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Neurofeedback and autism spectrum: A case study

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Abstract

The aim of the present study was to examine neurofeedback training (NFT) and speech therapy to enhance learning and speech ability in patients with a diagnosis of autism spectrum. Single case pre- and post-intervention study was adopted. The neuropsychological profile of the patient was compared pre and post NFT. A 6 year-old boy with a diagnosis of Autism Spectrum Disorder (ASD) completed 50 sessions of EEG biofeedback training and 20 sessions of speech therapy. Formal interview and self-reports of his mother reveal specially autism signs and symptoms. The training incorporated video feedback to increase the 4-7Hz band (using arousal protocol) on T4-P4. Parent management principles were being taught to his mother. Results of formal interview, qEEG and self-reports showed significant reduction in signs and symptoms and enhancement in performance. Current study shown that neurofeedback produced effective improvement in autistic children's performance. It can stimulate future research in using neurofeedback to treat this kind of disability.

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Keywords: autism, neurofeedback, speech therapy;

1. Introduction

Autism spectrum disorders (ASD) refer to a group of neurodevelopmental disorders (Autistic Disorder; Asperger Disorder; Pervasive Developmental Disorder, Not Otherwise Specified) characterized by core impairments in social, communication, and behavior (restrictive, repetitive and stereotyped behaviors and interests) (Mottron & Burack, 2001). Although individuals with ASD share these difficulties, the developmental course, range, and severity of these core symptoms and associated symptom impairments (e.g., intellectual and adaptive ability) can vary widely in different patients. Outcome studies have reported that, while some individuals with ASD achieve near to 'typical' maturity, many continue to struggle with impairments throughout their lives (Howlin, Goode, Hutton & Rutter, 2004; Lovaas, 1987; Rogers, 1998), and those individuals with significant impairments are often cared for over the long-term in group homes (Van Bourgondien, Reichle & Schopler, 2003). Studies evaluating early childhood prognostic indicators of successful future functioning of individuals with ASD have revealed that better outcomes are dependent on intelligence scores greater than a standard score of 50 and language attainment by the age 6 (Gillberg & Steffenburg, 1987; Lockyer & Rutter, 1969; Lord & Bailey, 2002; Lotter, 1974).

Neurofeedback is a means by which participants can learn voluntary control of the EEG and has been applied to a range of clinical conditions such as migraine (Kropp, Siniatchkin & Gerber, 2002), epilepsy, attention deficit hyperactivity disorder and traumatic brain injury (Birbaumer, N., Ghanayim, N., Hinterberger, T., Iversen, I.,

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Kotchoubey, B., Koubler, A., Perelmouter, J., Taub, E., Flor, H., 1999; Rockstroh, B., Elbert, T., Birbaumer, N., Wolf, P., Duchting-Roth, A., Reker, M., Daum, I., Lutzenberger, W., Dichgans, J.,1993; Vernon, D., Frick, A., Gruzelier, J. H., 2004), and to optimize performance in healthy subjects (Edge, J., Lancaster, L., 2004). Participants have electrodes attached to the head and EEG activity is converted to sounds or pictures on a screen and fed back to them. By reproducing internal sensations associated with different feedback configurations, participants learn to modulate their EEG activity.

Less is known about the effects of neurofeedback in children. In children, research on the effects of neurofeedback is mainly carried out in the area of ADHD (Fuchs, T., Birbaumer, N., Lutzenberger, W., Gruzelier, J. H., & Kaiser, J., 2003; Monastra, V. J., Lynn, S., Linden, M., Lubar, J. F., Gruzelier, J., & LaVaque, T. J., 2005; Vernon, Frick, & Gruzelier, 2004), but positive effects of neurofeedback have also been found for children with migraine (Kropp et al., 2002) and learning disorders (Fernandez, T., Herrera, W., Harmony, T., Diaz-Comas, L., Santiago, E., & Sanchez, L., 2003; Thornton & Carmody, 2005). Several studies suggest that neurofeedback protocols that have been successful for treatment of ADHD may also be efficacious for treating children with autistic related deficits. Sichel, Fehmi, and Goldstein (1995) report on Frankie, an 8.5-year-old boy with a mild form of autism. Frankie's 19-channel QEEG demonstrated theta (4–8 Hz) to beta (13– 21 Hz) ratios of 3.59 (Cz), 3.40 (C3), 3.03 (C4), 3.98 (Pz), 4.07 (P3), 3.63 (P4), and 3.02 (Fz). After 31 neurofeedback sessions aimed at inhibiting theta (4–8 Hz) and rewarding low beta (12–15 Hz), his mother reported positive changes in all the diagnostic criteria defining autism in DSM-III-R.

According to above findings, patients with ASD have benefited from NFT but this study was aimed to assess the efficiency of arousal protocol (which is based on optimum range of the patient's brain wave which is different from one patient to another) in reduction of ASD symptoms.

2. Method

2.1. Case report

Patient X was a 6 year-old boy. He attended a preschool program while referred to Atieh Comprehensive Center of Psych & Nerves Disorders to be assessed about ASD. His word domain was poor. He could speak in form of words and short incomplete sentences. Central auditory processing skills (reaction time, auditory coding, auditory stimulation and short term memory) were abnormal according to speech therapist's assessment. Chief complaint was agitation in class and also at home, learning disability, not speaking well and poor performance while doing school homework.

2.2. Materials

Assessment

- Data were acquired using a stretchable electrode cap embedded with 19 sensors at scalp locations Fp1, Fp2, F7, F3, Fz, F4, F8, T3, C3, Cz, C4, T4,T5, P3, Pz, P4, T6, O1, and O2, according to the International 10/20 System (Jasper, 1958). A ground electrode was placed between Fp2 and F8 and two ear clips were used as reference electrodes (A1 and A2). Impedance was kept below 5 kV, with a maximum difference of 1 kV between electrodes. Data were collected for 3 min in an eyes open and an eyes closed condition. qEEG results reported hypoactivity of Theta and Alpha bands and hyperactivity of Beta3 (18-22 Hz) band in parietal region.
- Atieh Center Primary Assessment Questionnaire which was used as a formal MMSE report.

Treatment

- 50 sessions of neurofeedback training. The training incorporated video feedback to increase the 4-7Hz band (using arousal protocol) on T4-P4.
- 20 sessions of speech therapy specially to improve central auditory processing skills.

Method

- The treatment process started with 10 sessions of speech therapy (2 sessions a week). Speaking ability improved moderately. Then neurotherapy started. He was treated for 50 sessions of 45 minutes, 3 days a week. Electrodes were placed according to the 10– 20 International System on T4, P4, and 4-7Hz rewarded while 1-3 Hz and 8-32Hz inhibited. The other 10 sessions of speech therapy continued parallel with neurotherapy. Parent management principles were taught to his mother to modify abnormal (especially aggressive) behaviors.

3. Results

The post assessment demonstrated significant changes in the speaking ability and short term memory. According to speech therapist's report, the capacity of short term memory changes from 2 items to 6 items. Reaction time and auditory coding improved to normal level in comparison with peers.
Weekly reports from mother and teacher indicated a significant reduction in aggressive behaviours with other children and high improvement in school performance. There was also a significant change in social communication.
The result of qEEG showed normal activity for 4-7Hz band which was low before neurotherapy both in absolute and relative powers. It also indicated reduction in Beta 3 (18-22 Hz) band which made the patient calm and reduced the rate of aggressive behaviours.

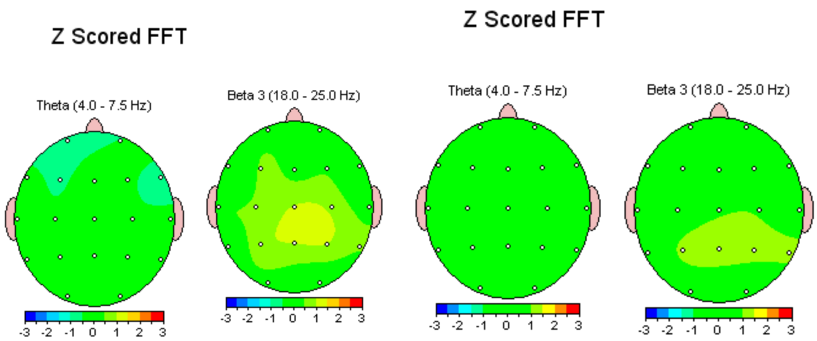

Figure1: Before neurotherapy After neurotherapy

4. Discussion

The aim of the present study was to examine the effect of neurofeedback training (NFT) and speech therapy on learning and speech ability in patients with a diagnosis of autism spectrum. According to the results, significant difference was found in brain wave power after neurotherapy in the studied case.

At a neurophysiological level, neurofeedback training successfully increased power of theta (4–7 Hz) and beta3 (15–18 Hz) bands in this case. At a cognitive level, neurofeedback training was hypothesized to improve the executive functions of children with ASD, (Butnik, 2005). Significant improvement in attention control, cognitive flexibility and goal setting were noted for this case according to mother's and teacher's report.

Results of the present study indicated that autistic subject was able to increase slow wave brain activity and that neurofeedback caused changes in qEEG and improvement in set-shifting, reciprocal social interactions, and communication skills.

Previous studies (Kouijzer, M. E. J., De Moor J, M. H., Gerrits, B., J., L., Buitelaar, J., K., & Van Schie, H. T., 2009a; 2009b, Kouijzer et. al, 2010) claim that increase theta band will help ASD children but in this study using arousal protocol and increasing theta band many signs and syndromes eliminate. It seems that we should pay attention to the qEEG pattern of each patient and base treatment protocol on it. Of course beta3 suppression and speech therapy had important roles in these achievements.

Randomized, controlled research should disentangle specific and unspecific effects of neurofeedback treatment. A case study can show benefits of a method but generalization is limited here. Intervention programs should control for unspecific effects that might affect the outcomes of the study by carefully designing adequate research designs. Parents' expectations of the treatment and the provision of time and attention to the treatment case or group could have influenced the data. Future research should disentangle these biases.

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