Brainmaster Case Study

Clinician Identifier, Credentials, and Date of Submission
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Case Identifier
TB

History/Symptom History
TB is an 11-year-old Caucasian male. He is in the 5th grade and is homeschooled. He was initially referred to this clinician for a Psychological Evaluation when attending a rural public school. Concerns from the school included refusal to complete work, easily distracted, unorganized work area, flat affect, "head twitching," avoidance of physical activities, physical awkwardness/clumsiness, and social immaturity.

TB was adopted within days of his birth and little was known about the birth parents. The adopted parents indicated that TB was 6-8 months delayed with nearly all developmental milestones. He was described as "overly cautious" with physical activities and would not ride a bike or engage in athletic games or sports. It was indicated that TB's handwriting was poor and his performance in school was deteriorating. Socially, it was indicated that TB did not seem attached to others, but was generally happy and compliant. There were no concerns with behavior problems. TB consistently demonstrated motor and vocal tics, including throat clearing, coughing and "neck twitching." TB was reported to have numerous sensory sensitivities. Results of a Sensory Profile completed by TB's mother revealed significant concerns in the subscales measuring Low Endurance/Tone, Sensory Processing Related to Endurance/Tone and Behavioral Outcomes of Sensory Processing. In addition, probable concerns were noted in subscale scores including Emotionally Reactive, Sensory Sensitivity, Fine Motor/Perceptual, Touch Processing, Modulation of Sensory Input Affecting Emotional Responses and Emotional/Sensory Responses. The Diagnostic Interpretive Guidelines from the Integrated Visual and Auditory Continuous Performance Test (IVA) indicated a working diagnosis of ADHD, Combined Type. His primary scores indicated significant concerns with impulsivity (response control) and mild concerns with attention (see table 2).

Diagnostic impressions from the Psychological Evaluation included a diagnosis of Tourette's Disorder as well as rule out diagnoses for ADHD, Combined Type, Sensory Integration Disorder, Specific Learning Disorders, Expressive Language Disorder, and Developmental Coordination Disorder.

Procedure
An initial qEEG assessment was conducted by a licensed psychologist who is also BCIA certified in EEG biofeedback. EEG data were digitally recorded at 19 electrode sites and referenced to linked ears using a Lexicor digital EEG acquisition system (Neurosearch-24). Data was analyzed using the Neuroguide database (Thatcher, 1998). When considering eyes open z scored FFT Absolute Power scores, TB showed a significant

excess of high beta activity, focused in parietal regions (see figure 1). There were also significant areas of hypercoherence in all bands. Nearly every dyadic comparison showed hypercoherence in the beta and high beta bands (see figure 1).

The neurofeedback treatment was 26 sessions in length. EEG biofeedback equipment from Brainmaster was utilized. Specifically, the Atlantis 4 x 4 was used along with the ANI (Applied Neuroscience, Inc) Z DLL software. This software enables the BrainMaster 2.5 and 3.0 software to compute and use z scores in real time for assessment and training. A 4-channel live z-score program with independent upper and lower limits was used for all treatment sessions (percent ZOKUL). The percent of targets required was set to 95. This setting resulted in the occasional occurrence of "capturing" 100% of the measured variables. The upper and lower thresholds were adjusted independently to result in a success rate between 70 and 80%. In general, these thresholds were between 2.2 and 2.0 for the upper threshold and –2.0 and –1.9 for the lower threshold. Dual monitors were used and feedback was provided through visual and auditory control of DVD movies.

Initial electrode placement was at T3, P3, FP2, and P4. This placement was based on the elevated absolute power in parietal regions as well as areas with the most consistently deviant coherence z scores (T3 and FP2). From a functional perspective, it was hoped that some of the sensory concerns may remit with training at P3 and P4 and social/emotional awareness may improve with training at FP2. This placement was maintained for 7 sessions. It was observed as early as session 2, that many of the most significant deviations "cleared up" midway through each session. The electrode placement was moved to FP1, FP2, FZ, and CZ for sessions 8 through 22. Again, it was observed that many of the most significant deviations appeared to "clear" fairly efficiently. In fact, by session 12, there were very few deviations above 1.0 z scores. Sessions 22 through 26 largely involved exploring different placements to determine the best location for continued treatment. The client's mother was reporting significant improvement and was interested in renting a home training unit to continue "fine tuning" the work already done. A home training unit was rented to this family with protocols designed to enhance 9-11 hz, and inhibit 12-15 hz and 20-30 hz at P4. After one month of home training, the family completed only two sessions and the home training was terminated.

Results

An individualized behavior questionnaire was developed in consultation with the mother of TB to track symptom progress during the course of neurofeedback. TB's mother was initially asked to develop a list of concerns. This list was then formed into 16 behavioral items scored on a 10-point Likert scale (1 = not at all; 10 = all the time). A checklist was completed at 19 of the 26 sessions. Because symptoms fluctuate for many reasons, the first three checklists were averaged and identified as pre-treatment scores, while the last three checklists were averaged and identified as post-treatment scores. It should be noted that this is, in all likelihood, a conservative approach, as TB showed progress very quickly. Consequently, it is likely that the pre-treatment scores are somewhat more positive than would have been true had this checklist been completed several weeks prior

to the beginning of treatment. Pre and Post treatment results are presented in table 3 and clearly demonstrate improvement in nearly all areas. The items with the most dramatic improvement involved the near elimination of tics and sensitivity around the head and neck area as well as significant improvement in distractibility and willingness to try new activities. At the 7th session, TB's mother wrote on the checklist that he "has been very cooperative in school this week," "trying new things at swim lessons and succeeding!" "only notice tics occasionally." At the 11th session, TB's mother noted that he "finally jumped in and swam in the deep end!" At session 13, she noted that he "finally rode a bike!."

Pre and Post Sensory Profile checklists were completed by the client's mother. Results (presented in table 1) indicate a clear trend toward improved general functioning. The total raw score improved from 77.7% of initial responses in the positive direction to 83.4% of responses in the positive direction at post treatment. The pre-test results indicate that three subscale scores were identified as showing a "definite difference" from a normative group, while six subscales were identified as showing a "probable difference." At post-testing, two scales continued to show a "definite difference" while only one showed a "probable difference." There was a clear trend for areas related to sensory sensitivity and emotional reactivity related to sensory processing to show significant improvements, while areas related to endurance/tone showed no movement.

TB completed a pre and post IVA computerized test of attention (see table 2). A comparison of the two testings shows significant improvement in self-control with no significant change in attention scores. In fact, there was a trend toward decreased visual attention, although it was not considered significant (more than one standard deviation).

A pre-post comparison of the most deviant absolute power and coherence z scores shows a clear trend of movement toward "average" (see figure 1). Seven High Beta absolute power z scores were identified as significantly elevated (greater than 1.96 standard deviations) at pre-testing. These elevations occurred at locations P3, T5, P4, O2, F8, T6, and PZ. None of the 19 locations examined demonstrated significant elevations at post-testing. In fact, of the seven locations identified as significantly elevated at pre-testing, the highest z score at post-testing was 0.69. When considering the z scored FFT coherence measures at pre-testing, there was one dyad with significant hypercoherence in delta, two in theta, four in alpha and fifteen in beta. At post testing, there was zero hypercoherent dyads in the delta band, one in theta, one in alpha, and two in beta. It should be noted, that there were two dyads at post-testing with hypocoherent connections, one occurred in the delta range, the other in the alpha range.

Summary

In 26 sessions, 4-channel live z-score training was effective in dramatically reducing or eliminating a range of long-standing symptoms including vocal and motor tics, sensory sensitivities, distractibility, emotional reactivity, and impulsivity. While it is difficult to determine what aspects of the EEG biofeedback resulted in these changes, the most notable changes in brainwave patterns occurred in a reduction of beta hypercoherence and high beta absolute power.

Table 1

Sensory Profile:

The Sensory Profile (Dunn, 1999) is a 125-item scale designed to provide a standard method to measure a child's sensory processing abilities. Items were written as behavioral statements and were rated as occurring always, frequently, occasionally, seldom, or never. TB's mother completed this assessment prior to beginning neurofeedback as part of a full Psychological Evaluation, and again after treatment had been discontinued. Scores for subscales are reported as belonging in one of three possible categories. Typical Performance scores are those that are within one standard deviation of the mean. Probable Difference scores are those that fall between one and two standard deviations of the mean and will be identified with a single asterisk (*). Definite Difference scores are those that fall more than two standard deviations below the mean and will be identified with two asterisks (**). Lower raw scores are indicative of more concerns in that area. Each factor/section, raw scores, and category assignment are shown below for the pre and post measures.

Sensory Profile Pre-Post Parent Ratings

	Pre		**Post**	
	Score/Possible	Classification	Score/Possible	Classification
Factor				
Sensory Seeking	68/85	Typical	75/85	Typical
Emotionally Reactive	51/80*	Probable	60/80	Typical
Low Endurance/Tone	34/45**	Definite	33/45**	Definite
Oral Sensory Sensitivity	39/45	Typical	40/45	Typical
Inattention/Distractibility	28/35	Typical	29/35	Typical
Poor Registration	37/40	Typical	39/40	Typical
Sensory Sensitivity	15/20*	Probable	17/20	Typical
Sedentary	12/20	Typical	10/20*	Probable
Fine Motor/Perceptual	8/15*	Probable	10/15	Typical
Sensory Processing				
Auditory Processing	31/40	Typical	34/40	Typical
Visual Processing	37/45	Typical	41/45	Typical
Vestibular Processing	49/55	Typical	52/55	Typical
Touch Processing	72/90*	Probable	79/90	Typical
Multisensory Processing	29/35	Typical	31/35	Typical
Oral Sensory Processing	52/60	Typical	55/60	Typical
Modulation				
Sensory Processing Related to Endurance/Tone	34/45**	Definite	33/45**	Definite
Modulation Related to	44/50	Typical	45/50	Typical

Body Position/ Movement				
Modulation of Movement Affecting Activity Level	23/35	Typical	23/35	Typical
Modulation of Sensory Input Affecting Emotional Responses	15/20*	Probable	18/20	Typical
Modulation of Visual Input Affecting Emotional Responses &Activity Level	15/20	Typical	17/20	Typical
Behavior and Emotional Responses				
Emotional/Social Responses	60/85*	Probable	64/85	Typical
Behavioral Outcomes of Sensory Processing	17/30**	Definite	23/30	Typical
Items Indicating Thresholds for Response	14/15	Typical	14/15	Typical
Total Raw Score	785/1,010	77.7%	842/1,010	83.4%

Table 2

Integrated Visual and Auditory Continuous Performance Test (IVA):

The IVA CPT (Integrated Visual & Auditory Continuous Performance Test; Sanford, 2002) is a test of attention and impulse control which measures responses to 500 intermixed visual and auditory stimuli spaced 1.5 seconds apart. The task is to click the mouse when the stimulus is a visual or auditory "1" and to refrain from clicking when the stimulus is a visual or auditory "2". The IVA analysis provides six global composite quotient scores and 22 other scales. The basic measurements of reaction time, accuracy, and variability under different conditions give rise to the raw scale scores, which are converted into Q (quotient) scores, defined as (100+15 *[subjects score – mean scale score]). The mean Q score is 100 with a standard deviation of 15 points.

Integrated Visual and Auditory Computerized Performance Test Global Pre and Post Scores

	Pre	**Post**
Full Scale Response Control	67	99**
Auditory Response Control	66	98**
Visual Response Control	74	100*
Full Scale Attention	84	77
Auditory Attention	72	72
Visual Attention	98	86

Note: Changes between 1 and 2 standard deviations are identified with a single asterisk (*). Changes greater than 2 standard deviations are identified with two asterisks (**).

Table 3

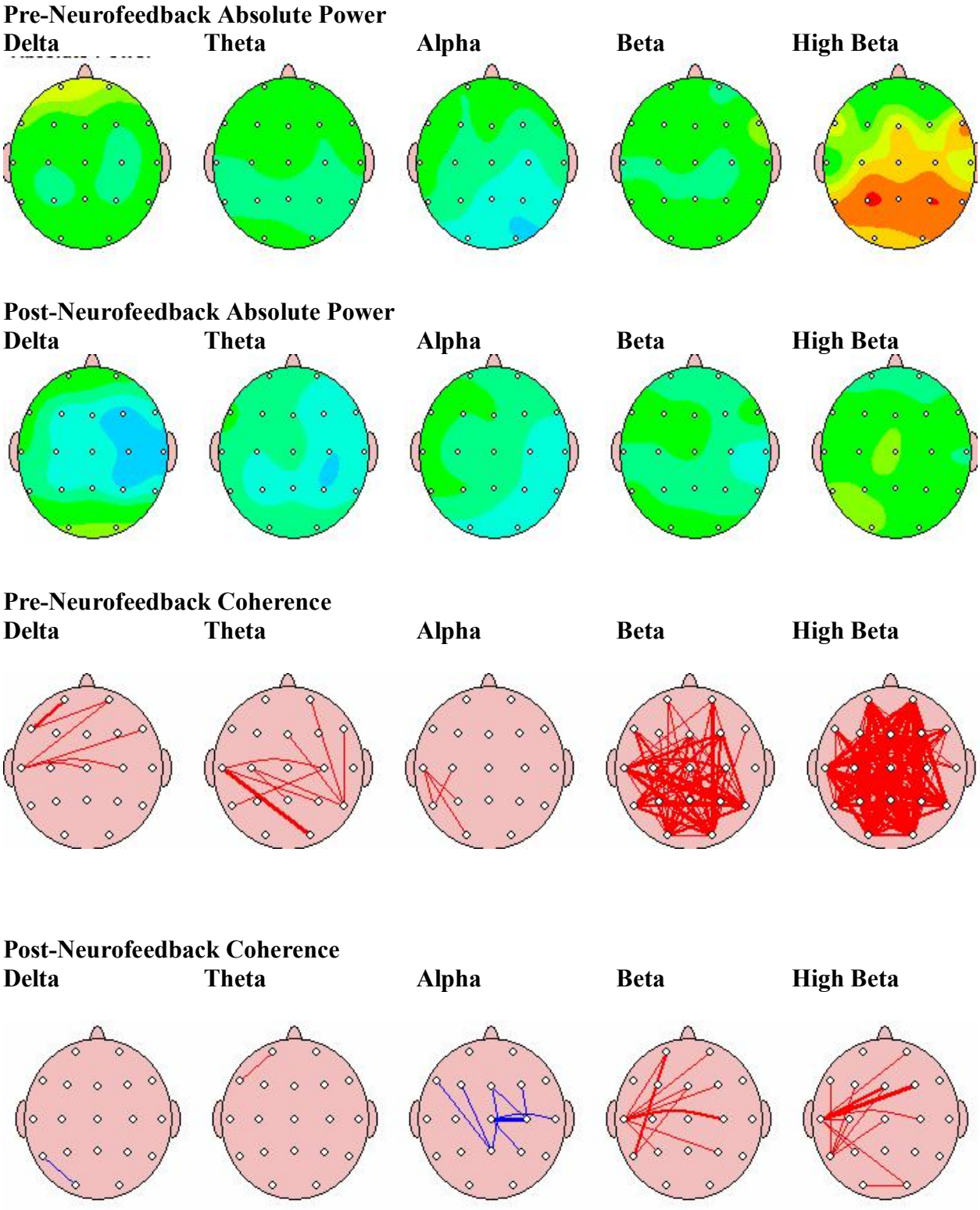
Pre and Post Comparisons of Individualized Behavior Ratings

	Pre	**Post**
Stays focused and follows directions	5.33	7.33
Willing to work on assignments that involve writing	5.66	6.67
Legible handwriting	5.66	6
Shows improvement with spelling	6.66	8
Stays on task during school	5.33	7.33
Controls anger	5	6
Resolves conflict with sibling without using violence	5.66	6
Feels confident in abilities	5.33	7.66
Displays emotional self-control	5	6.33
Not distracted or bothered by loud noises	6.66	9.33
Feels secure in friendships	7	8
Willing to try new physical activities	5	7.66
Displays age appropriate behavior	5.33	7.33
Shows self-control	6	6.66
Tics or increased rate of tics	6	1.33
Sensitive around head, ears, neck, and shoulders	6	1.66

Note: Scores ranged from 1 (not at all) to 10 (all the time). Pre test scores as reported are an average of the first three checklists. Post test scores as reported are an average of the last three checklists.

Figure 1

Z-Score FFT Pre and Post Comparisons of Absolute Power and Coherence



References

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