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19-Channel Neurofeedback in an Adolescent with FASD

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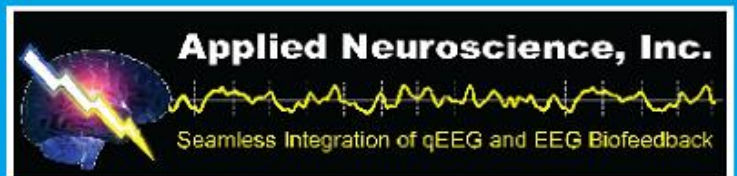
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19-CHANNEL NEUROFEEDBACK IN AN ADOLESCENT WITH FASD

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Fetal alcohol spectrum disorders (FASD), resulting from gestational exposure to ethanol alcohol, can result in a wide range of lifelong and severe challenging behaviors with a concomitant lowered quality of life. This article presents the results of neurofeedback treatment (80 sessions over 14 months) with an adolescent diagnosed with FASD and attention deficit hyperactivity disorder and who had a significantly low social adaptive quotient (<1 percentile) and marginally low intelligence (13th percentile). Significant neural dysregulation, as measured by quantitative electroencephalography, resolved almost entirely. This occurred with a parallel improvement of his challenging behaviors as subjectively reported by his family and one of his workers.

INTRODUCTION

In Canada, Fetal Alcohol Spectrum Disorder (FASD) tends to be an all-embracing term that includes neurological, behavioral, and environmental outcomes of individuals that is thought to be directly related to maternal consumption of ethanol alcohol during pregnancy. These outcomes include Fetal Alcohol Syndrome (FAS), partial FAS (p-FAS), and Alcohol-Related Neurodevelopmental Disorder (Pacey, 2010). Research has clearly shown that ethanol alcohol is a teratogen that can cause abnormal migration of cells during the first 8 to 10 weeks of fetal growth, cell death throughout the pregnancy, and general inhibition of central nervous system development.

The definition of FASD is stipulated as a developmental/neurological disorder that also includes growth deficits and, for some, a specific continuum of facial features as the result of gestational exposure to ethanol alcohol (Chudley et al., 2005). Among other problems, intellectual disabilities, mental illness, impulsivity, behavioral dysfunction, criminality, depression, low self-esteem, dysfunctional

social skills, and disrupted education have all been linked to gestational exposure to ethanol alcohol (Streissguth & Kanter, 1997). Neuropsychological deficits include, but are not limited to, lifelong cognitive and functional disabilities; attention and speed of information processing; and deficits to executive functioning, language, visual perception, learning and memory, and number processing. Behavioral dysfunctions, in comparison to age peers, include poorer academic performance, adaptive behavior, and emotional functioning (Kodituwakka, 2007). Of special interest and importance, there is no reported biomedical research that points to any ethanol-related teratogenic differences between racial groups. Dissimilarities in how FASD presents within different social and cultural groups is likely linked to the extent of the disorder in any particular individual, the effectiveness and ability to deliver preventive and interventional programs, unfavorable life experiences/outcomes, and the social and economic environment of mother and child. On the other hand, specific sociological population studies may be necessary to understand and better address how

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FASD affects the social/environmental structures of different racial groups/minorities. Intervention programs tend to focus on the secondary features just listed, as well as the development of individualized environments, and/or compensations. The impact of FASD has been shown in the literature to be a serious public health concern. In Canada, specific organizations, as well as federal and provincial governments, see FASD as a priority, and as a result a number of programs have been established to address the prevention of FASD and provide long-term treatment (Pacey, 2010). The outcomes associated with FASD in the general population have also been documented. Individuals with FASD may have substantial later-life difficulties manifested as alcohol or drug problems, trouble with the law, confinements, inappropriate sexual behaviors, and disrupted school experience (Streissguth et al., 2004). Even so, treatment has been relatively ineffective as can still be seen more than 40 years after the first researchers defined the syndrome in the high numbers of affected individuals in front of the courts, incarcerated, or who live marginalized lives. It is possible to identify many possible gaps that relate to treatment and intervention. What is clearly lacking is knowledge of *what can be done* to lessen the impact of this neurological disorder/dysfunction/damage on the individual's day-to-day life. It is the intent of this article to provide one possible interventive approach that is relatively quick; cost-effective; and, as the literature suggests, likely permanent.

Case Report

Both Dallas and his mother gave permission to use his first name as they felt it was important to let others read about his success. He was first seen by this author for a neuropsychological evaluation at the age of 8 years 6 months and for a second evaluation at the age of 12 years 11 months. His file indicated that his biological mother consumed alcohol during the pregnancy. He weighed 3,892 g at birth, and the gestation period was 40 weeks (both somewhat atypical for an infant with FASD). He was

placed in foster care at 5 months and lived in two foster homes before being adopted. At 6 years of age, Dallas was diagnosed with FASD as well as attention deficit hyperactivity disorder, at British Columbia's Children Hospital in Vancouver. Although there were significant delays, many of the developmental milestones were met at expected ages. Early reports of his challenging behaviors included hyperactivity, temper tantrums, poor attention span, sloppy table manners, poor memory, impulsivity, frequent interruptions, low frustration threshold, not listening when spoken to, unusual fears, argumentative, nightmares, unpredictable, self-critical, lack of confidence, easily upset, feeling unliked or unwanted, nervousness, demanding attention, loneliness, and acting like he was driven by a motor. At older ages, some of the behaviors often connected with FASD were also seen, such as stealing (see his mother's description of his behaviors next).

At the age of 13 years, Dallas had a Full Scale IQ at the 13 percentile (Stanford-Binet, Fifth Edition; Full Scale IQ = 79–87, Nonverbal Domain IQ = 85–97; Verbal Domain = 72–84) and a Social Adaptive quotient at less than the first percentile (Scales of Independent Behavior–Revised). This is, in this writer's experience, a common FASD profile. In fact, in British Columbia, the Crown Corporation providing supports to adults with Intellectual Developmental Disabilities (*DSM-IV-TR* category of at least 317), does not require a significantly low IQ for eligibility if the individual has a formal diagnosis of FASD or Pervasive Developmental Disorder but does require the social adaptive quotient to be 55 ± 5 or lower. Dallas's social quotient was in the range of 55 to 60.

METHOD

Dallas was evaluated prior to electroencephalographic (EEG) biofeedback with a quantitative EEG (QEEG) in the summer of 2010 and then again in the summer of 2011. Recording electrodes were placed according to the 19 standard regions defined by the International 10/20 System of electrode placement, referenced to linked ears. He was taking Biphentin,

Ritalin, Risperdal, and Fluoxetine in the summer of 2010. This medicine regime did not change during the time he received EEG biofeedback, although the Risperdal was increased by 0.25 mg per day in April 2011. All electrode impedances were offsets at or below 20 as determined internally by the BrainMaster Discovery program. Ten minutes of eyes-closed recording was gathered, and after deartifacting there was almost 3 min of data available for analysis with the NeuroGuide normative database (update 1.57). Split-half reliability was 0.98 and test-retest reliability was 0.98 for QEEG done in 2010, and split-half reliability was 0.98 and test-retest reliability was 0.97 for the data gathered in 2011. Live z-score neurofeedback treatment was done with the BrainMaster Discovery program utilizing 19 channels and the Mark Smith z-scores PercentZ0KUL training protocol. Reinforcement occurred for all possible categories (absolute power, relative power, power ratios, asymmetry, coherence, phase, as well as all frequency bands). Feedback involving all 19 channels and all possible categories was chosen due to both the large number of dysregulations shown in the QEEG (see Figure 1), as well as no clear definition of any region when the NeuroGuide Symptoms Checklist was used. Feedback utilized the BrainMaster Multimedia DVD program, pause/unpause setting, for 25 min of video per session. Videos were chosen by Dallas's family. The positive/negative z-score band was set at ± 0.8 standard deviations, and percentage reward was adjusted during feedback to be within the band of 80% to 90%. Due to the distance between his community and the author's clinic (a distance of more than 400 km), training consisted of four groups of 20 sessions at a frequency of twice a day, approximately 3 to 4 months apart.

RESULTS

As shown in Figure 1, other than amplitude asymmetry for High Beta, all areas (amplitude asymmetry, coherence, and phase lag) displayed significant dysregulation. A clear picture

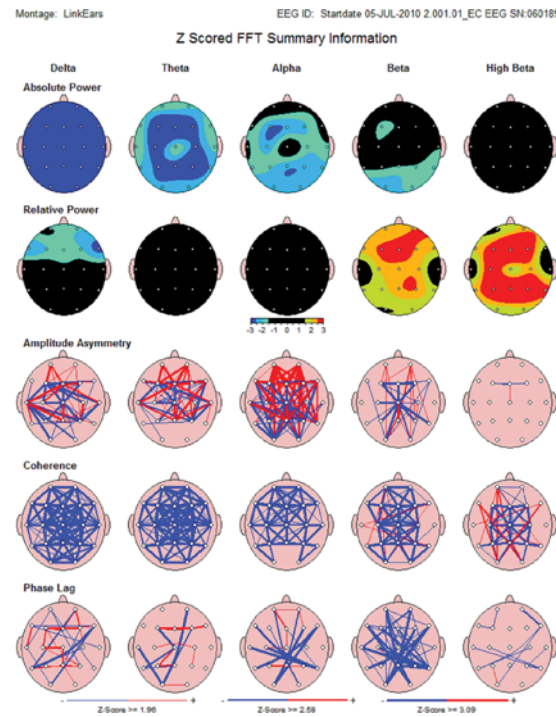


FIGURE 1. Pre-QEEG. (Color figure available online.)

of which regions were likely more affected than others was not apparent through analysis of the QEEG, or use of the NeuroGuide Symptoms Checklist, and thus all areas were trained.

Dallas's mother made the following observations after his first few days in school (fall of 2011) following 4 years of home schooling:

Good news. Dallas has settled down and his brain has caught up with his environment. I now have the old/new Dallas back [she was referring to Dallas's behaviors following EEG biofeedback] and it is wonderful.

From the time Dallas was a wee little boy 2 years old and up he has always been in movement. He is perpetual movement. He never stops. He was never calm. When I first got him [he was initially fostered by this family before they adopted him] I would run downstairs, grab my meat for supper from the freezer, run upstairs and hope he hadn't destroyed anything. He was 2 years old. I have tried various techniques to help calm him down. Nothing has worked as good as EEG biofeedback. These were some of the behaviors that Dallas had prior to biofeedback:

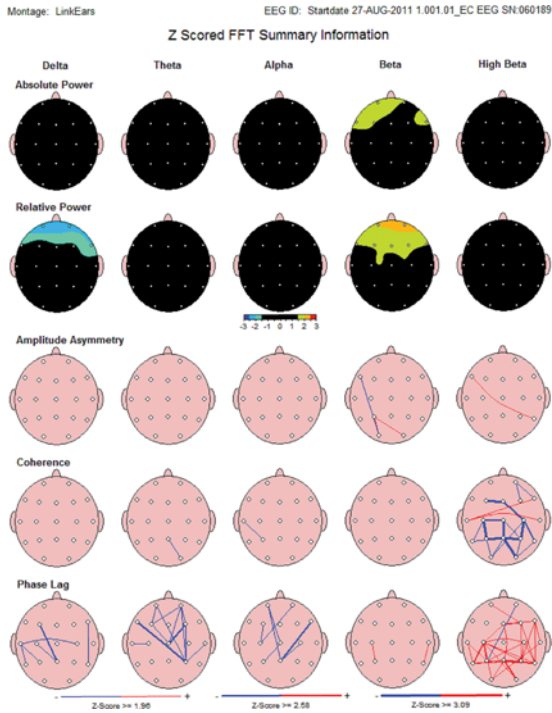


FIGURE 2. Post-QEEG. (Color figure available online.)

1. Always in motion
2. Argumentative
3. Poor memory
4. High anxiety
5. Interrupted a lot
6. Did not engage other adults
7. Always wanted to be on the go
8. Stealing

Following the 80 sessions of EEG biofeedback, the QEEG almost cleared (see Figure 2). There was still some high beta coherence dysregulation, mostly in posterior regions, as well as phase lag dysregulation in the posterior regions for high beta, and more in the anterior regions for delta, theta, and alpha. Dallas’s mother went on to state:

After biofeedback the most obvious thing I notice about Dallas is that he is calmer, as well as:

1. He has picked up pamphlets off the table and read them; something that he has never done before.

2. He accepts the answer “no” without argument and if he does not want to, it is not argumentative; it is negotiation.
3. He is able to remember things better; for example, if I ask him to do a task he can now wait a few minutes and remember to do that task.
4. His anxiety is much lower.
5. Dallas does not interrupt as often as he used to and when he does he does it in a more appropriate manner.
6. Dallas will initiate a conversation with adults that are not family, but that he is familiar with.
7. Dallas is able to sit and play his video games, watch television and have a conversation.
8. Before EEG Dallas had a problem with stealing and stole on a semi-regular basis. We have not had many issues since EEG and the ones we have had he has returned the items without being prompted to. We have set temptations out for him and he has never taken them.

Dallas is respecting social boundaries. For example, not entering others bedrooms without knocking or not taking others things without asking. He has a better sense of justice. Dallas’s communication skills are better. When he is telling a story it is easier to follow the chronological events.

Dallas has been attending the ARK Youth Centre in town for several years now. This is the observation of one of the workers:

I noticed Friday night at The Ark that Dallas seemed much calmer. I only had to make one request that he wear his helmet and he did. He came over and chatted with us, which has never happened. Normally we have to make several attempts at calming him down, last Friday I didn’t have to make any.

Dallas has been unable to follow a morning routine even when it is written out; he always forgets or leaves out something. Since EEG, Dallas does his morning routine without any prompting. I don’t believe he even uses his

written prompt sheet. Dallas now consistently takes his medication without being reminded. I have added to Dallas's responsibility and he is stepping up to the challenge.

CONCLUSIONS

The improvements in Dallas's behaviors have been astounding in comparison with the improvements of hundreds of similar children this author has assessed over the past 30 years who have been exposed to other forms of intervention (medical and behavioral). Based on this one case, EEG biofeedback would appear to have great potential to not only improve the quality of life of these children but also decrease some of the costs associated with FASD. Having said that, it is important to view these changes with a jaundiced eye, particularly as the following issues may guide future research and clinical choices:

1. Because early ethanol consumption in pregnancy (the first 8 weeks) have been reported to interfere with neural migration (e.g., de la Monte et al., 2009), in children so affected (including Dallas) and thus resulting in brains that are *wired differently than the average age-peer*, can we directly compare his QEEG with those in databases of individuals with *normal* brains?
2. Because there is some research that suggests that in certain syndromes, such as FASD (e.g., Streissguth, 1992) or Down Syndrome (e.g., Fishler & Koch, 1991), there is a delay in maturation rates, how much of the changes in Dallas's profile are due to the 14 months of development between QEEGs?
3. Although the behavioral changes have been positive for Dallas's family and for him, his mother does note that "Dallas has many challenges still. This [EEG biofeedback] did not cure him, but it has made his life better. He is more successful. We still have to watch his anxiety, but he can do more. His ADHD is still a problem and it may always be."
4. Finally, the results with Dallas took 80 sessions. This represents a substantial cost

to families that may already be tapped financially. Techniques to reduce the number of sessions required may help, however, when dealing with individuals who have multiple challenging behaviors, we need to know when enough is enough.

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