Obsessive Compulsive Disorder and the Efficacy of qEEG-Guided Neurofeedback Treatment: A Case Series

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Key Words
Neurofeedback
Obsessive Compulsive Disorder
Quantitative Electroencephalography

ABSTRACT
While neurofeedback (NF) has been extensively studied in the treatment of many disorders, there have been only three published reports, by D.C. Hammond, on its clinical effects in the treatment of obsessive compulsive disorder (OCD). In this paper the efficacy of qEEG-guided NE for subjects with OCD was studied as a case series. The goal was to examine the clinical course of the OCD symptoms and assess the efficacy of qEEG guided NE training on clinical outcome measures.

Thirty-six drug resistant subjects with OCD were assigned to 9-84 sessions of qEEG-guided NE treatment. According to follow up interviews conducted with them and/or their family members 19 of the subjects maintained the improvements in their OCD symptoms. This study provides good evidence for the efficacy of NF treatment in OCD. The results of this study encourage further controlled research in this area.

INTRODUCTION AND BACKGROUND
OCD is a debilitating psychiatric disorder. It is characterized by recurrent and persistent thoughts, impulses, images (obsessions) and/or repetitive behaviors, or mental acts that the person is driven to perform, that are intrusive and inappropriate and cause marked anxiety or distress. It is the fourth most common mental disorder and the tenth leading cause of disability in the world.

There are only 3 published reports1 on NF in the treatment of OCD. Currently, the most widespread treatment modalities for this disorder are pharmacological treatment with serotonin reuptake inhibitors (SRIs) with cognitive behavior therapy (CBT). Despite the proven efficacy of both SRIs and CBT, a substantial percentage of patients receive little benefit from these standard approaches.

As effective as these treatments are, a response is usually considered an amelioration of the symptoms and not the remission of symptoms. After treatment persons suffering from this disorder may not all patients show a response to these treatments. While controlled trials with SRIs have demonstrated a selective efficacy in OCD, up to 40-60% of patients do not have a satisfactory outcome. The fact remains that a large fraction of patients without substantial response to standard treatment experience significant morbidity5.

When investigating SRIs Ackerman and Greenland6 found that a meta-analysis of 25 drug studies with OCD patients had modest improvement with clomipramine. The average treatment effect on the Y-BOCS was 10.64 (uncorrected for placebo effects), which is a 1.33 standard deviation improvement. For fluvoxamine, which is the most effective SSRI treatment for OCD, the mean Y-BOCS improvement was only 5.4 points. If the 10.64 average change of Ackerman and Greenland is used, patients scoring high on the Y-BOCS (20-30 points) will still have a mild to moderate range of symptoms (20-30 points) after drug treatment.

The efficacy and response to CBT treatment is quite variable, and also may not be sustained in the long term, It is claimed that 76%-86% of patients who complete CBT treatment make improvements;7 On the other hand, intensive CBT has been found to have a 75% remission rate. O'Connor et al.8 found that either cognitive behavioral therapy or medication alone can help the patients to a certain level.

It is evident that other novel treatment methodologies may be needed. As an alternative treatment Rucklidge9 introduced micronutrients to a patient who did not respond to medications and subsequently underwent CBT with a modest response. Micronutrients worked well with this patient. Rucklidge concluded that many OCD patients are resistant to conventional treatments so alternative treatments should be introduced to patients and further research is needed on the mechanisms of micronutrients.

qEEG Findings and NF
Currently there is little evidence on the psychopathology of OCD. However, in order to apply NF treatment one needs to know which band to train and on which brain area to place the electrode. For this the qEEG method is quite successful in helping guide the practitioner in placement and band selection since some studies have been done in assessing the qEEG findings in OCD. One of the first qEEG studies conducted on OCD was done by Simpson et al: In this study, patients’ qEEG was recorded under symptom provocation (both live and imaginary). The results indicated that significant EEG changes were elicited by live contaminants, but not imaginary ones, and that an increase in OCD symptoms showed an increase in posterior relative alpha activity (in comparison to anterior areas).

1. Ackerman and Greenland
2. Rucklidge
3. Simpson et al.
PiureepDeVriendt and a group classified as OC D. D. who shared the
seizure-sainaiodeology,gtji or stufied into 2 subgroups by qEEG. One
pair tars characterized as harming diffuse excessive al pha and
emotive beta in frontal central and mid-temporal areas, whereas the
other group was charact erized by despe-rate alpha activity, especially
in the frontal anC posterior-temporal areas. Theta abnormalities have also
been reported by Insel et a.7 Jenike and Brotman, 7 Falq et al. and
Rockwell and Simmons. Furthermore, Pichop e and Hansen A.23 have
been able to identify pathophysiological subgroups within the OCD
case that exhibit differences with respect to their response to
antidepressive medications (responders vs. non-responders). Those
patients with excess alpha relative power (with some frontal and central
beta excess) were found to respond positively 82% of the time to
sessional medication antidepressants, whereas the second subgroup with
increased theta relative power (with some alpha minima) failed to
improve 80% of the time with SRs.
In a study conducted by Pagarell et al. authors found that
patients who had high levels of obsessions had higher absolute EEEG
power measures, especially in the faster frequencies (alpha2, beta),
whereas patients with high compulsion scores had lower absolute EEG
Power. This may be related to increased mental activity in
obsessions as opposed to compulsions.
In a study conducted by Burn et al. decrease of the slow a- band
power in COD as compared to healthy subjects was observed. A
significant negative correlation between the slow a-band power and the
time to complete a neurops ycho trait test explaining executive functions
was found: the more reduced the slow a-band power, the slower the
performance on this test. Lileweg et al. found an excess in the alpha
range with sources in the corpus striatum, in the orbital frontal and
temporal-frontal regions in untreated OCD patients. This abnormality was
seen to decrease following a successful treatment with paroxetine. Finally,
Tol et al. found OCD patients to be characterized by increased slower
frequencies and slow alpha frequencies, especially in the left fronto-
temporal area, when compared against age matched norms.
As can be seen, since qEEG findings tend to see COD as a hetero-
genous group who share the same symptoms, this may explain why
current treatments are not effective in all patients, and the duration of
positive effects are not long lasting. This may indicate that different mo-
dalities of treatment may be needed to efficiently treat these sub-
groups.
NF is an intervention aimed at training individuals to better regulate
their biological functioning of their own brain. This has generally involved
the self-regulation of EEG rhythmic activity, traditionally referred to as
EEG biofeedback, NF or neurotherapy. In NF training the subject is
placed in front of a computer screen which displays the subjects
diagnosed and analyzed brain electrical activity. The display can be
either in the form of a complex video game type of display, or in the
form of simple bar graphs. The thresholds of the activities which are
to be increased and/or decreased are set on the display. When the undesired
activity decreases below the threshold anode when the desired activity
increases above the threshold a pleasant tone is heard through the
attached headphones, and the display will change. In some systems, the
subject can also earn points based on his/her performance providing
additional feedback. As the sessions are repeated, the thresholds are
gradually modified inhibiting the undesired activities and reinforcing the
desired activities thereby conditioning to endure these activities.°
NF has been used successfully with ADHD/Learning
epilepsy, 1 anxiety, 2,4 mild head injuries' and even in autism. 4
the treatment of OCD with NE. Therefore, seeing a need for more
information in this area we decided to investigate the efficacy of qEEG-
guided NE in subjects with COD in case series

MATERIALS AND METHODS
We studied 36 subjects ranging in age 18-59 years old. Inclusion
criteria: Subjects were included from patients visiting the center who
met DSM-IV diagnostic criteria for OC D. Subjects should have had
received at least one treatment modality which was ineffective.
Additionally, the subjects should not have any history of physical illness,
the baseline laboratory tests (hemogram, 812, 86, P.1, Acid, TSH and
urine drug screening for illicit drugs) had to be normal. Exclusion
Criteria: The presence of any other psychiatric disorder, history of past
use or present drug abuse, head trauma with loss of consciousness, suicide
risk and/or abnormal blood tests, All the subjects in the study
used medication prior to the treatment. The mean total number of
medications used in the past was 3.6 (± 2.2). The mean duration of
illness was 8.0 years (± 4.7y). On inclusion all medications were
discontinued and 34 patients were medication free at baseline and for
the entire NF treatment duration. Only 1 patient received medication
(chlorpromazine) during NF treatment since it was necessary to manage
her symptoms However, she was taking 2 medications at the time of
administration. It was discovered that another patient was self-medicating
with bupholidine during the treatment phase. Evaluation measures
included family hand. QEEG data which was processed with the NEE
Link database, and the following raiting scales.
The Yale-Brown obsessive compulsive scale (Y-BOCS) was
designed to remedy the problems of existing rating scales by
providing a specific measure on the severity of the symptoms of OCD
that is not influenced by the type of obsessions or compulsions
present. The scale is a clinician-rated, 10 item scale, each item
rated 0 (no symptoms) to 4 (extreme symptoms) (total range 0 to 40).
The scale rates obsession and compulsive components and provides
subscores for each. A cut-off score of 16 is usually used for inclusion
into OCD medication trials. In this study subjects were rated before
treatment, and after completion of treatment.
The clinical global impression ( CGI) rating scale is a commonly used
scale that measures symptom severity, treatment response and the
efficacy of treatments r treatment studies of patients with mental
disorders. 5 In this study changes in the severity scale, pre- and
post-treatment were assessed. The clinical global impression severity scale
(CGI-S) is a 7-point scale that requires the clinician to rate the severity of
the subject's illness at the time of assessment, relative to the
diagnostic past experience with subjects who have the same diagnosis.
Considering the total clinical experience, a subject is assessed on the
severity of the mental illness at the time of rating where: 1 = normal, not
at all ill. 2 = borderline mentally ill. 3 = mildly 4 = moderately ill, 5 =
markedly ill 6 = severely ill, and 7 = extremely.

An MMPI was administered to all subjects before treatment and after
completion of treatment, however, results were only available for 17 out
of the 36 subjects. The MMPI although developed as a tool to assess
personality, lends itself to measuring changes in psychopathology. It is
appropriate for assessing treatment outcomes in patient samples where
Psychopathology is being evaluated, particularly if the emphasis is being
placed on DSM-IV Axis I disorders. Since it is sensitive to psychopath-
ology, as the illness recedes the pathological scores decrease (e.g,
normalized). The MMPI is very difficult to fool, whereas the patient can
more easily manage the doctor interview and the Y-BOCS rating thus
affecting the CGI and Y-BOCS results. Since this is not a double-blind

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study the MMPI may provide a counterpoint to the bias of the doctor. All patients were interviewed by the center staff. Informed consent was obtained from all subjects, and independent investigations were conducted.

To determine the locations and bands to be used in NF treatment, eEGs were recorded with a Lexicor Neurosearch-24 EEG system (software version 3.10). All EEGs were recorded drug free. In order to ensure that all subjects were drug free, all medications were discontinued at screening, and the recordings were performed after a washout period equal to 7 half-lives of the medication they were taking prior to admission. For example, the half-life of chlorimipramine is 35 hours so 7 half-lives (in days) would be equivalent to $7 \times 35/24 = 10.21$ days, therefore, the EEG would be recorded on the 12th day after cessation of medication. EEG signals were sampled at 128 samples per second per channel. Samples were analyzed with a normative neurometric approach using the Nv-Link database software (version 2.40). The Nv-Link database software is based on the work of E. Roy John and is a method of quantitative EEG that provides a precise, reproducible estimate of the deviation of an individual record from normal. QEEGs were recorded and compared against the Nlink database both before and after treatment as well as every 40 sessions, in order to reveal the divergence of the brain electrical activity from norms, in the form of z-scores, and to guide the NF treatment protocols by training the areas that show deviations from normal, as determined by the comparisons to the Nlink database. In Neurometric QEEG analysis, all QEEG variables are calculated as z-scores which is a score equal to the distance (deviation) from the norm in standard deviation units. The rationale behind this approach is that the subjects who normalize their QEEG z-scores will benefit the most from NF.

When the baseline eEG of this population was analyzed, excessive theta and/or alpha with a generalized distribution, especially in relative power was observed. In addition, the following findings were observed (Table 1). As can be seen, a little over half of the subjects showed increased relative alpha activity (in comparison to norms) and half of those with increased relative alpha power also showed increased coherence (hypercoherence) in the alpha band. Hypercoherence is said to be present in the EEG when two brain sites or areas are overly connected, as indicated by the two waveforms at these different sites being more similar in terms of morphology than an age-matched normal subject. Hypercoherence can be regarded as a kind of immaturity wherein cortical areas do not specialize and take on specific abilities and thus appear only in infants and children. (NF Treatment)

All the NF training was performed using Lexicor Biolex software (version 2.40). Each session was of 60 minutes duration, with 1 session per day. Electrodes were placed according to the International 10-20 System. Between 9 and 84 NF training sessions were completed, depending on the case. Treatment termination was based on the changes (a decrease) of symptoms in comparison to the pre-treatment complaints. The mean number of sessions was 50.2 (t 22.4 STD).

Electrode sites for training were selected based on the QEEG analysis (using the (Nv-Link database). The location of the deviant Z-scores is most important no matter what the EEG measure. A general rule is to link the patient's symptoms to deviant Z-scores located in regions of the scalp related to functional specialization in the brain and the patient's symptoms. The importance of proper area and band selection was also shown by Moore in a review of 2 OCD studies he conducted, where he found that pure alpha training did not produce any benefits. Moore concluded that the reason was that there were 2 OCD

<table>
<thead>
<tr>
<th>Primary Finding</th>
<th>Secondary Finding</th>
<th>Table I</th>
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<tbody>
<tr>
<td>Increased relative alpha power</td>
<td>Increased alpha coherence</td>
<td>20</td>
</tr>
<tr>
<td>Increased relative theta power</td>
<td>Increased theta coherence</td>
<td>10</td>
</tr>
<tr>
<td>Increased relative beta power</td>
<td>Increased beta power</td>
<td>4</td>
</tr>
<tr>
<td>Increased relative theta and beta power</td>
<td>Increased alpha and beta power</td>
<td>30</td>
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</table>

subgroups both of which would not have benefited from alpha training. The frontal and frontotemporal electrode sites were selected according to the subject's QEEG and also according to previous studies based on the frontal, prefrontal and fronto-temporal deviations from norm based on the QEEG recording of OCD patients. The most commonly used electrode sites were as follows (both bipolar and monopolar). In NF inhibit means keeping the activity below a set threshold whereas reward means keeping the activity above a set threshold:

The frontal and centro-parietal-temporal electrode sites below were selected according to subjects QEEG and Broadmann Areas (BA) The criteria to shift from one site to another is the z-score values or based on the first author's clinical experience.

FP1-FP2: Theta or p-inhibit, a-inhibit, p(21-32)-inhibit
FP3: Theta or (x-inhibit, a-inhibit, p(21-32)-inhibit or (13-32)-inhibit
FP: Theta, a-inhibit, p(21-32)-inhibit or (13-32)-inhibit
Fp1-4: Theta-inhibit, a-inhibit, p(21-32)-inhibit or p(13-32)-inhibit
Fp5: Theta-reward, a-inhibit, p(21-32)-inhibit or a-reward. Theta-inhibit, p(21-32)-inhibit
Fp6: Theta-reward, a-inhibit, p(21-32)-inhibit or a-reward. Theta-inhibit, p(21-32)-inhibit

Central-parietal area electrode sites were selected for procedural memory and brain area 24, the Anterior Cingulate for being the hub of the affective limbic system. Brain Area 40 representing cognitive reasoning, imagination was also used.

C4-P4: Theta-inhibit, a-inhibit, p(21-32)-inhibit or p(13-32)-inhibit or SMR-reward, Theta-inhibit, p(21-32)-inhibit P4: Theta-inhibit, a-inhibit, p(21-32)-inhibit or (13-32)-inhibit

The sensory area was selected for sleep regulation. BA 24 Anterior Cingulate: Hub of affective limbic system.

Cz-G4: Delta-inhibit, Theta-inhibit, p(21-32)-inhibit

Coherence training was performed according to z-scores. Hyper coherence can be considered as a lack of differentiation of brain functions or as a decrease in "flexibility" of functioning.

FP1-FP2: F3-F4, P3-P4: is coherence-inhibit, a-inhibit, p(21-32)-inhibit or p(13-32)-inhibit
RESULTS

The study included 12 males and 24 females. The mean age for the group was 30.1y (+9.0y). For males the mean age was 25.8y (+5.2y) and for females was 32.3y (+9.8y). Twenty-six out of 36 had a family history of some sort of psychiatric illness. Since the inclusion was based on patients that came for treatment to the clinic, without any a priori selection criteria, more females than males were included.

The pre- and post-study results are shown in Table 2. As can be seen NF treatment reduced Y-BOCS total score from 27.58 (+9.65 std) (which is above the cut-off score of 16) to 6.06 (+10.36), which corresponds to a reduction of 21.53 points A repeated measures ANOVA, where intra-subject effects were accounted for, was performed on the data and the overall change was found to be significant at the p<0.01 level (F(1,35) = 134.77, 01,35) = 0.79). Tests were performed on the subscales separately and all were found to be significant at a p < 0.001 level of significance. One group reported only obsessive symptoms (N=15), one group only compulsion symptoms (N=3) and a third group reported both symptoms (N=18). These were analyzed separately and all 3 groups reduced their scores significantly (p <0.01).

The results of the CGI pre- and post-treatment assessment along with the statistical analysis of the results (based on repeated measures ANOVA corrected for intra-subject variance) are given in Table 3.

According to the CGI results the decrease of the score of -4 points was found to be statistically significant at the p < 0.01 level F(1,35) = 205.94. 11(1,35) = 0.85 The group (as a whole) was rated as being severely ill, whereas at the end of treatment they were rated as being borderline mentally ill showing a 4 point decrease in the severity of their illness.

For illustration purposes only, due to small N (3)

The MMPI was administered to all subjects before and after treatment; however, results were only available for 17 out of the 36 subjects. Two scores were analyzed, the psychasthenia score and the depression score. The Pt scale was originally developed to measure the general symptomatic pattern labeled by Marks et al. as psychasthenia not commonly used today, which is characterized by excessive doubts, compulsions, obsessions, and a rigid and perfectionist personality with unreasonable fear. Psychasthenia can be considered very close to modern OCD. The depression score was analyzed because it showed unreasonable fear. Psychasthenia
Table 4

MMPI results. Changes in the severity of illness based on the Minnesota multiphasic inventory (MMPI)

<table>
<thead>
<tr>
<th></th>
<th>Depression</th>
<th>Psychasthenia</th>
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<tr>
<td></td>
<td>Score</td>
<td>Score</td>
</tr>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Count</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>Mean</td>
<td>74.76</td>
<td>56.88</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>11.78</td>
<td>10.37</td>
</tr>
<tr>
<td>Minimum</td>
<td>50</td>
<td>37</td>
</tr>
<tr>
<td>Median</td>
<td>78</td>
<td>55</td>
</tr>
<tr>
<td>Maximum</td>
<td>90</td>
<td>78</td>
</tr>
<tr>
<td>Mean Difference (Post-Pre)</td>
<td>-17.88</td>
<td>-15.41</td>
</tr>
<tr>
<td>F(1,32)</td>
<td>27.07</td>
<td>19.42</td>
</tr>
<tr>
<td>F(101,32)</td>
<td>0.64</td>
<td>0.55</td>
</tr>
<tr>
<td>Significance</td>
<td>P &lt; 0.01</td>
<td>P &lt; 0.01</td>
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</table>

Figure 1.

Changes in PI category scores before and after NF treatment.

variance ($F(1,16) = 27.07$, $0.16 = .64$). The same was true for the psychasthenia score which showed a change of -15.41, was also significant at the $p < 0.01$ level ($F(1,16)=19.42$, $01,16)=0.55$). Also, as can be seen in Figure 1, there is a trend towards normalization of all scores from 1-2 standard deviations above the norm, (50 = normal, 60 = 1std, 70 = 2std) to within the norm (under 60).

Long-Term Follow-Up

Two years after the subjects completed their treatment they were followed-up by telephone and queried as to their disposition. The average time of contact after termination of treatment was 26 months. Of the 36 original patients, all were reached. Of these 19 remained symptom free or improved, 9 had developed mild symptoms, and 5 relapsed. Therefore, for the majority of this group of patients, NF treatment was not only effective, its effects lasted up to 26 months after cessation of treatment. These results are congruent with the results of long term follow-ups that have been done in other NF studies. The same long-term effect of NF is also seen in this study of OCD.

Only 1 subject received medication (chlordipramine) during the course of the study. This subject did not respond to either NF or medication treatment. A second subject who responded to NF was later found out to have been self-medicating with biperidine. At this juncture it cannot be determined whether the improvement is due to NF treatment, the medication or the combination of the two.

Another important factor that NF may be able to address is learned helplessness, their inability to control their obsessions and compulsions, and the inability of their previous treatments in alleviating their condition reinforced their helplessness in overcoming this disorder. Learned helplessness is seen in people with pessimistic explanatory style — which sees negative events as permanent ("it will never change"), personal ("its my fault"), and pervasive ("I can't do anything correctly") — are most likely to suffer from learned helplessness and depression. A common complaint verbalized by all of the subjects in this study was "Am I ever going to get better?", or "Do I have to live with this illness the rest of my life and I should get used to it?" In some cases the fact that they had to get used to living with this illness was conveyed by the physician that they sought treatment from, before coming to our center. Their inability to control their obsessions and compulsions, and the inability of their previous treatments in alleviating their condition reinforced their helplessness in overcoming this disorder. With NF treatment all subjects were actively engaged in their treatment since all of them complied with their schedule and training regimen. In this way the subject's own control systems most probably came into play without any recommendations and/or promoting from the center staff, and they learned how to work to overcome their disorder themselves.

The anatomical basis for OCD is complex and still under investigation although anterior cingulate cortex (ACC) abnormalities are being seen consistently in the pathophysiology of OCD. The ACC can be divided into cognitive (dorsal) and emotional (ventral) components. The dorsal part of the ACC is connected with the prefrontal cortex and...
parietal cortex as well as the motor systems and frontal eye fields." The ventral part has connections to the amygdala, the nucleus accumbens, the hypothalamus, and the anterior insula. It is involved in assessing the importance and relevance of emotional and motivational information. A number of SPECT studies report hyperfrontality (increased right and left anterior prefrontal cortex activity and increased anterior cingulate gyrus activity) and increased basal ganglia activity in obsessive compulsive disorder (OCD).% NF may be involved in helping in the proper self-regulation of these pathways.

The average length of treatment in our study was 1-2 months. This duration is less than seen with pharmacological treatment in OCD. According to the "Practice Guideline For The Treatment of Patients With Obsessive-Compulsive Disorder", prepared by the Work Group On Obsessive-Compulsive Disorder:

Most patients will not experience substantial improvement until 4-6 weeks after starting medication, and some who will ultimately respond will experience little improvement for as many as 10-12 weeks. Successful medication treatment should be continued for 1-2 years before considering a gradual taper by decrements of 10%-25% every 2 months whereas they were suffering with their disorder for years, and taking numerous medications with little or no effect.

When compared to 2 years of treatment, 1-2 months is favorable. Also when the previous treatment history of this group is taken into account we see that the mean of the total number of medications used in the past is 16 (± 2.2), and the mean of the duration of illness was 8.0 years (± 4.7 y.). This group was able to be medication free and functioning within 2 months whereas they were suffering with their disorder for years, and taking numerous medications with little or no effect.

The goal of this study was to investigate the utility of NF as a treatment for OCD. Although the results were positive there are obvious limitations to this study. The male/female ratio was unbalanced; the treatment duration was not controlled showing variability in the number of sessions necessary for treatment, and the investigator and the patient were not blinded as to the treatment. It would be appropriate and useful to investigate whether these results are replicable with better, more controlled study designs, since in this group of patients we were able to see results comparable to those seen after medication treatment.

DISCLOSURE AND CONFLICT OF INTEREST
T. Srum and A. Ertsem have no conflicts of interest in relation to this article.

REFERENCES


