The efficacy of electroencephalogram neurofeedback training in cognition, anxiety, and depression in alcohol dependence syndrome: A case study

Tulika Ghosh,
Masroor Jahan,
Amool R. Singh

Department of Clinical Psychology, Ranchi Institute of Neuro-Psychiatry and Allied Sciences, Kanke, Ranchi, Jharkhand, India

Address for correspondence:
Dr. Tulika Ghosh,
Department of Clinical Psychology, Ranchi Institute of Neuro-Psychiatry and Allied Sciences, Kanke, Ranchi - 834 006, Jharkhand, India.
E-mail: itstulika@yahoo.com

ABSTRACT

Electroencephalogram (EEG) neurofeedback's efficacy in reducing the symptoms of patients with alcohol dependence syndrome is well-documented in previous literature. Here, a case is being described who presented with alcohol dependence syndrome was given EEG neurofeedback training. After 10 sessions of EEG neurofeedback training program, a significant reduction was found in the cognitive deficits, anxiety, and depression of the patient. Furthermore, noticeable improvement was found in his memory and neurological functioning. He also showed a significant reduction in his alcohol intake on follow-up.

Alcohol is a substance that accompanies humanity since its early times and has always occupied a privileged place in all cultures as a fundamental element of religious rituals, source of noncontaminated water or else as a constant presence in celebrations and fraternizations, when there are toasts for everyone and everything. More recent studies have continued to find deficits related to heavy alcohol and other substance use and disorders in various domains of cognition, such as learning, memory, executive functioning and problem-solving, visuospatial and verbal abilities, and speed of information processing.[1-4] Differences in attention and working memory have been found in relation to a range of substances, but they may be especially associated with alcohol use disorders.[5,6]

Vernon *et al.*, did a study in which the volunteers completed a number of neurofeedback sessions requiring them to enhance one aspect of brain activity while simultaneously inhibiting others and found that across both tests that those receiving neurofeedback increased their recall from 70.6% to 81.6%, while recall in the control group only increased from 72.5% to 75.1%.[7] It is evident from the above description that "electroencephalogram (EEG) neurofeedback" plays a pivotal role in reducing the problems associated with alcohol dependence syndrome but further research needs to be done to strengthen the findings of the past researches and to determine the effectiveness of EEG neurofeedback in individuals suffering from alcohol dependence syndrome. The present case study is a demonstration of the efficacy of EEG neurofeedback training in improving the cognitive functions, memory, neurological integration and reducing the symptoms of anxiety and depression in a patient having alcohol dependence syndrome.

CASE REPORT

The patient was a 39-year-old male suffering from alcohol

dependence syndrome, married, Hindu, Hindi-speaking, educated up to tenth standard, working as a contractor, coming from middle socioeconomic status and nuclear family, belonging to urban background of Ranchi, Jharkhand, India. He came to Ranchi Institute of Neuro-Psychiatry and Allied Sciences (RINPAS) outpatient's department with the complaints of consuming alcohol since the last 14 years, decreased sleep and appetite, aggressive, abusive, and assaultive behavior and roaming here and there and hence was brought to RINPAS, Kanke, Ranchi in the month of May 2012 by his father.

History of present illness

The history of his illness suggested that he was maintaining well before 14 years. The mode of onset of the illness was insidious with episodic course and deteriorating progress. He started taking alcohol at the age of 25 years in the company of his friends.

Initially, he used to take a limited amount of alcohol (2–3 pegs occasionally) but slowly he became dependent on alcohol and his intake went on increasing. After marriage, he was not having any job and any issue also which added on to his tensions due to which he started taking more alcohol to reduce his tensions. He started working as a contractor and invested huge amounts of money in his business. But there also, he failed to get the desired amount of success as he used to spend more time in drinking and devoted very less time to his work.

As a result, he suffered from huge loss in his business and whatever money he had earned was wasted in alcohol. Gradually, he started taking alcohol daily in unlimited quantity. Consequently, his sleep and appetite decreased, he started showing aggressive, abusive, and assaultive behavior toward his wife. He was unable to control his drinking, and slowly his drinking habits led to fights between him and his wife, he started abusing and assaulting his family members especially his wife. His parents and wife tried to convince him not to take alcohol but were unsuccessful. The situation went on deteriorating, so he was brought to RINPAS and admitted.

He had been treated in RINPAS in the past, but after discharge, he again relapsed and started taking alcohol. There was no history suggestive of epilepsy, mental retardation, significant head injury, high fever, any other psychoactive substance abuse other than alcohol, and any other major psychiatric or physical illness.

He is the middle child having one elder sister and one younger brother. Both of them are married. The patient had been staying with his father and brother's family. He had a normal upbringing. Academically, he was an average student and was educated up to matriculation. Premorbidly,

he was found to be rigid and wanted his demands to be fulfilled immediately. His family and marital adjustment were not satisfactory because of his alcohol drinking habits.

There was no family history of any psychiatric illness. His mother had diabetes and blood pressure. He did not have any co-morbid psychiatric disorder, vision or hearing impairment, there was no history suggestive of organic pathology, mental retardation, significant physical illness, and no withdrawal features were present during baseline assessment.

At first, rapport was established with him, and clinical interview was conducted. Then he was informed about the whole procedure of test administration, its purpose, and the intervention plan, his informed consent was taken and the baseline assessment was done.

Measures

The following tools were used for assessment:
- Sociodemographic and clinical data sheet
- Alcohol use disorders identification test
- Michigan alcoholism screening test
- Cognitive symptoms checklist (CSC)
- Comprehensive Trail-Making Test
- Wechsler Memory Scale-III
- Quick Neurological Screening Test (QNST)
- Beck Depression Inventory (BDI)
- Hamilton Anxiety Scale
- Multi-channel bio-feedback device.

Therapy package

Multi-channel biofeedback device was used for giving EEG neurofeedback training which was of 40 min each. It has been developed by Thought Technology Ltd. It consists basically of BioGraph Infiniti Multimedia Software and ProComp Infiniti Encoder Hardware as encoding and processing devices. It can give real-time computerized biofeedback and data acquisition. The encoder is able to render a wide and comprehensive range of signs used in clinical observation and biofeedback thought technology's advanced design and active electronic sensors meet rigorous standards for instrument accuracy, sensitivity, durability, and case of use. All sensors are completely noninvasive and require little or no preparation for use. Present study was done using EEG-Z.

Before beginning the sessions with him, Jacobson progressive relaxation training was taught to him in order to make him learn to relax himself and when he learnt to relax himself on his own without the support of the therapist, then the biofeedback sessions were started and additionally he was psycho-educated regarding alcohol and its impact, was made aware of his responsibility in the treatment process, he was told about what he can do in his spare time and thus can prevent himself from taking alcohol.

The techniques to handle craving and how to avoid triggering situations or triggers (peer pressure, domestic issues, seeing a bar) were also described to him. He was also encouraged to become assertive in particular situations like, for example, when he is with his group of friends, and if they ask him to drink alcohol, then he should assertively say no to his friends. Each of these was discussed along with the EEG neurofeedback sessions. In this training, patient was made to sit in a relaxed manner on the chair and with the introduction to the procedure; EEG electrodes were placed on the scalp of the head. The patient was given the neurofeedback of the electrical activities of the brain using the computer screen. Totally, 10 sessions were done on an average of 3–4 times a week which were of 40 min each. Pre- and post-treatment assessment was done.

DISCUSSION

This study was a single case study done to assess the effect of EEG neurofeedback upon a patient with alcohol dependence syndrome. Thus, it is clear from the above findings that EEG neurofeedback has definitely played a very significant role in reducing the symptoms of the patient with Alcohol dependence syndrome [Figure 1]. It is clear that the alpha peak frequency mean, theta mean, low alpha mean, high alpha mean, alpha mean, and beta standard mean have a gradual decline beginning from the first session to the last session. This makes it apparent that as the sessions were progressing or as the patient was gaining more control over his mind and bodily state, he was becoming more able to relax both his mind and body. This finding is consistent with Trudeau's finding that "neurofeedback" treatment for addictions in adults is probably efficacious, and several reported approaches are described with their indications.[8]

The client was given 10 sessions of EEG neurofeedback on an interval of 2 days between each session and the findings from each session are being shown below:

Peniston and Kulkosky applied an alpha-theta brainwave biofeedback training program as a novel treatment technique for chronic alcoholics and found that compared to a nonalcoholic control group and a traditionally treated alcoholic control group, alcoholics receiving brainwave training (BWT) showed significant increases in percentages of EEG record in alpha and theta rhythms, and increased alpha rhythm amplitudes. Alcoholics receiving BWT showed a gradual increase in alpha and theta brain rhythms across the 15 experimental sessions. These experimentally treated alcoholics showed sharp reductions in self-assessed depression (BDI) compared to the control groups. Alcoholics receiving standard medical treatment (abstinence, group psychotherapy, antidepressants) showed a significant elevation in serum beta-endorphin levels at the conclusion of the experiment. 13-month follow-up data indicate sustained prevention of relapse in alcoholics that completed alpha-theta BWT.[9]

As shown in Figure 2, the Hamilton Anxiety Scale score was "11" in the pre-test condition and "6" in the post test condition indicating that mild level of anxiety was present in him after intervention but the intensity had reduced which can be attributed to the biofeedback sessions. According to Watson *et al.*, In an earlier study on patients with alcohol problems, an experimental group given 10 hour-long alpha biofeedback training sessions showed greater improvement on State and Trait Anxiety scores than did a control sample.[10]

Similarly, he had obtained the score of "23" on BDI in the pretest and "19" in the posttest which indicated "mild level of depression" although the intensity had reduced and chief features elicited also reduced from sad mood, sense of failure, lack of satisfaction, self-hate, crying spells and sleep disturbance to sense of failure, self-accusations, crying spells, and irritability. Saxby and Peniston conducted an experimental study of 14 alcoholic outpatients using the Peniston and Kulkosky[11] brainwave treatment protocol

Number of sessions	EEG neurofeedback values					
	Alpha peak frequency mean	Theta mean	Low alpha mean	High alpha mean	Alpha mean	Beta standard mean
1	8.57	18.19	14.16	7.08	16.29	11.32
2	8.93	12.53	8.22	4.68	9.26	5.49
3	8.65	8.97	7.89	3.31	8.56	3.86
4	9.14	7.73	4.97	3.24	5.95	3.66
5	9.04	1.15	0.90	0.53	1.03	0.65
6	9.17	0.59	0.44	0.29	0.53	0.37
7	9.17	0.45	0.33	0.22	0.40	0.31
8	9.17	0.45	0.33	0.22	0.40	0.31
9	8.82	1.96	1.82	0.89	2.01	1.08
10	8.71	1.65	1.38	0.67	1.54	0.75

EEG – Electroencephalogram

Test scores

Variables	Pretest scores	Posttest scores
Hama score	11	8
BDI score	23	19
CTMT T-score sum	120	128
CTMT composite score	21	23
QNST score	29	24
CSC total score	71	47
CSC attention and concentration	20	12
CSC language	9	5
CSC memory	13	9
CSC visual processes	9	6
CSC executive functions	20	15

BDI – Beck depression inventory; CTMT – Comprehensive Trail-Making test; QNST – Quick neurological screening test; CSC – Cognitive symptoms checklist

for alcohol abuse and found that experimentally treated alcoholics with depressive syndrome showed sharp reductions in self-assessed depression (BDI).[12]

On Comprehensive Trail-Making Test, no improvement was found in his cognitive functioning as severe level of impairment was found in both the pretest and posttest conditions. His neurological integration improved from a moderate level of impairment to average neurological integration which is evident from the QNST findings. On CSC, dysfunction was found in the areas of executive functions, memory, and attention/concentration in the pretest conditions whereas in the posttest condition, dysfunction was found only in the area of executive functions. Passini *et al.*, evaluated the therapeutic efficacy of alpha-wave biofeedback treatment for alcoholics and found that the experimental showed more improvement than did controls on alpha production and two anxiety measures. Contradictory results appeared on two suspicion/paranoia measures. Alpha training appeared useful in the treatment of anxiety, but not other problems. However, the absence of significant correlations between the amount of change on alpha and the anxiety measures suggests that the improvement may be due to a placebo effect.[13]

As is shown in Figure 3, the patient showed significant improvement in his WMS-III performance also. His scores on the different domains of the test improved significantly which can be attributed to the therapeutic intervention program. His auditory immediate index was 50 at the preassessment phase which increased to 102 at postassessment.

Similarly, the auditory delayed index score was 80 at preassessment which increased to 92 at postassessment. The visual immediate index was 81 at preassessment and 94 at postassessment. The visual delayed index was 81 at

preassessment which changed to 103 at postassessment. Similarly, immediate memory index score was 57 at preassessment which increased to 98 at postassessment.

The general memory index was 73 at preassessment and 91 at postassessment. The working memory index was 83 at preassessment and 88 at postassessment phase. Thus, it is clear that the patient benefitted with the EEG neurofeedback intervention program. Similar findings were reported by Reiner *et al.* who explored the processes of consolidation of memory during awake hours and hypothesized that elevated theta during awake hours will enhance memory consolidation. They found significant improvement in performance in the theta group, relative to the beta and control groups, immediately after neurofeedback. Performance was further improved after the night sleep in
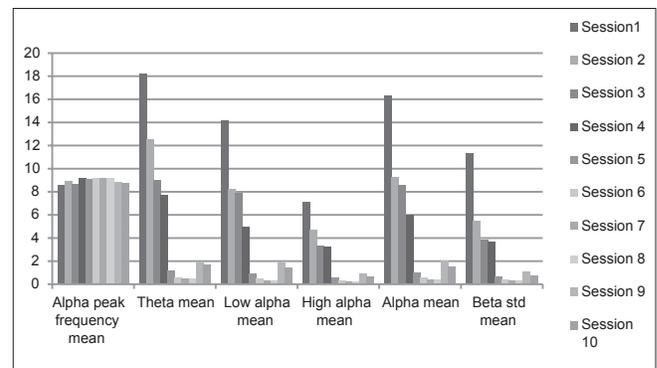

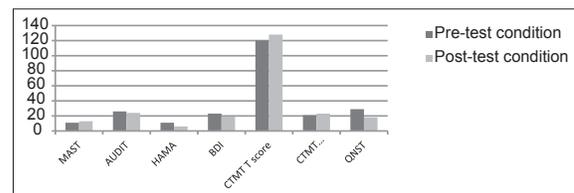**Figure 1:** Graphical representation of the electroencephalogram neurofeedback sessions

Figure 2: Test findings

WMS-III scores

Variables	Pretest scores	Posttest scores
WMS AII	50	102
WMS ADI	80	92
WMS VII	81	94
WMS VDI	81	103
WMS IMI	57	98
WMS ARDI	65	80
WMS GMI	73	91
WMS WMI	83	88
WMS STL percentile rank	9	44
WMS LS percentile rank	3	60
WMS retention percentile rank	32	25
WMS retrieval percentile rank	94	88

WMS – Wechsler memory scale; AII – Auditory immediate index; ADI – Auditory delayed index; VII – Visual immediate index; VDI – Visual delayed index; IMI – Immediate memory index; ARDI – Auditory recognition delayed index; GMI – General memory index; WMI – Working memory index; STL – Single trial learning; LS – Learning slope
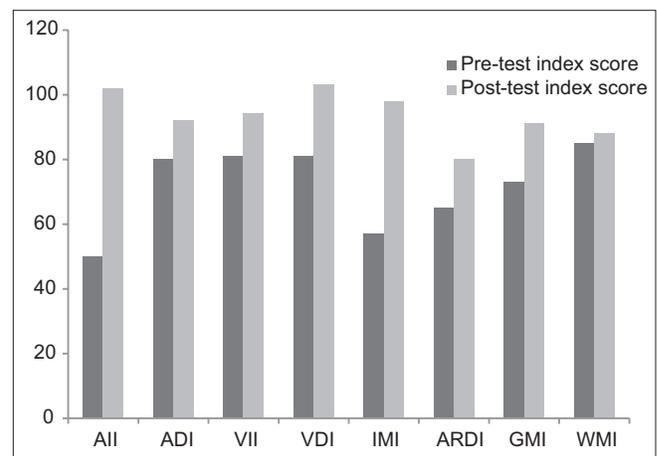

Figure 3: Wechsler Memory Scale-III findings

all groups, with a significant advantage favoring the theta group. Theta power during training was correlated with the level of improvement, indicating a clear relationship between memory consolidation and theta neurofeedback.[14]

Apart from these changes in the patient, his alcohol intake also decreased significantly. Earlier, he used to take alcohol daily, and his intake amount was also excessive. After discharge, he continued taking alcohol but his intake was reduced to once in 2 weeks or even less than that and whenever he used to take alcohol, the amount was limited to 2–5 pegs and not more than that. He had also learnt to refuse when offered to drink by his friends. Thus, it can be said that his assertiveness and self-confidence had also improved.

CONCLUSION

Thus, we can conclude from the findings of this study that EEG biofeedback has a pivotal role in the treatment of patients suffering from alcohol dependence syndrome. But further research needs to be done upon a larger population and patients suffering from other psychiatric disorders as well.

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