

CASE REPORT

Neurofeedback (NFB) Training in Aspergers

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ABSTRACT

The prevalence of Autism Spectrum Disorder (ASD) is increasing globally. Due to its high incidence rate reported globally, ASD should be considered as a public health emergency that requires immediate attention to the process of screening, diagnosis, and intervention. This is a preliminary case study to test the efficacy of the neurofeedback technique in helping an Asperger's child to reduce his pathological symptoms (e.g., sociability, sensory/cognitive awareness, communication/ speech/ language, and physical behaviour). Neurofeedback is brain training based on the operant conditioning concept to regulate brainwave activities voluntarily using audio or visual feedback (real-time). In this study, we conducted neurofeedback training on an eight-year-old boy diagnosed with Aspergers aimed to enhance Sensorimotor Rhythm (SMR) wave (12 to 15 Hz) and at the same time inhibiting theta wave (4-8 Hz) and high beta wave (22-36Hz) at C4 over the right motor area, with the reference electrode placed on A2 and ground electrode placed on A1. Twenty (20) sessions of neurofeedback training were conducted on the boy's aims to improve his behaviour and emotional expression, language comprehension. The participant showed observable improvement after 20 sessions of neurofeedback training in sociability and speech/ language or communication subscale of the Autism Treatment Evaluation Checklist (ATEC), and parent's report. This study provided important evidence that neurofeedback training can be employed to improve the child's Asperger's symptoms.

INTRODUCTION

Years ago, autism was a rare diagnosis but now it has been seen the rise of a seeming epidemic. Autism and Asperger's is a spectrum of pervasive developmental disorders that can disrupt a person's ability to communicate with other people and to interact with the outside world. It is defined as an impairment in communication and restricted, social interaction, repetitive, and stereotyped patterns of behavioural interests that limit learning, interpersonal, and occupational functioning (Chapin & Russell-Chapin, 2014). The child seems normal infants and toddlers, normally by age three. The effects of this spectrum on the child's lives are stricken and its effects on their families can be ranged from difficult and sad to heartbreaking and catastrophic.

The Centre for Disease Control reported a rising percentage of the world population diagnosed with an autism spectrum disorder (ASD). According to the statistic in 2014, an estimated one (1) per cent of the world population had been diagnosed an ASD, an estimated 3.5 million population of the United States, or one (1) in 68 American children living with ASD. In 2013, the National Autism Society of Malaysia (NASOM) reported in the past three years there was a 30% increase in the intake of individuals with autism in the organization. Statistics in the year 2018 estimated 300,000 people living with ASD in Malaysia (New Strait Times, 2018).

There are many types of interventions that have been implemented to help autistic children, however, there were no definitive treatments or cures for this disorder. There are also no specific therapeutic guidelines that can be referred to reduce the disorder symptoms, increase life functioning, and thus improve the quality of life of people with autism. Conventional medicine considers autism as a psychosocial disorder, and strongly reliant on inherited genes. This disorder was

not thought to be curable, thus the approved treatments normally included drugs and the therapies program designed to improve life functioning, such as behaviour modification and/or speech therapy (Hill & Castro, 2009). The Autism Research Institute lists treatments, including drugs, nutritional supplementation, hyperbaric oxygen treatment, allergy treatment, removal of heavy metals (chelation), and dietary changes.

Neuroimaging therapies have demonstrated that autism is a neurological disorder that reveals distinct abnormalities in the brain. Neuropsychologist Rob Coben has studied the brainwave activity of autistic children extensively. His research findings revealed that the brains of children with autism have areas that are too loosely connected (Coben & Padolsky, 2007). Too many leads to decreased resilience and reduced ability to reorganize itself, and too little decreases the communication necessary to organize by reducing the numbers and intricacies of the interfaces.

Neurofeedback is the method developed in neurophysiological labs of scientific institutes in the USA and has been proven to be effective in altering brain activity. It is a computerized method based on tracking the electrical activity of the brain (EEG) and giving feedback about the brain activity to the therapist, however, the extent to which such alterations can influence behaviour is still unknown. Vernon (2003) claimed that previous studies have indicated that neurofeedback can be used to help treat a number of some early childhood disorders as such attention-deficit/hyperactive disorder (ADHD), Aspergers's disorder, learning disability, obsessive-compulsive disorder (OCD), and ASD (Demos, 2005; Evans, 2002). Several randomized clinical studies on the usage of neurofeedback techniques have proven the efficacy of neurofeedback technique for ADHD (Bakhshayeshet al., 2011; Gevensleben et al., 2010; Liechti et al., 2012). The findings have led to studies of neurofeedback as an alternative

treatment for autism since generally autistic children show symptoms of attention deficit and hyperactivity (Wang et al., 2013). This preliminary case study aimed to test the efficacy of neurofeedback training in helping an Asperger's child to reduce his pathological symptoms (e.g., sociability, communication/speech/language, sensory/cognitive awareness, and physical behaviour).

CASE PRESENTATION

An eight-year-old boy is not attending formal school programmes. The school that he attended to enter rejected him due to his agitation behaviours, difficulties in focusing and social relations with other children, and not speaking well. He was accompanied by his mother who came for the training at the university Bio-Neurofeedback Lab in March 2019. He was diagnosed with Asperger's syndrome when he is in three-year-old. He had received various therapies and programmes before coming for neurofeedback training.

Neurofeedback Training (NFT)

The boy has attended NFT since March 2019 and had completed approximately 15 hours of NFT (20 sessions of NFT). He was accompanied by his mother to the Bio-Neurofeedback Lab average twice a week and completed a session that lasted 30 to 45 minutes. During each NFT session, a protocol consisted of a three-minute baseline set, followed by 10 three-minute intervals of neurofeedback training (e.g., video game). Neurofeedback intervals were separated by short rest periods every three-minute video game. The video game included: Mazes, Variable-Dot-Mazes, Island, Highway, and Jump box. He had the choice of the video games he wanted to play at each session. The computer system used for NFT was EEGer Neurofeedback System Device and the operating system was using a personal laptop and television monitor.

Before the NFT, the mother was interviewed to examine the anamneses of him, his family history, and his current problems. Procedures and possible side effects of the NFT were explained to the mother and the informed consent was signed by the mother. Then, pre-baseline performance tests consisting of a symptom checklist, Autism Treatment Evaluation Checklist (ATEC), The Autism Rating Scale (CARS), and Quantitative EEG (qEEG) were conducted. The Autism Treatment Evaluation Checklist (ATEC), The Autism Rating Scale (CARS) were repeated after 20 sessions and compared with his pre-baseline performance results to estimate behavioural improvements. Symptom profiles were reviewed at each session.

For administered protocols, the 20 sessions of the NFT were aimed to enhance SMR wave (12 to 15 Hz) and at the same time inhibit theta wave (4 – 8 Hz) and high beta wave (22 – 36 Hz) at C4 over the right motor area, with the reference electrode placed on A2 and ground electrode placed on A1. Many trainers such as Margeret Ayers, Othmers, and Lubar (Soutar & Longo, 2011) prefer to begin at the motor strip area. Othmers (2008) stated that the largest and oldest pyramidal cells are in the motor strips area, so it is easiest to influence thalamic oscillators from this area. This protocol was recommended to improve autistic behaviour.

Autism Treatment Evaluation Checklist (ATEC)

Autism Treatment Evaluation Checklist (ATEC) was developed by Rimland and Edelson (1999). The ATEC is designed specifically to measure the effectiveness of various treatments. It is not a diagnosis checklist but a checklist that provides a general condition of a child's current behaviours and skills. The ATEC consists of four subtests: (a) Speech/Language Communication (14 items: Scores range from 0 to 28); (b) Sociability (20 items: Scores range from 0 to 40); (c) Sensory/ Cognitive Awareness

(18 items: Scores range from 0 to 36); and d) Health/ Physical/ Behaviour (25 items: Scores range from 0 to 75). The four subscale scores can be used to calculate a total score (total scores can range from 0 to 180). The lower the score, the less impaired the participant. The age range for the ATEC is 2 years of age and older. The parents, teachers, or caretakers

were asked to complete the instrument. ATEC provides a total score and subscale scores. The higher the score, the more serious the problems or reverse. The total score and scores of each subscale can be extrapolated to determine the percentile of the severity of the participant in comparison with score distributions provided by the Autism Research Institute (Table 1).

Table 1 The percentile of the severity of the Autism Treatment Evaluation Checklist (ATEC)

	Scale I	Scale II	Scale III	Scale IV	
	Speech	Sociability	Sensory/ Cognitive	Health/ Physical/ Behaviour	Total Range: 0 – 180
	Range: 0 – 28	Range: 0 – 40	Range: 0 – 36	Range: 0 – 75	
Centile					
Mild	0 – 2	0 – 4	0 – 5	0 – 8	0 – 30
0 – 9	3 – 5	5 – 7	6 – 8	9 – 12	31 – 41
10 – 19	6 – 7	8 – 10	9 – 11	13 – 15	42 – 50
20 – 29	8 – 10	11	12 – 13	16 – 18	51 – 57
30 – 39	11 – 12	12 – 13	14 – 15	19 – 21	58 – 64
40 – 49	13 – 15	14 – 15	16 – 17	22 – 24	65 – 71
50 – 59	16 – 19	16 – 18	18 – 19	25 – 28	72 – 79
60 – 69	20 – 21	19 – 21	20 – 21	29 – 32	80 – 89
70 – 79	22 – 24	22 – 25	22 – 25	33 – 39	90 – 103
80 – 89	25 – 28	26 – 40	26 – 36	40 – 75	104 – 179
90 – 99					
Severe					

Source: Autism Research Institute (retrieved from <https://www.autism.org/autism-treatment-evaluation-checklist/interpreting-atec-scores/> on 8 November 2019)

Symptom Checklist

The symptom checklist used in this study was designed by the New Mind Neurofeedback Center (Soutar & Longo, 2011). The checklist was used at the beginning of each neurofeedback training session. The checklist was used to help evaluate and track the participant’s neurofeedback training progress. The checklist consisted of 16 items (e.g., short-term memory, concentration, motivation/energy, assertiveness, restlessness, negative mood, negative emotions, quality of sleep, positive moods, appetite, worry/ negative thinking, patience, pain/ physical discomfort, fatigue, and irritability) that rate on a scale of 1 to 10, 1 is rated as low, little, or poor, and 10 is rated as high, a lot, or excellent. Impulsivity

that is measured in this checklist includes disorganization, foot in mouth, impulse buying, blowing up at people, and so forth. And the distinction between emotion and mood is an emotion lasts 20 minutes to an hour, however, a mood lasts several hours, days, or weeks.

Autism Treatment Evaluation Checklist (ATEC) Results

This boy has attended NFT for about five months. After 20 NFT sessions improvement was detected in all four subtests of ATEC. Especially, for Speech/ Language/ Communication improved 80%, from score 20 (centile of 20 – 29) to score 2 (mild) and Sensory/Cognitive Awareness improved 88%,

from score 18 (centile of 50 – 59) to score 2 (mild). Sociability improved only 9%, from score 22 (centile of 70 – 79) to score 20 (centile of 60 – 69); and Health/ Physical Behaviour improved 19%, from score 41 (centile of 80 – 89) to score 33 (centile of 70 – 79); and from a

total score of 91 (centile of 70 – 79) improved to score 57 (centile of 20 – 29) (37%). Table 2 showed the distinction between the baseline ATEC scores and the client’s ATEC scores after neurofeedback training.

Table 2 Autism Treatment Evaluation Checklist (ATEC) results for the boy before and after Neurofeedback Training

NFT	Autism Spectrum Level				
	Speech/ Language/ Communication	Sociability	Sensory/ Cognitive Awareness	Health/ Physical Behaviour	Total
Before NFT	10 (centile of 20 – 29)	22 (centile of 70 – 79)	18 (centile of 50 – 59)	41 (centile of 80 – 89)	91 (centile of 70 – 79)
After NFT	2 (Mild)	20 (centile of 60 – 69)	2 (Mild)	33 (centile of 70 – 79)	57 (centile of 20 – 29)
Improvement	8	2	16	8	34
Percentage of Improvement	80%	9%	88%	19%	37%

Behaviour Symptom Checklist Results

After 20 NFT session, results also indicated a substantial decline in his autistic behavior especially, in restlessness (improved 32.56%); irritability (improved 30.23%); impulsivity (improved 30.0%); worry/negative thinking (20.51%); negative mood (improved 17.50%) and negative emotions (improved 13.16%) (Table 3).

Parent’s Report

In the interview conducted with the mother related to her observation of her son throughout the 20 sessions of neurofeedback training, the mother reported that he has shown marked symptom decrease. He was more awake, more concerned, and more interested in his surroundings after neurofeedback training. His mother was also reported that he used more complicated and logical speech, spoke

more clearly and understandably. Besides, the mother reported considerable improvements in his social interaction, reduction in temper tantrums, and better control of emotion and mood changes. Some examples of the mother responses based on her observation of her son were “... *this morning he (her son) asked me whether I have taken my breakfast. This is the first time he asked me and never happen before*”; “... *I cut my finger yesterday, I brought him with me to the medical hospital he just sits quietly while we were waiting for the doctor. He seems like worry about me*”; “... *he fought with a friend in the tuition class yesterday. Fighting for a toy and the toy was belong to his friend. When I asked him to return the toy to his friend, he got angry and temper tantrums. But he can calm down fast than before...*”; and “... *he quarrelled with his sister yesterday. His sister was so angry with him. He scarred the sister does want to make friends with him so he wrote an apology letter to her sister...*”

Table 3 Behaviour Symptom Checklist Results of the boy before and after Neurofeedback Training

Session	Concentration	short-term memory	Quality of Sleep	Appetite	Motivation/Energy	Positive Moods	Patience	Assertiveness	Restlessness	Worry/Negative Thinking	Negative Mood	Negative emotions	Pain/Physical Discomfort	Fatigue	Irritability	Impulsivity
The Average First 5 Sessions	8.6	8.2	7.8	4.8	6.2	6.4	7	6	8.6	7.8	8	7.6	5.6	7.4	8.6	8
The Average Final 5 Sessions	7.6	7.6	7.8	5.2	6.6	7.2	7.4	7	5.8	6.2	6.6	6.6	6	6.2	6	5.6
Average 5s Improvement (%)	-1.0	-0.6	0	0.4	0.4	0.8	0.4	1	2.8	1.6	1.4	1	-0.4	1.2	2.6	2.4
improvement)	(11.6%)	(7.32%)	(0%)	(8.33%)	(6.45%)	(12.5%)	(5.71%)	(16.67%)	(32.56%)	(20.51%)	(17.50%)	(13.16%)	(7.14%)	(16.21%)	(30.23%)	(30.0%)

Brain Wave Pattern

After completing 20 sessions of NFT at C4, the result of the boy’s brain wave pattern as shown in Figures 1 and 2. The result revealed a reduction of the ratio of theta/beta wave, SMR power (12 – 15 Hz) increased over time at C4. However, theta and high beta power were not stable over the 20 sessions.

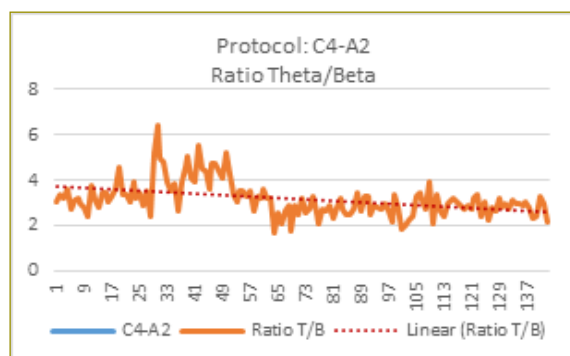


Figure 1 The ratio of theta/ beta wave

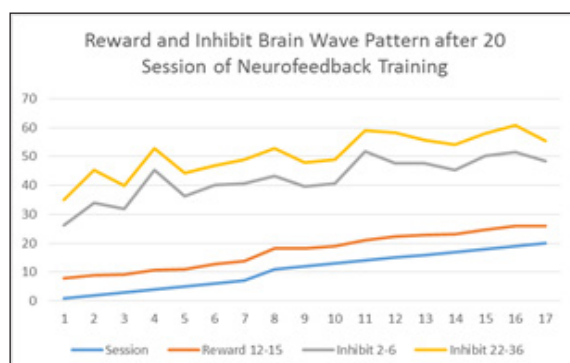


Figure 2 SMR, theta, and hi beta brain

Neurofeedback is believed can change and elicit growth at cellular levels of the brain, which in turn will improve behavioral cognitive performance and brain functioning (Demos, 2005). Neurofeedback training has

been proved to be useful in the treatment of different disorders in adults and children. The finding in this case study presented another evidence of the efficacy of neurofeedback training for individuals with Asperger’s Syndrome. After 20 sessions of NFT at C4 that aimed at rewarding SMR (12 – 15 Hz), inhibiting theta (4 – 8 Hz), and inhibiting high beta (22 – 36 Hz), results revealed a significant decline in his autistic behaviour as reflected in the Autism Treatment Evaluation Checklist (ATEC). Especially, in Communication/Speech/Language and Sensory/Cognitive Awareness. The moderate improvement was also detected in the total score of the measure and Health/Physical behaviour component and only a small improvement was detected in the child’s Sociability component. The improvement in his behaviour also was reported by the mother in the behaviour symptom checklist which revealed a substantial decline in his restlessness, irritability, impulsivity, worry/negative thinking, negative mood, and negative emotions. Parent reports furthermore indicated considerable improvements in his communication, social interaction, reduction on temper tantrums, better control on emotion and mood changes, more awake, concerned, and interest in surroundings. Furthermore, the boy’s brain wave patterns were also changed in a more positive direction after 20 neurofeedback training sessions at C4.

DISCUSSION

The findings of the current study are consistent with the neurofeedback study conducted by Scolnik (2005) with five (5) children diagnosed

with Asperger disorder, the study also indicated that after 24 sessions of neurofeedback training aimed to reward 12 – 15 Hz lower beta range and to inhibit 4 – 10 Hz theta band, the parents and teachers reported improvements in the participants' behaviour, such as higher self-esteem, more empathy, less anxiety, more flexibility, increased social interaction, improvement in fewer severe mood changes and frustration toleration.

The finding also showed that the theta/beta ratios changed in a positive direction for their two participants. Sichel et al. (1995) in their neurofeedback study of an 8-year-old boy with attention impairments and a mild form of autism, reported that after 31 neurofeedback sessions aimed to inhibit theta (4 – 8 Hz) and rewarded low beta (12 – 15 Hz), the boy showed positive changes in all the diagnostic criteria of autism in DSM-III-R (e.g. more attending, more talking, more eye contact with others, more imaginative play and seeking comfort).

The results of the current study have further supported the study by Jarusiewicz (2002) for a relation between theta/beta power and autism. Jarusiewicz (2002) investigated the influence of neurofeedback training in 12 autistic children aimed to inhibit theta (2 – 7 Hz) and reward SMR activity (10 – 13 Hz) over the right motor area. Jarusiewicz (2002) reported a significant decline in autistic behaviour for the 12 autistic children as compared to the control group. Parent reports indicated improvements in socialization, anxiety, vocalization, tantrums, sleep, and schoolwork. Whereas, no or minimal changes were found for the control group. The findings of the current study and previous studies (Jarusiewicz, 2002; Scolnik, 2005; Sichel et al., 1995) suggested that neurofeedback protocols that inhibit theta and reward low beta or SMR may hold particular value for the treatment of autistic children. The findings of the current study also provide further evidence in supporting the efficacy of neurofeedback training in helping an Asperger's child to

reduce pathological symptoms (e.g., speech/ language/ communication, sociability, sensory/ cognitive awareness, and physical behaviour). Importantly, these findings provide important information that through which we can understand the relation between SMR, theta power, and autistic pathological symptoms.

CONCLUSION

In conclusion, the finding in this case study presented another evidence of the efficacy of neurofeedback training for Asperger's Syndrome. The current study suggested that neurofeedback protocols that inhibit theta, high beta, and reward SMR showed particular value for the treatment of autistic children. Although the current findings are encouraging, the limitation of the case study method and the influence of situational variables (e.g., daily activities of the child, therapies attended, diet, surrounding environment, etc.) need to take into consideration. Thus, further methodological improvement is necessary for the form of sample sizes, a more accurate description of sample characteristics, controlled studies, and follow-up studies.

CONFLICT OF INTEREST

The authors declare that they have no competing interests in publishing this case.

CONSENTS

Written consent was obtained from the patient's mother to publish this case report. A copy of the written consent is available for review by the Chief Editor.

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