social interaction and communication and increased Alpha-beta activity in some parts of the brain as seen in the brain waves from brain mapping and results from NFT training.

Acknowledgements

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