

# QEEG Guided Neurofeedback Therapy in Personality Disorders: 13 Case Studies

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## Key Words

Neurofeedback  
Personality Disorders  
Quantitative EEG

## ABSTRACT

According to DSM-IV, personality disorder constitutes a class only when personality traits are inflexible and maladaptive and cause either significant functional impairment or subjective distress. Classical treatment of choice for personality disorders has been psychotherapy and/or psychopharmacotherapy. Our study is to determine if subjects with antisocial personality disorders will benefit from quantitative EEG (qEEG) guided neurofeedback treatment.

Thirteen subjects (9 male, 4 female) ranged in age from 19 to 48 years. All the subjects were free of medications and illicit drugs. We excluded subjects with other mental disorders by clinical assessment. Psychotherapy or psychopharmacotherapy or any other treatment model was not introduced to any of the subjects during or after neurofeedback treatment. For the subject who did not respond to neurofeedback, training was applied with 38 sessions of LORETA neurofeedback training without success. Evaluation measures included qEEG analysis with Nx Link data base, MMPI, T.O.V.A tests and SA-45 questionnaires at baseline, and at the end of neurofeedback treatment. Lexicor qEEG signals were sampled at 128 Hz with 30 minutes-neurofeedback sessions completed between 80-120 sessions depending on the case, by Biolex neurofeedback system. At baseline and after every 20 sessions, patients were recorded with webcam during the interview.

Twelve out of 13 subjects who received 80-120 sessions of neurofeedback training showed significant improvement based on SA-45 questionnaires, MMPI, T.O.V.A. and qEEG/Nx Link data base (Neurometric analysis) results, and interviewing by parent/family members. Neurofeedback can change the view of psychiatrists and psychologists in the future regarding the treatment of personality disorders. This study provides the first evidence for positive effects of neurofeedback treatment in antisocial personality disorders. Further study with controls is warranted.

## INTRODUCTION

Personality disorder, according to DSM-IV, constitutes a class only when personality traits are inflexible and maladaptive and cause either significant functional impairment or subjective distress. These patients are far more likely to refuse psychiatric help and deny their problems than are patients with anxiety, depression, or obsessive compulsive disorder. Psychotherapy and/or psychopharmacotherapy are classical treatments of choice for personality disorders. To determine if subjects with personality disorders will benefit from quantitative EEG (qEEG) guided neurofeedback treatment, we studied subjects selected

according to DSM-IV general diagnostic criteria for Cluster B personality disorders but only those with antisocial personality disorder.

Antisocial personality disorder is a condition in which people show a pervasive disregard for the law and the rights of others. Those with antisocial personality disorder may tend to lie or steal and often fail to fulfill job or parenting responsibilities. The terms "sociopath" and "psychopath" are sometimes used to describe these persons, and early adolescence is a critical time for the development of antisocial personality disorder. Those who grow up in an abusive or neglectful environment are at higher risk, and adults who suffer from the disorder were usually showing behavioral problems before the age of 15. Antisocial personality disorder affects men three times as often as it does women and is much more prevalent in the prison population than in the general population. Antidepressant drugs and mood stabilizers may be helpful for depressed and/or labile mood. Antipsychotic drugs may also be used when there are distortions in thinking.<sup>1</sup>

Unfortunately, many people with antisocial personality disorder do not take their medications as prescribed. Premature termination is a common problem in their treatment. Psychotherapy can help people with antisocial personality disorder develop appropriate interpersonal skills and instill a moral code. A critical part of this therapy is developing and maintaining a strong therapist-patient relationship. This can be challenging, as the person is often angry, emotionally unstable, interpersonal<sup>^</sup> inappropriate and prone to impulsive behavior. There are studies about early termination and prediction of personality disorders with psychotherapy as it is a long process.<sup>2,3</sup>

Studies suggest that people predisposed to impulsive aggression have impaired regulation of the neural circuits that modulate emotion.<sup>4</sup> The amygdala, a small almond-shaped structure deep inside the brain, is an important component of the circuit that regulates negative emotion. In response to signals from other brain centers indicating a perceived threat, it marshals fear and arousal. This might be more pronounced under the influence of drugs like alcohol, or stress. Areas in the prefrontal area of the brain act to dampen the activity of this circuit. Recent brain imaging studies show that individual differences in the ability to activate regions of the prefrontal cerebral cortex, thought to be involved in inhibitory activity, predict the ability to suppress negative emotion.<sup>5</sup> Personality disorder has been related to a dysfunction of anterior cingulate cortex, amygdala, and prefrontal cortex and has been associated clinically with impulsivity, affective instability, and significant interpersonal distress.<sup>6</sup>

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Neurofeedback (NFB), also called neurotherapy, neurobiofeedback or EEG biofeedback (EEGBF), is a therapy technique that presents the user with realtime feedback on brainwave activity, as measured by sensors on the scalp, typically in the form of a video display and sound. The aim is to provide realtime information to the Central Nervous System (CNS) as to its current activity. The feedback provided by the computer is both visual and auditory. For instance subjects are asked to increase beta or sensorymotor rhythm and decrease delta and theta. This process is called operant conditioning and we do this conditioning every day in our lives. There are empirical evidences that NFB is used for the brain regulation. There are controlled studies that show the efficacy of NFB for AD/HD,<sup>7,11</sup> and there are empirical evidences that support the decrease of seizures and the decrease in EEG abnormalities.<sup>12</sup> After NFB training children with AD/HD have improved socialization, and initiated and maintained conversations.<sup>13,14</sup> There are studies that show the effectiveness of NFB with learning disabilities,<sup>15,17</sup> and there are controlled studies that show the effectiveness of NFB training in substance abuse.<sup>18</sup> Supporting literature shows the effectiveness of NFB in depression<sup>19-22</sup> and personality and mood instability.<sup>23</sup>

A recent improvement in NFB is in the use of qEEG to identify the specific brainwave patterns that need to be redressed.<sup>24,25</sup> qEEG offers the clinician an accurate laboratory test to aid in the detection and differential diagnosis of several common neuropsychiatry disorders.<sup>26</sup> EEG and qEEG studies provide valuable information to the psychiatrist regarding diagnoses and treatment responsiveness. qEEG studies are particularly well suited to identifying subtle changes in the topographic distribution background activity. They can aid difficult differential diagnoses such as schizophrenia, mood disorders, dementia, alcohol and substance abuse, post concussion syndrome, cognitive and attentional disorders.<sup>27</sup> Neurometry is a method of quantitative EEG that provides a precise, reproducible estimate of the deviation of an individual record from normal. This computer analysis makes it possible to detect and quantify abnormal brain organization, to give a quantitative definition of the severity of brain disease, and to identify subgroups of pathophysiological abnormalities within groups of patients with similar clinical symptoms. Reliable and meaningful results require an adequate amount of good quality raw data, correlated with age, transformed for Gaussian distributions, and corrected for intercorrelations among measures.

Neurometric analysis is able to detect consistent patterns of abnormalities in patients with subtle cognitive dysfunctions and psychiatric disorders. These analyses may also prove useful in determining therapy and monitoring its efficacy.<sup>28</sup> In neurometric qEEG analysis all qEEG variables are calculated as z-scores which means  $\pm 2$  standard deviation for age is normal. The magnitude of the standard deviation represents the severity of neuropathology and abnormality. Subjects who normalize the z-score on their qEEG will most benefit from NFB. We thought qEEG guided NFB treatment may address the core symptoms of personality disordered patients, who are not getting pleasure from life, lying, aggressivity, not having a stable academic or occupation life, having no remorse, no insight, spending excessive money, sleeping poorly, having attention/concentration problems, not reading, impatient, resistant to treatment and having poor insight.

#### METHODOLOGY

Thirteen subjects ranged from 19 to 48 years old ( 9 male, 4 female). Evaluation measures includes qEEG analysis with Nx Link data base, MMPI, Test of Variables of Attention (TO. V.A tests) and SA-

45 questionnaires at baseline, and at the end of NFB treatment. Lab tests (Hemogram, B12, B6, Folic acid, TSH and urine test for abused substances) were normal, and abused substances were not detected in urine of subjects. Lexicor qEEG signals were sampled at 128 Hz. Thirty minutes-NFB sessions were given twice a day by Biolex NFB system and completed between 80-120 sessions were completed depending on the case. For baseline and following every 20 sessions patients were recorded with webcam during the interview. Electrodes were sited according to the International 10/20 System qEEG/Nx Link data base results, Fp1-Fp2, Fp1-F3, F7-F8, Fpz-Fz, Fz-T4 electrode placements were used with an alpha (8-12 Hz) reduction reward, (inhibits at 4-8 Hz). O1-O2, P3-P4, T3-T4, T5-T6, Fp1-Fp2, F3-F4 electrode placements were used with alpha or beta or theta coherence reduction reward, (inhibits at 8-12 Hz alpha). C3-C4 SMR reward, inhibits at 4-8 Hz or 8-12 Hz. Cz-C4 electrode placement was used with a delta (0-4 Hz) reduction reward, inhibits at 4-8Hz for insomnia 6-8 sessions. One of the subjects with nocturnal enuresis responded well to electrode placement at P4-T6 theta down reward and inhibits up training 8-12 Hz (alpha).

#### Inclusion Criteria for treatment

A signed consent was obtained from the patients, who were between the age of 19 to 48 years old. All the subjects should have had at least one unsuccessful treatment before coming to us. At the first interview, subjects should have a personality according to DSM-IV. The qEEG Nx-Link data base determined abnormality of the brainwave patterns without medication (based on discontinuation for 7 half-lives of the drug). By history none of the subjects had physical problems. None of the subjects received psychotherapy, psychopharmacology or other treatments during NFB therapy.

#### Exclusion Criteria for treatment

Exclusion criteria: Other psychiatric disorders, drug abuse, at risk of suicide, NFB treatment abandoned, risk due to medical history, presence of abnormal blood tests.

#### CLASS OBSERVATION OF THREE CASES

##### Case 1

A 23-year-old jobless male had no insight; no idea that he had serious problems. He had been seen by psychiatrists since age 14. During his high school years the subject escaped from the school many times. He lied all the time, did not obey the rules, was aggressive, did not like his name so he had people call him with different names, and frequently bought a new phone. He could not get along with anybody, even his parents, sibling and girlfriends always left him. The subject always wanted to spend money, did not work but spent his father's money. When none was given he became very aggressive, messed up the house and stole money. The patient was a poor decision maker and impatient. After 20 NFB treatment sessions his aggression markedly decreased, he began to make daily plans, and his motivation increased. After 45 sessions he stopped lying, patience developed, aggression continued to decrease. His father gave him weekly wages, and he did not fight to get more money or to steal from him. After 100 sessions (60 days later), he had stopped buying new phones, and lying discontinued. The subject started a course to become a security guard. His insight developed and he began to recognize his mistakes. Figure 1A displays the pre- and post-NFB treatment changes of his qEEG with hypercoherence at alpha, theta, beta bands and asymmetry abnormalities in all bands seen at baseline qEEG. After NFB treatment (100 sessions), coherence and asymmetry abnormalities markedly decreased (see Figure 1A).



**Figure 1.** A. Coherence and asymmetry abnormalities for patient 1. B. Alpha and alpha coherence abnormalities for patient 2. C. Beta coherence and asymmetry abnormalities for patient 3. The left column is the recording before treatment and right column is after treatment.

**Case 2**

A 48-year-old female subject, married with 3 children, experienced intense bouts of anger, mood swings, and anxiety that would last only hours. Her husband and her parents brought her to the treatment center. She said her husband needed treatment. Always restless, always aggressive, she had sleep problems, wanted to leave home, nothing made her happy, and she had recurrent suicidal thoughts. The patient had chronic feelings of anger and homicidal thoughts against her husband, with transient paranoid ideations about her husband cheating. She had problems for 34 years and was nonresponsive to antidepressants, antipsychotic medications and psychotherapy over the years. During her high school years she escaped from the school, and home many times, and did not obey the rules. After 24 NFB treatment sessions, in the interview she said that she began to feel relaxed after 5-6 sessions, and her restlessness declined. After 40 sessions the patient's sleep problems disappeared, her feeling of leaving home disappeared, and her aggression markedly declined. After 80 sessions her anger and homicidal thoughts disappeared, and she began to get pleasure from life. After 120 NFB sessions her feelings of anger about her husband and paranoid ideations disappeared. Figure 1B shows the pre- and post-NFB treatment changes of her qEEG. Hypercoherence at alpha band and excessive alpha at relative and absolute power are present at baseline qEEG. After NFB treatment (120 sessions), alpha hypercoherence is reduced. Relative alpha is also markedly decreased (see Figure 1B).

**Case 3**

A 30-year-old single male was brought to the treatment center by his parents. He denied having problems and mentioned that his family had severe problems. According to his parents he spent money recklessly, changed many jobs in a short time, and left his girlfriends and one fiance. He lied, was very aggressive, and cursed all the time. Since his childhood the patient had never obeyed the rules at home and at school. He beat his friends, and ran away from home and from school several times. The subject had no idea that he had problems. The family was obliged to cancel the consultation several times because he refused to come to the interview. After several NFB sessions, he felt relaxed and was aware of the necessity for continuing the treatment. After 20 sessions of NFB treatment his family told us that his aggression had markedly declined. He said that he could now think logically. Insight developed about his mistakes, and the need for treatment. After 40 sessions his family said that his behavior was more mature and he spent his money carefully. The patient stopped lying after 40 sessions. After 80 sessions his family said that he was more reliable and organized. He reported that he really felt like he was a different person. Figure 1C displays the pre- and post-NFB treatment changes of his qEEG, with hypercoherence at alpha band and asymmetry abnormalities at all bands seen at baseline qEEG. After NFB treatment (80 sessions), alpha hypercoherence is markedly decreased and asymmetries somewhat decreased (see Figure 1C).

**RESULTS**

Twelve out of 13 antisocial personality disorder subjects who received 80-120 sessions of NFB training showed significant improvement based on SA-45 questionnaires, MMPI, T.O.V.A. and qEEG/Nx Link data base results, and parent interviews (mean age: 41.6, SD: 5.8). When we compare the brainwaves of the personality disorder subjects with normals we see abnormal brainwave patterns.

**Table 1**

Symptom assessment - 45 Questionnaire (SA-45)			
	Mean	SD	P
TOTAL_A	116.15	37.25	
TOTAL_B	74.23	24.19	
Difference of Total Score	41.92	39.22	0.002

All the subjects with personality disorders had excessive frontal alpha, theta and beta abnormalities in their qEEG compared with normal peers through the neurometries. Alpha, theta and beta coherence abnormalities were also noted. Those subjects were not willing to join the NFB treatment, and at the beginning they resisted coming. These subjects sometimes escaped but their family and our staff kept calling them to continue the treatment. We requested them to come for the treatment every day, not telling them directly that they had serious problems, as they had no insight, but to improve their brain performance. We realized that at the end of treatment they would have gained insight. During the first week patients started to feel relaxed and were aware of the positive changes which let them feel good, so they kept coming to the treatment center. NFB treatment seems to increase the adherence to treatment, and altering the brainwaves may open the responsible part of the brain to insight. NFB treatment is provided by psychologists who are not involved in any conversation with the subjects other than to explain how to control their brainwaves. This approach was welcomed by the subjects, and all of them admitted that this treatment was different from previous ones, because no one advised them what to do with their life, and our approach did not seem a challenge to them. Table 1 shows the results of pre- and post-NFB treatment on Symptom Assessment - 45 Questionnaire (SA-45). The nonparametric Wilcoxon test was applied. P value is significant (p: 0.002). Table 2 shows the results of pre- and post-NFB treatment on Minnesota Multiphasic Personality Inventory (MMPI) for psychopathy subtest mean value, and mean differences of all the subtests. The nonparametric Wilcoxon test was applied. P value is significant (p: 0.00) for psychopathy. P values are significant at the mean differences of all the subtests. Table 3 shows the results of the impulsivity part of Visual and Auditory commission errors of T.O.V.A (Test of Variables of Attention). Visual commission median errors, baseline VT\_ERROR1 diminished after NFB treatment (p: 0.043) as well as Auditory median commission errors, AT\_ERROR1 (p: 0.050). The nonparametric Wilcoxon test was applied.

Table 4 shows Common Clinical Findings before the treatment and Improvement after the treatment, such as: Aggression, Failure to sustain consistent work or school obligations, Insomnia, Lack of remorse, Loss of interest to life, Lying, No insight, No interest in reading a book and spending money excessively. All the statements above were answered "YES" by 13 subjects before the treatment, and after the treatment 12 subjects responded "NO." For example, before the treatment they were asked if they were aggressive or not, they all responded "YES," and after the treatment 12 subjects responded "NO" to the same question,  $\chi^2 = 22.29$ ,  $p=0.0001$  (Pearson Chi-Square test) was applied. Table 5 shows how subjects responded to the question "Do you have any interest in reading a book" before and after the treatment. Before the treatment, 13 subjects said they had "no interest in reading a book," after the treatment 10 subjects said they started reading books almost every day and during the NFB sessions,  $\chi^2 = 16.25$ ,  $p=0.0001$  (Pearson Chi-Square test) was applied.





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