Post WISC-R and TOVA Improvement with QEEG Guided Neurofeedback Training in Mentally Retarded: A Clinical Case Series of Behavioral Problems

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Key Words

Biofeedback
Electroencephalography
Mental Retardation
Neurofeedback
Quantitative EEG

ABSTRACT

According to the DSM-IV, Mental Retardation is significantly sub-average general intellectual functioning accompanied by significant limitations in adaptive functioning in at least two of the following skill areas: communication, self-care, home living, social/interpersonal skills, use of community resources, self-direction, functional academic skills, work, leisure, health and safety. In pilot work, we have seen positive clinical effects of Neurofeedback (NF) applied to children with Trisomy 21 (Down Syndrome) and other forms of mental retardation. Given that many clinicians use NF in Attention Deficit Hyperactivity Disorder and Generalized Learning Disability cases, we studied the outcomes of a clinical case series using Quantitative EEG (QEEG) guided NF in the treatment of mental retardation.

All 23 subjects received NF training. The QEEG data for most subjects had increased theta, alpha, and coherence abnormalities. A few showed increased delta over the cortex. Some of the subjects were very poor in reading and some had illegible handwriting, and most subjects had academic failures, impulsive behavior, and very poor attention, concentration, memory problems, and social skills. This case series shows the impact of QEEG-guided NF training on these clients' clinical outcomes. Fourteen out of 23 subjects formerly took medications without any improvement.

Twenty-three subjects ranging from 7-16 years old attending private learning centers were previously diagnosed with mental retardation (severity of degree: from moderate to mild) at various university hospitals. Evaluation measures included QEEG analysis, WISC-R (Wechsler Intelligence Scale for Children-Revised) IQ test, TOVA (Test of Variables of Attention) test, and DPC-P (Developmental Behaviour Checklist) were filled out by the parents. NF trainings were performed by Lexicor Biolex software. NX-Link was the commercial software reference database used to target the treatment protocols, along with the clinical judgment of the first author. QEEG signals were sampled at 128 samples per second per channel and electrodes were placed according to the International 10-20 system. Between 80 and 160 NF training sessions were completed, depending on the case. None of the subjects received any special education during NF treatment. Two subjects with the etiology of epilepsy were taking medication, and the other 21 subjects were medication-free at the baseline.

Twenty-two out of 23 patients who received NF training showed clinical improvement according to the DPC-P with QEEG reports. Nineteen out of 23 patients showed significant improvement on the WISC-R, and the TOVA. For the WISC-R test, 2 showed decline on total IQ due to the decline on some of the subtests, 2 showed no improvement on total IQ although improvement was seen on some of the subtests, however even these cases showed improvement on QEEG and DPC-P. This study provides the first evidence for positive effects of NF treatment in mental retardation. The results of this study encourage further research.

INTRODUCTION

According to the DSM-IV (2004), the essential feature of Mental Retardation is significantly sub-average general intellectual functioning: an IQ of approximately 70 or below on an individually administered IQ test that is accompanied by significant limitations in adaptive functioning in at least two of the following skill areas: 1: Communication, 2: Self-care, 3: Home living, 4: Social /Interpersonal skills, 5: Use of community resources, 6: Self-direction, 7: Functional academic skills, 8: Work, 9: Leisure, 10: Health and safety.

Common problems are: attention and concentration, learning, speech and language, behavioral, health, sociability, and fine and gross motor problems.

QEEG has been found to be a valuable assessment tool in psychiatry. A report by the Committee on Research of the American Neuropsychiatric Association[1] concluded that QEEG offers the clinician an accurate laboratory test to aid in the detection and differential diagnosis of several common neuropsychiatric disorders such as both Generalized Learning Disability (GLD) and Attention Deficit Hyperactivity Disorder (ADD/ADHD).[2-9]

Behavior problems often coexist with developmental disorders. Psychostimulants remain the mainstay of pharmacologic treatment for ADHD. However, they may not be tolerated by some children, may be ineffective in some, and in yet others may exacerbate comorbid medical conditions such as seizures and tics. Most of the conventional antipsychotics used do not combat persistent irritability, extreme agression, and other maladaptive behaviors, which often coexist in children with mental retardation. Risperidone has been noted to be useful for insomnia in pervasive developmental disorder[10] and for behavioral problems in developmentally disabled children.[11-14] Adverse events were reported for antipsychotic drug studies in mental

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Received: June 15, 2009; accepted: November 13, 2009.

retardation such as somnolence, headache, weight gain, sedation, peak prolactin levels,[15,16] dyspepsia and extrapyramidal side effects.[12,16]

NF is an operant conditioning method for training brain wave (EEG) patterns. An increasing number of clinicians use operant conditioning of EEG activity as a method of helping children with ADHD/ADD and/or GLD.[17-24] A meta-analysis of the outcome literature on NF treatment of ADD/ADHD[24] found this method of treatment meets empirical research guidelines to be classified as an efficacious and specific treatment for ADD/ADHD.

The published studies on ADD/ADHD and learning disability which have evaluated IQ changes pre- and post-treatment have found that IQ scores increase following NF training. These improvements ranged from an average of 9 IQ points improvement in one study,[25] to an average 12 IQ point improvement in a study,[20] a mean improvement of 19 IQ points in another study,[26] and even as high an average increase as 23 IQ points.[27] Only a few studies have addressed the issue whether improvements are sustained. Tansey (1990)[26] discussed the academic and behavioral changes achieved by his participants and included an anecdotal report suggesting continued progress. Tansey (1993)[28] did report a 10-year follow-up with one participant though there was no specific data regarding intelligence test scores. Lubar (1995)[29] published follow-up data on 51 participants for up to 10 years after treatment. An independent professional evaluator, blind to the treatment, collected behavioral rating scale data via telephone interviews and found significant improvements in all areas. However, like the Tansey reports, there were no data regarding IQ scores.

Reports of improved IQ scores for children with various attention, neurological and learning disorders are especially remarkable, given that IQ scores are generally very stable and not particularly malleable[30] Cheng, Liu, and Gong(1993)[31] reported that across a 1.5 to 2 year interval, both learning disabled and normal children displayed stable Verbal, Performance and Full Scale IQ scores on a Chinese version of the WISC-R. In 1991 Streissguth, Randels, and Smith[32] reported that IQ scores of patients with fetal alcohol syndrome or possible fetal alcohol effects remained stable over the average test / retest interval of 8 years. Both Haddad, Juliano, and Vaughan (1994)[33] and Kaye and Baron (1987)[34] reported that with learning disabled children WISC-R Verbal IQ scores tended to decrease while Performance IQ scores increased over a 3-year period.

Finally, Spitz (1986)[35] reviewed the history of attempts to raise IQ in developmentally delayed and/or culturally disadvantaged children. Efforts included early intervention and compensatory education programs such as Head Start, behavior modification, medical and dietary interventions, and various sensory and motor therapies. Spitz concluded that none has shown any significant effect in raising intelligence scores.

Some children with mental retardation display symptoms of ADHD/ADD, GLD or both. Prior to this study we have seen important and valuable effects of NF in the study of children with mental retardation[36-38] and some children with Down Syndrome have some common problems with mentally retarded children as mentioned above. EEG NF treatment of patients with Down Syndrome (case series) showed promising results.[39-41] Some children with mental retardation have epilepsy. Epilepsy and its treatment with EEG feedback therapy has a literature which is well established.[42-45] We believed that NF may have potential in helping children with mental retardation. Our aim is to show the effectiveness of QEEG guided NF in the treatment of mental retardation.

BACKGROUND AND METHODOLOGY

Traditional methods for assisting mentally retarded children such as neurocognitive rehabilitation, special education, behavior training, and medication are expensive, time consuming, and of questionable long-term effectiveness with this population. The purpose of this preliminary study was to evaluate whether QEEG-guided NF training would be effective in improving attention, concentration, learning skills, decreasing behavioral problems, and impulsivity and improving speech and sociability. We studied 23 subjects, ranging in age from 7-16 years old whose total IQ score was below average, who were previously diagnosed as mentally retarded (severity of degree, from moderate to mild) at various university hospitals and were attending private learning centers. Two subjects were taking medication with the etiology of epilepsy and the other 21 subjects were medication-free at the baseline. Seven subjects were not put on medications before coming to us and 16 out of 23 subjects had a history of taking from 1-4 medications from 1 to 7 years without any improvement. The others had unknown etiology. One subject had taken Risperidone but developed homicidal thoughts and another had taken methylphenidate prior to NF treatment but had developed tics.

Inclusion criteria

Subjects with DSM IV axis II diagnosis of mild or moderate mental retardation with an IQ of 40-68 were accepted for treatment with the informed consent of their family. They were all previously diagnosed as mentally retarded before coming to the center. All the patients had at least received one treatment modality which did not work. None of the patients received medication other than antiepileptics, and none of the patients received special education. The patients did not have a history of physical illness.

Exclusion criteria

Subjects with the presence of any other developmental disorder, childhood disintegrative disorder, any neurological disorder other than epilepsy, any perceptual disturbance in hearing or vision were excluded. Patients who were on medication (except for epilepsy) were excluded.

Evaluation measures included clinical observations, DBC-P,[46,47] family history, blood tests (hemogram, B12, B6, folic acid, TSH), QEEG data which was processed with the Nx-Link database,[5] and a Test of Variables of Attention (TOVA) was taken at baseline and following treatment. WISC-R (Wechsler Intelligence Scale for Children-Revised) tests were given at baseline and on 6 months follow-up after the completion of the treatment by WISC-R certified psychologists who were blinded to NF treatment status. All WISC-R results were below the normal range. Two of the subjects could not take the verbal comprehension and the performance part and one of them could not take the verbal part prior to the training. According to TOVA most children had attention, impulsiveness, response time and response time variability problems. All the subjects and their parents were recorded by a webcam at baseline and every 20 sessions.

Most children with mental retardation have problems with their emotions and behavior. DBC-P checklist is beneficial to learn more about the problems and how they might respond to treatment with the help of the parents by completing the checklist. The DBC-P checklist consists of 96 questions that are rated from 0 (not true as far as you know) to 2 (very true or often true). However, 41 of the questions were deemed not applicable to our population and therefore were not statistically analyzed. The evaluation of this study was done on the subjects who corresponded to questions; for example, 4th question (N=5), and 83th question (N=16).

Lexicor EEG signals were sampled at 128 samples per second per channel. Samples were analyzed with a normative neurometric approach using Nx-Link database software both pre- and post-treatment, and every 40 sessions, to show the divergent electrical activity of the brain according to Z-scores and to guide the NF treatment protocols. All the NF training was performed using Lexicor Biolex software. Each session was 30 minutes duration, with 1-2 sessions per day. Sessions were judged as completed based on behavioral changes alone, and the mean number of sessions completed by the subjects is 120 sessions within 90 days to 180 days. Special education was not provided, either by our team or outside, though it should be noted that all subjects had taken special education classes previously with "little or no" improvement over the years. Good parenting skills were emphasized. Proper diet (low carbohydrate, high protein) was recommended though not required.

When we observe the baseline QEEG of this population we primarily see excessive theta and/or alpha with a generalized distribution, especially in relative power. Almost all subjects had coherence abnormalities. A few subjects showed increased delta over the cortex. Electrode sites for training were selected based on the QEEG (Nx-Link) analysis.

The frontal and frontotemporal electrode sites below were selected according to the subjects' QEEG. Those sites were helpful mostly for the behavioral problems such as impatience, aggressivity and also speech and language problems: Fp1-Fp2, F3-F4 inhibiting alpha and theta bipolar montage training; Fp2-F4, F8-T4 inhibiting alpha and theta bipolar montage training; F7-T5 inhibiting alpha and theta bipolar montage training. The following site was helpful for the fear and anxiety problems. FPO stands for Frontal Pole Orbital (pre-frontal) and "2" signifies the right side of the brain. This site is off the standard 10-20 system, at the juncture of the right brow bone and the top of the nose, in the inner corner of the eye socket[48]: FPO2 rewarding alpha, inhibiting theta bipolar montage. Parietotemporal electrode sites were selected for the learning problems: P3-T5 inhibiting alpha and theta bipolar montage; P4-T6 inhibiting alpha and theta bipolar montage.Temporal sites were selected for the wetting and soiling problems: T4-T6 inhibiting alpha and theta bipolar montage; T3-T4 inhibiting theta and alpha bipolar montage. Sensory area was selected for attention and hyperactivity, impulsivity: Cz-C4 rewarding SMR inhibiting theta bipolar montage.[49] Occipital area was selected based on the qEEG analysis: 01-02 inhibiting alpha and theta bipolar montage.

Coherence training was according to z scores. The criteria to shift from one site to another is the z score values or based on the first author's clinical experiences.

RESULTS

Generally the children needed between 20-40 sessions of NF before changes started to become obvious. Twenty-two out of 23 patients who received NF training showed clinical improvement according to the DBC-P and QEEG reports with reducing abnormal z scores; 21 patients showed significant improvement based on WISC-R and some TOVA results. Among 21 patients, 2 were not able to take both Verbal and Performance parts of the test before the treatment, and one could not take the Verbal part. Following NF treatment all subjects succeeded in taking the entire test. Two of the subjects showed decline on WISC-R.

All children showed behavioral improvement, with a reduction of impulsivity, as well as reduction of aggression, and an apparent clinical improvement in sociability observed in the clinical interview. Academic skills were improved from the baseline. Five children stopped wetting their pants, 2 stopped soiling their pants, and 3 children had no more constipation problems. Five children stopped asking the same questions over and over in an obsessive manner. Three subjects stopped stuttering, 8 stopped lying chronically. Five children showed substantial improvement in fine and gross movement problems, and 5 children stopped biting their fingernails. Eleven children got along well with their siblings. Seizure frequency, severity and duration was reduced for 1 of the children with epilepsy.

QEEG guided NF protocols may reduce seizures and reduce the amount of dose required to control them. We had 2 children with the etiology of epilepsy. Information below shows the baseline, the progress during the entire treatment and after the treatment.

1st Child with seizure

A 12-year-old female patient developed seizures 3 years before our study. They started with an aura (abdominal pain, right hand numbness) followed by screaming during the seizure with tonic-clonic movements throughout the body. During attacks her eyes deviated to either side, and at the end she lost consciousness. She was on Depakote 400 mg BID in the past. Before starting NF treatment she was on Tegretol CR 200 mg BID, during the NF treatment her medication dose was increased to 400 mg BID and was kept on the same dose after the treatment. Before NF treatment her seizures were 8-10 times a day, 240-300 times a month with 5-10 minutes duration. During the NF treatment the epileptic aura disappeared, loss of consciousness occasionally occurred during spells. No seizure activity was seen for 20 days in the first month of NF treatment, 6 spells in the 2nd month, no spells in the 3rd month, 12 in the 4th month, no spells in the 5th month, 2 in the 6th month, with 1-2 minutes duration. After the NF treatment no attacks were seen during the following three months, 2 spells in the 4th month, and after that 3-6 attacks were seen every month up to 2 years, with 1-2 minutes duration.

2nd Child with seizure

A 13-year-old male patient had a history of grand mal seizures for 12 years since the age of 8 months. Before coming to our study no seizure activity was seen for the last 2 years. He was taking Convulex with 150mg in the morning and 300mg in the evening. Sixty NF sessions later the dose of the Convulex was reduced to 150 mg BID. Baseline sleep EEG showed 21 spikes and slow wave activity in 1h 10 mins recording. After the NF treatment sleep EEG showed 6 spikes and slow wave activity in 1h 10 mins recording.

Before the treatment their mean age was 12.17 years, on 6 month follow-up after the completion of NF treatment the second WISC-R was administered. At that time their mean age was 13.17. Standard deviation is 3.024 and the ages ranging from 7-16. The actual mean verbal IQ scores was 49.6 pre-treatment and 53.05 post-treatment; Performance IQ scores was 55.45 pre-treatment and 63.20 post-treatment ; Full scale mean was 49.0476 pre-treatment and 54.6667 post-treatment. The mean and standard deviation of the number of sessions were M=134.78 and SD= 7.874. The range of the sessions were from 80-200.

WISC-R results are summarized in Table 1/1a. T test and nonparametric Wilcoxon test were used in analyzing WISC-R data . The results were significantly improved following training for verbal IQ ($p<.0295$), for performance IQ ($p<.0007$) and for the total IQ scores ($p<.0003$) and the significant p values for the subtests in Table 1a.

Visual TOVA results are summarized in Figure 1, Table 2. Nonparametric Wilcoxon test was used to evaluate the results. There were significant TOVA improvements for omission, commission errors and response time variability. Improvement in response time was not significant. Auditory TOVA results are summarized in Figure 2, Table 3. Nonparametric Wilcoxon test was used to evaluate the results. There were significant improvements for omission, commission errors and response time variability. Improvement in response time was not significant.

Table 1

WISC-R results

Paired samples statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Verbpre	49.6000	20	7.19210	1.60820
	Verbpost	53.0500	20	8.74477	1.95539
Pair 2	Perfpre	55.4500	20	7.69467	1.72058
	Perfpost	63.2000	20	9.03560	2.02042
Pair 3	Totalpre	49.0476	21	6.20061	1.35308
	Totalpost	54.6667	21	7.22726	1.57712

Paired samples test

		Mean	Std. Deviation	Std. Error Mean	t	P
Pair 1	WVPRE–WVPOST	3.45000	6.76271	1.51219	2.281	.034
Pair 2	WPPRE–WPPOST	7.75000	6.95758	1.55576	4.981	.000
Pair 3	WTPRE–WTPOST	5.61905	4.43256	.96726	5.809	.000

Test statistics[b]

	Z	P
WVPRE – WVPOST	2.176[a]	0.0295
WPPRE – WPPOST	3.387[a]	0.0007
WTPRE – WTPOST	3.658[a]	0.0003

a. Based on negative ranks

b. Wilcoxon Signed Ranks test

Table 1a

Sub test results

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	INFORMATION_PRE	1.3478	23	1.11227	.23193
	INFORMATION_POST	2.0000	23	1.50756	.31435
Pair 2	SIMILARITIES_PRE	1.8696	23	2.20133	.45901
	SIMILARITIES_POST	4.5217	23	3.16040	.65899
Pair 3	ARITHMETICS_PRE	2.0870	23	1.88084	.39218
	ARITHMETICS_POST	3.1304	23	2.52810	.52715
Pair 4	VOCABULARY_PRE	1.8261	23	1.07247	.22363
	VOCABULARY_POST	2.4783	23	1.67521	.34931
Pair 5	COMPREHENSION_PRE	1.7826	23	1.50625	.31407
	COMPREHENSION_POST	2.9130	23	2.31425	.48255
Pair 6	DIGIT SPAN_PRE	3.7391	23	3.23640	.67484
	DIGIT SPAN_POST	4.9130	23	3.34274	.69701
Pair 7	PICTCOMP_PRE	2.8261	23	2.69093	.56110
	PICTCOMP_POST	5.1304	23	2.97420	.62016
Pair 8	PICTARRANG_PRE	2.2174	23	2.46718	.51444
	PICTARRANG_POST	3.6957	23	2.80316	.58450
Pair 9	BLOCKDESIGN_PRE	3.5217	23	2.40963	.50244
	BLOCKDESIGN_POST	5.3043	23	2.36326	.49277
Pair 10	OBJECTASSESS_PRE	3.3913	23	1.97114	.41101
	OBJECTASSESS_POST	5.0435	23	2.20492	.45976
Pair 11	CODING_PRE	2.7391	23	2.07183	.43201
	CODING_POST	4.7826	23	2.71287	.56567

Wilcoxon Signed Ranks Test – Test Statistics[b]

	Z	P
INFORMATION_PR – INFORMATION_POST	2.719[a]	.007
SIMILARITIES_PR – SIMILARITIES_POST	3.947[a]	.000
ARITHMETIC_PR – ARITHMETIC_POST	2.867[a]	.004
VOCABULARY_PR – VOCABULARY_POST	2.683[a]	.007
COMPREHEN_PR – COMPREHEN_POST	3.267[a]	.001
DIGITSPAN_PR – DIGITSPAN_POST	3.529[a]	.000
PICTURECOMP_PR – PICTCOMP_POST	3.797[a]	.000
PICT ARRANG_PR – PICT ARRANG_POST	3.304[a]	.001
BLOCK DESIGN_PR – BLOCK DES_POST	3.126[a]	.002
OBJECT ASSE_PR – OBJECT ASSE_POST	3.562[a]	.000
CODING_PR – CODING_POST	3.845[a]	.000

a. Based on negative ranks; b. Wilcoxon Signed Ranks test

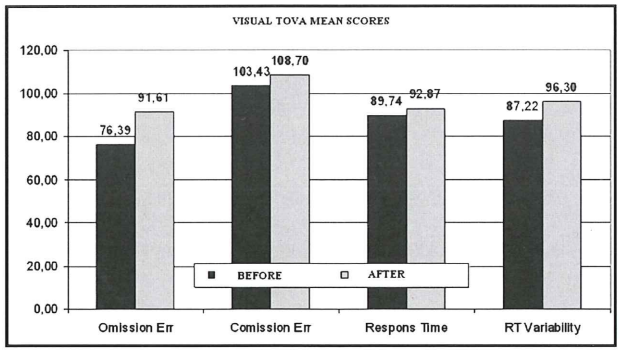

Figure 1.

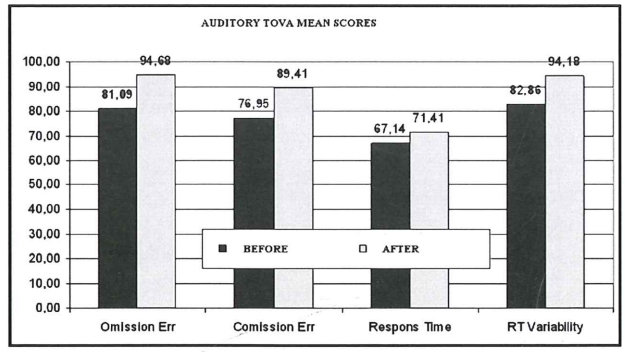

Figure 2.

Table 2
Visual TOVA results

n=23	VISUAL TOVA BEFORE MEAN	SD	AFTER MEAN	SD	p	
Omission Err	76.39	23.92	91.61	19.77	0.014	**
Commission Err	103.43	13.21	108.70	8.19	0.025	*
Response Time	89.74	19.38	92.87	19.95	0.164	NS
RT Variability	87.22	16.93	96.30	15.55	0.024	*

*p<0.05, **p<0.01, NS: not significant

Table 3
Auditory TOVA results

n=23	AUDITORY TOVA BEFORE MEAN	SD	AFTER MEAN	SD	P	
Omission Err	81.09	24.81	94.68	14.82	0.012	**
Commission Err	76.95	22.83	89.41	18.77	0.015	*
Response Time	67.14	20.79	71.41	19.97	0.074	NS
RT Variability	82.86	20.17	94.18	17.16	0.008	**

*p<0.05, **p<0.01, NS: not significant

Following is a summary of questions with significant DBC-P results where the Nonparametric Wilcoxon test was used to evaluate changes. See Table 4 for details about individual patients, initial complaints, medications and IQ.

Below significant changes on DBC-P questions will be presented.

4th question: Swears at others

Before the NF treatment 66.7% of the 15 applicable cases frequently swore at others. After NF treatment their parents reported that they no longer did this. Before the treatment 33.3% of the subjects occasionally swore at others, and after the treatment as reported by the parents this no longer occurred.

9th question: Cannot attend to one activity for any length of time, poor attention span

Before the treatment 100% of the 23 cases could not attend to one activity for any length of time. After the treatment 95.7% of the cases could attend to one activity for any length of time as reported by the parents; 1 out of 23 cases had no change at all.

19th question: Easily distracted from his/her task, e.g., by noises

Before the treatment 100% of the 23 cases were easily distracted from his/her task. After the NF treatment 43.3% of the cases were not distracted from the task as reported by the parents; 52.2% of the cases were distracted to some degree; only 1 out of 23 had no change at all as reported by his parents.

31st question: Has temper tantrums

Before the treatment 95.7% of the 23 cases frequently had temper tantrums as reported by the parents. After the NF treatment, according to family reports, 22 out of 23 no longer had temper tantrums. Before the treatment 1 case (4.3%) had occasional temper tantrums, and after the treatment he remained the same.

35th question: Impatient

Before the treatment 100% of the 23 cases were very impatient, and after the treatment 95.7% of the cases were mostly patient as reported by the parents; 1 out of 23 cases had no change.

37th question: Impulsive, acts before thinking

Before the NF treatment 100% of the 23 cases were almost always impulsive. After treatment 78.3% of the cases were no longer impulsive as reported by the parents; 17.4% of the cases occasionally became impulsive as reported by the parents; 1 out of 23 cases had no change.

67th question: Sleeps too little, disrupted sleep

Before the NF treatment 13% of the cases frequently had disrupted sleep, 82.6% only occasionally, and 1 case had no disrupted sleep. After NF treatment 22 cases no longer had disrupted sleep.

83rd question: Tells lies

Before the NF treatment 81.3% of 23 cases almost always told lies, 18.8% lied only occasionally. After the treatment 95.7% of the cases as reported by the parents no longer told lies, and 1 case did not stop lying.

CASE REPORTS

Four case examples will be provided that illustrate some of the most significant improvements that were seen from NF.

Case 1

A 7-year-old boy with mental retardation could not express himself appropriately. His problems included obsessions, lack of sociability, aggressiveness, fighting with friends, disobeying rules, stubborness, lack of self-confidence, not knowing how to tell time, fine and gross motor coordination problems and an orientation problem such as not knowing the date, place, surroundings. Following NF training this boy began to express himself, his obsessions disappeared, he began to play with the peers, aggressiveness disappeared, started obeying rules, stubbornness disappeared. He was self-confident, knew how to tell time, date, place, and had substantial improvement in fine and gross motor coordination problems. Figure 3 displays the pre- and post-treatment changes in the QEEG of this mentally retarded child. Baseline QEEG showed excessive generalized theta in relative power, with excessive theta at the frontal-central in absolute power. Following NF treatment (120 sessions) QEEG showed significant decrease of both absolute and relative theta, and normalization of theta hypercoherence.

Table 4

Shows the medication history of the children with mental retardation treated with NF

Patient	Age	Sex	Initial Complaints	Drugs Used Previously	Duration	Outcome	Drugs used with NF	IQ
1	16	F	Aggression, hyperactive demanding, poor attention, nail biting, learning problems	Hydroxyzine	8 months	Drug discontinued	No	52
2	14	M	Inattention, poor reading writing ability, cursing, malicious thoughts, deceitful, disobeyer	Risperidone, Imipramine, Haldol gutten, Methylphenidate	5 years	Drugs discontinued	No	68
3	9	M	Poor attention, poor reading irritable, learning problems	Risperidone Methylphenidate	2 years	Drugs discontinued	No	51
4	12	F	Learning problems, inattention, aggressive, nail biting, slow reader illegible writing, cannot express self	Pirasetam	1 year	Drugs discontinued	No	55
5	12	F	Epilepsy, learning problems, aggression, poor attention	Depakote	6 years	Continue	Tegretol CR	43
6	13	M	Learning problems, disobeyer, aggression, conduct problems, poor self-confidence	Methylphenidate Imipramine	3 years	Drugs discontinued	No	50
7	10	M	Irritation, impulsivity, poor sleep, learning problems, inattention	Methylphenidate, Essitalopram, Risperidone	3 years	Drugs discontinued	No	66
8	16	F	Aggression, cursing, cut herself, learning problems, nail biting, deceitful, conduct problems	Methylphenidate	2 years	Drugs discontinued	No	59
9	16	M	Social incongruity, truancy, deceitful, inattention, aggression idee fixe, self destruction	Fluoxetine, Olenzapine, Hydroxyzine	2 years	Drugs discontinued	No	68
10	15	F	Learning problems, edgy, annoyed, inattention, obsessions, ask the same questions continuously	Methylphenidate	3 years	Drugs discontinued	No	47
11	13	M	Epilepsy, learning problems, deceitful, inattention, constipation, cursing, encopresis, nail biting	Convulex	7 years	Convulex		40
12	13	M	Learning problems, aggression, inattention, disruptive behavior	Methylphinate, Risperidone	3 years	Drugs discontinued	No	64
13	13	F	Anxious, cursing, edgy, obsessions, ask the same questions over and over	Valerian root Imipramine	2 years	Drugs discontinued	No	59
14	13	M	Noncompliance, disobeyer, cursing, deceitful, aggression, learning problems	Sitalopram Risperidone, Methylphenidate Ketiapin	4 years	Drugs discontinued	No	64
15	9	M	Learning problems, disobeyer, stubborn, cursing, poor sleep, poor appetite, gross motor weakness, inattention	Methylphenidate Risperidone Pirasetam	2 years	Drugs discontinued	No	55
16	8	F	Deceitful, inattention, incontinance, learning problems, hitting self/hair pulling when pissed off	Melleretes gutte	1 year	Drugs discontinued	No	56

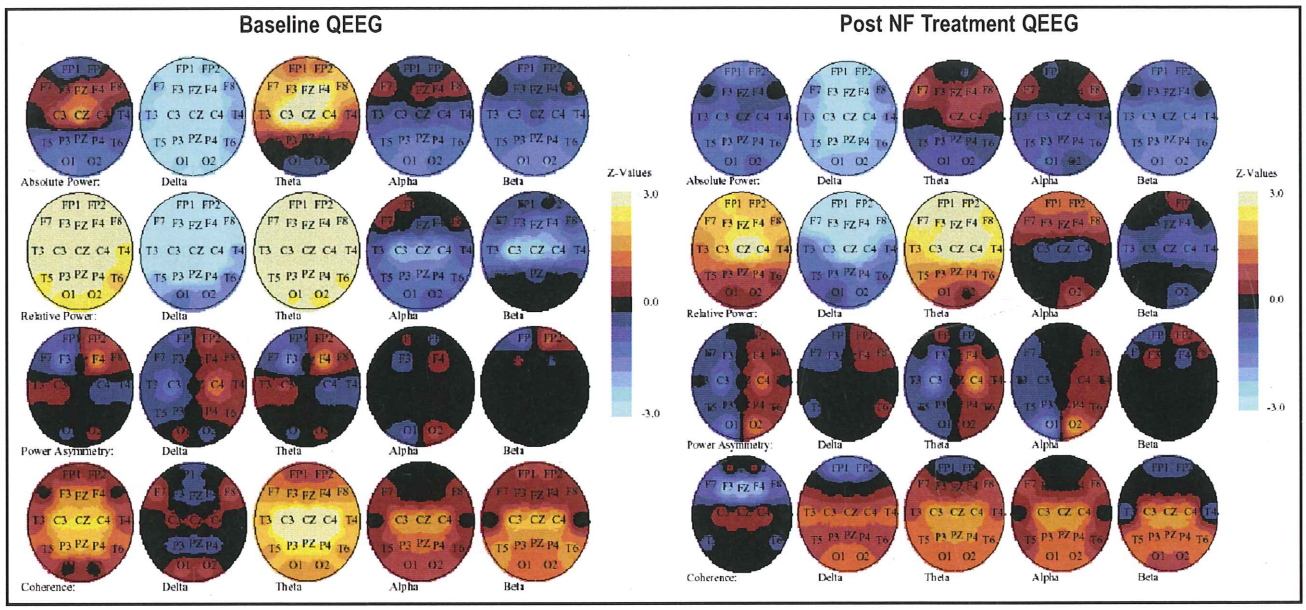

Figure 3.
Z-values of EEG features referenced to norms.

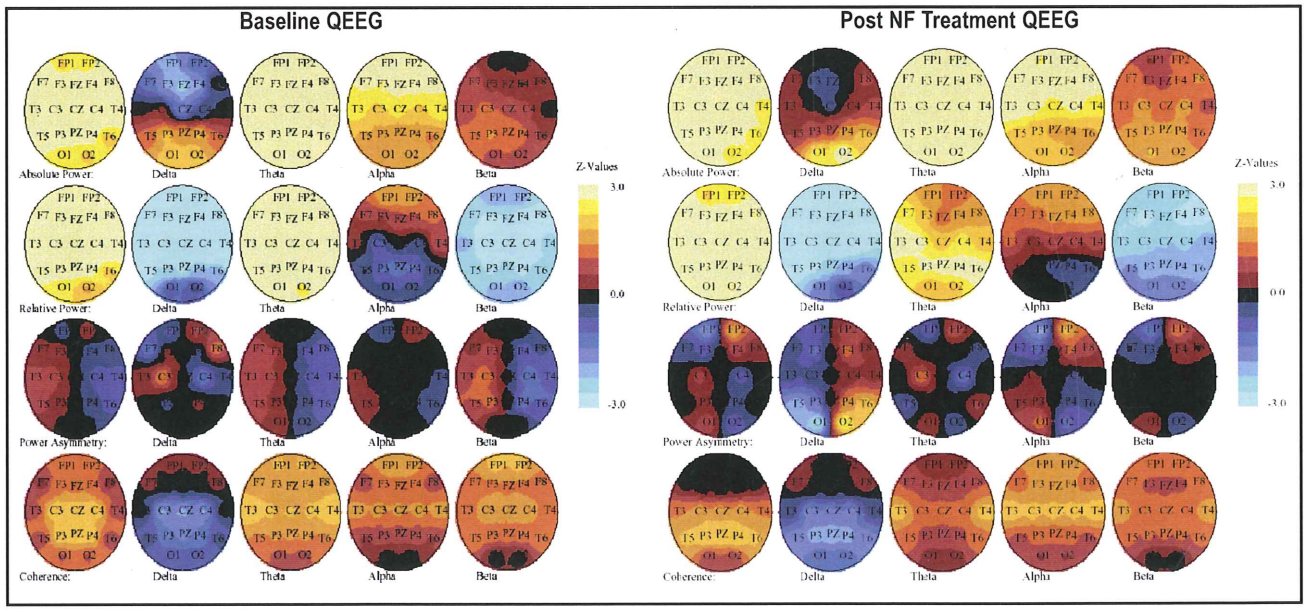

Figure 4.
Z-values of EEG features referenced to norms.

Case 2

A 15-year-old girl with mental retardation could not express herself appropriately. Her problems included asking the same questions over and over, difficulty in learning and serious memory problems. She tired quickly, became angry and took offence very quickly, showing puerile behavior. The paitent had serious problems with her younger sister, had academic problems, obsessions and orientation problems such as not knowing country, date, place, time, season. Following NF training this girl began to express herself very well, stopped asking the same questions over and over, began to learn and to remember what she was being taught, no longer became tired, aggressivity disappeared. Offensiveness or puerile behavior disappeared, she began to protect her younger sister, academic problems were slightly reduced, and obsessions disappeared. The subject went out by herself and could get on the bus alone. Her mother was really happy about the outcome. Figure 4 displays the pre- and post-treatment changes in the QEEG of this mentally retarded child. Baseline QEEG showed excessive generalized theta in absolute and relative power with excessive frontotemporal alpha in the absolute and relative power. Following NF treatment (160 sessions) QEEG showed significant decrease of relative theta and rather normalized left posterior alpha in relative power.

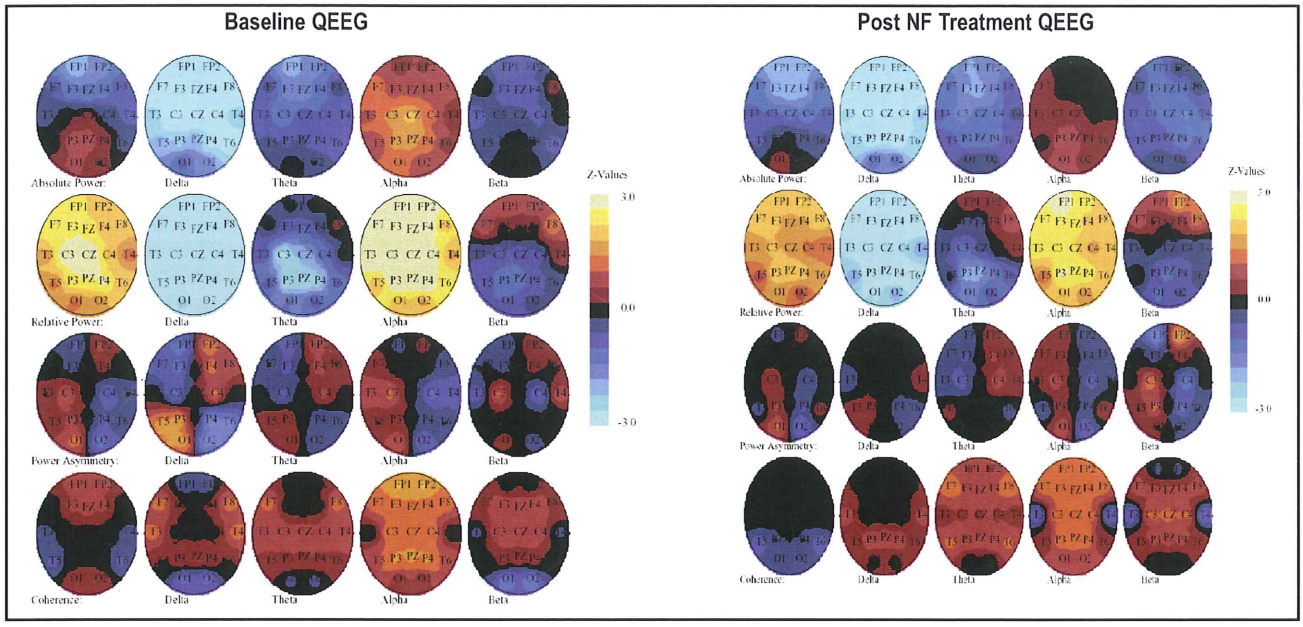

Figure 5.
Z-values of EEG features referenced to norms.

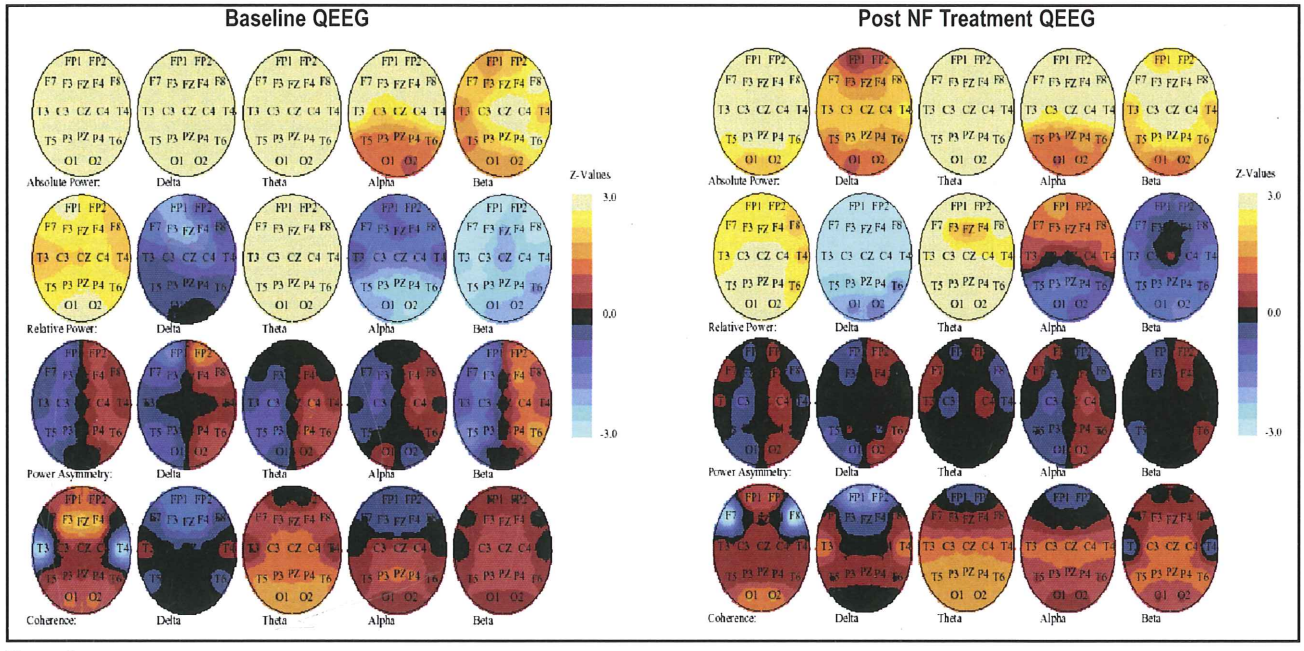

Figure 6.
Z-values of EEG features referenced to norms.

Case 3

This is a case of a 9-year-old boy with mental retardation. His problems included knowing the alphabet but not reading, disobeying rules, stubbornness. He had difficulty balancing his body, fine and gross motor coordination problems, and a problem with enuresis. Following NF training he began to read, write by dictation, obeyed the rules. He could kick a ball with his foot without falling down, his stubborness was reduced, he was easily convinced, and no longer displayed a problem with enuresis. Figure 5 shows the pre- and post-treatment changes in the QEEG of this mentally retarded child. Baseline QEEG showed excessive alpha in relative power and power asymmetry at the frontal and posterior areas with occipital delta and beta hypocoherence. Following NF treatment (120 sessions) QEEG showed a decrease of excessive alpha in relative power and normalization of delta asymmetry and hypocoherence.

Case 4

A 12-year-old girl had severe epilepsy and mental retardation. She was on Tegretol. Her problems included not expressing herself appropriately, being sleepy all day (most likely due to a medication side effect

and to daily seizures), aggressiveness, difficulty being successful in school, lack of motivation in reading and writing, forgetting to bring her homework home, had grand mal seizures 2-4 times daily and smaller seizures 3-4 times daily. Following NF training she started expressing herself better, aggressiveness disappeared, improved her scores at school, enjoyed reading and writing , started to bring her homework home, forgetfulness reduced, feeling sleepy during the day reduced (no change on dose of Tegretol), had seizures once or twice every 40 days with the reduction in severity, frequency of repetition and duration. Figure 6 shows the pre- and post-treatment changes in the QEEG of this mentally retarded child. Baseline QEEG showed excessive delta, theta, alpha and beta in absolute power. Excessive theta in relative power with asymmetry in all bands. Following NF treatment (160 sessions) QEEG showed a decrease of excessive delta in absolute power with a decrease of theta in relative power, and an increase of alpha and beta in relative power with a decreased asymmetry in all bands.

DISCUSSION AND CONCLUSIONS

During 2 years of follow-up, parents of each child were contacted once every 3 months for up to 2 years via telephone. The families of all 22 of the subjects who improved reported that their children are still doing fine and feeling much better every passing day. Significant reduction in number of problems and significant improvement in attention was observed. All improvements in behavior and attention that had been observed during the treatment remained stable in the 2 years of follow-up according to parents' reports.

It seems that EEG self-regulation skills were preserved. The stability of changes might be explained by normalizing brain functions that are responsible for inhibitory control, impulsivity and hyperactivity. These results are congruent with the results of long-term follow-ups that have been done in other NF studies.[49-52] The same long-term effect of NF is also seen in this study of mental retardation. The long-term effects of NF could be considered as a major advantage for this treatment compared with previous pharmacological treatment that some subjects had received before the NF treatment.

Finally, Spitz (1986)[35] reviewed the history of attempts to raise IQ in developmentally delayed and/or culturally disadvantaged children. The efforts included early intervention and compensatory education programs such as Head Start, behavior modification, medical and dietary interventions, and various sensory and motor therapies, which have not shown any significant effect in raising intelligence scores according to the conclusion in the Spitz article. However, when comparing post-treatment IQ results with the baseline it was found that the results were significantly improved in verbal IQ, performance IQ and total IQ scores.

Disrupted sleep is common with psychostimulants and antipsychotics prescribed in medical practice for treatment of behavioral problems. In a mental retardation population the authors have found that medication treatment often does not diminish problems and may actually bring about other problems such as tics, homicidal thoughts, sedation, dyspepsia, and extrapramidal symptoms. When one of our subjects had taken Risperidone, homicidal thoughts developed, and another patient who had taken methylphenidate developed tics before coming to NF treatment. During NF treatment no side effects were reported. Thus, in our clinical experience a significant proportion of parents have expressed a preference for non-medication treatments such as NF.

Many will underestimate the abilities of these patients and assume that only certain achievements could be accomplished. Parents of all the children reported that none of the special education centers helped their children with improvements such as were shown during the short time they spent with NF treatment. The parents were upset that the children had lost many years with IQ scores going down every 6 months because NF treatment was unknown and not accepted by the medical community. If they had known, they would have had their children take NF treatment as early as age 5 or 6.

It is our conclusion that if NF is provided concurrently with special education, children with mental retardation may experience superior benefits in contrast with special education alone. This is the first study providing evidence that NF treatment can produce improvements in children with mental retardation. Based on our positive results it is recommended that further control group research be conducted which includes additional outcome measures. If further research supports our findings we believe that pediatric psychiatrists, pediatricians, teachers and special educators will find a new openness to adding NF as part of the routine care of children with mental retardation.

DISCLOSURE AND CONFLICT OF INTEREST

Tanju Surmeli and Ayben Ertem have no conflicts of interest in relation to this article.

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