



# EEG NEURO-FEEDBACK TRAINING IN RELATION TO COGNITIVE FUNCTIONS OF INDIVIDUALS WITH ALCOHOL DEPENDENCE SYNDROME.

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**Abstract:** This study was undertaken to study the effects of EEG Neuro-feedback Training upon the cognitive functions of individuals with alcohol dependence syndrome. Several previous research studies have found that alcohol has a significant effect upon the cognitive functioning of individuals with alcohol dependence. **Aim:** To assess the role of EEG Neuro-feedback training upon the patients with alcohol dependence syndrome. **Materials and Methods:** The sample for the study comprised of 20 diagnosed cases of alcohol dependence syndrome based on the 10<sup>th</sup> revision of International Classification of Diseases (ICD-10) criteria in the age range of 20-40 years were selected from the different inpatient departments of RINPAS, Kanke, Ranchi and ten participants were randomly assigned to the experimental group and ten individuals were assigned to the control group. A total of ten sessions were given. All participants were assessed using AUDIT, MAST and CSC. EEG Neuro-feedback training was given to the participants of the experimental group using the available multi-channel biofeedback device. Obtained data was analyzed using SPSS-16. **Results:** Findings of Mann Whitney U-Test indicated that there was a significant difference in the scores of both the groups from pre-test to post-test. EEG Neurofeedback group had shown significantly better outcomes as quantified by the percentage of patients scoring less on the outcome variable of Cognitive Symptom Checklist. Conclusion: EEG Neurofeedback training was found to be effective in improving the cognitive functions/symptoms of alcohol dependence syndrome patients at the pre-assessment, post assessment and follow up stage. The findings indicated that the intervention had a significant impact upon the cognitive functions of individuals with alcohol dependence syndrome.

**Index Terms** - Alcohol Dependence, AUDIT, MAST, CSC, EEG Neurofeedback.

## I.INTRODUCTION

**Background:** 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 non-contaminated water or else as a constant presence in celebrations and fraternizations, when there are toasts for everyone and everything.

According to the ICD-10, the dependence syndrome is a "cluster of behavioral, cognitive, and physiological phenomena that develops after repeated substance use and that typically include a strong desire to take the drug, difficulties in controlling its use, persisting in its use despite harmful consequences, a higher priority given to drug use than to other activities and obligations, increased tolerance, and sometimes a physical withdrawal state" (World Health Organization, 1994).

Cognitive functions and abilities are among the most studied and well understood mental phenomena and it has been found that individuals abusing alcohol have a significant level of impairment in the domain of cognitive functioning. The present study was conducted with the aim of assessing the effect of EEG Neuro-feedback training in improving the cognitive functions of patients having Alcohol Dependence Syndrome.

**Materials and Methods:** The study was conducted at Ranchi Institute of Neuropsychiatry and Allied Sciences, Kanke, Ranchi. A sanction from the Institutional Ethical Committee was obtained before starting the study. Written informed consent was obtained from all the participants.

**Study Design:** The study was a center-based exploration study using pre-and-post treatment with control group design and EEG Neurofeedback Training was considered to be the independent variable. Improvement in scores on the Cognitive Symptom Checklist was taken as the dependent variable.

**Sampling Frame:** Diagnosed cases of Alcohol Dependence Syndrome meeting the inclusion and exclusion criteria were part of the study.

**Sampling Technique:** Purposive sampling technique was used. A sample consisting of 20 hospitalized male patients with alcohol dependence syndrome were selected among which, 10 were randomly assigned for EEG Neuro-Feedback training with treatment as usual (experimental group) and 10 of them were assigned for usual treatment only (control group). Both groups were matched on socio-demographic and clinical variables, neuropsychological functioning and medication.

**Sample:** The sample for the study comprised of 20 diagnosed cases of alcohol dependence syndrome. The selection criteria for the study population is given below:

**Inclusion Criteria:**

- Individuals diagnosed as having ADS according to the DCR of ICD-10.
- Educated up to secondary level at least.
- Male patients.
- Age range is within 20 to 40 years.
- Patient who gave informed consent to participate in the study.

**Exclusion criteria:**

- With significant co-morbid psychiatric, physical or neurological conditions.
- History of mental retardation.
- History of other psychoactive substance abuse (except nicotine).
- Family history of mental illness.
- History suggestive of having ECT in the past.

**Procedure:**

The sample comprised of twenty diagnosed cases of alcohol dependence syndrome (diagnosed according to the DCR of ICD-10). The nature and purpose of the study was explained to them. Required history was collected after conducting clinical interviews, from the clients and case record file. Socio-demographic and Clinical Data Sheet were filled for initial information. Baseline assessment of all the patients was done using AUDIT and MAST in order to identify the presence and severity of alcohol use. Cognitive Symptom Checklist was administered to assess impairment in daily functioning due to cognitive problems. After baseline assessment, the drawn sample was randomly divided into two groups- Group A (experimental group) and Group B (control group)

with 10 patients in each group. Both the groups underwent an informal psycho-educational program, along with routine therapeutic intervention (group meeting and pharmacotherapy). However, only the experimental group received the EEG Neuro-Feedback Program in addition, continuously for three weeks and the total number of sessions was ten sessions for each individual which was given to them in a structured form. The duration of each session was 40 minutes, on average three to five sessions a week. In this training, individuals were first taught the “Progressive Muscular Relaxation” exercise, then the EEG Neuro-Feedback Training was started. The patients of the experimental group were reassessed after completion of three weeks of training. The patients of the control group were also re-assessed after three weeks of baseline assessment. The follow-up data was taken from all the patients of experimental and control group, who came for follow up after 20 weeks. The following tools were administered:

- Consent Form
- Socio-demographic and Clinical Data Sheet
- Alcohol Use Disorders Identification Test
- Michigan Alcoholism Screening Test
- Cognitive Symptoms Checklist

**STATISTICAL ANALYSIS:** The Statistical analysis was done with the help of Statistical Package for Social Sciences-16(SPSS-16).

### RESULTS: SAMPLE CHARACTERISTICS

The socio-demographic variables which were categorical in nature were analyzed using Chi-square test. The comparison between experimental and control group on the socio-demographic variables which were categorical in nature have been shown in Table 1. After the analysis, it was found that among the experimental group, 40% were in the age range of 20-30 years and 60% were in the age range of 30-40 years and among the control group, 30% were in the age range of 20-30 years and 70% were in 30-40 years of age range. There was no significant difference found between the experimental and control group regarding the age ( $\chi^2=0.220$ ,  $p>0.05$ ). All the participants were male. It shows that in both the groups, majority of the patients were married ( $\chi^2=3.086$ ,  $p>0.05$ ). In terms of employment, 20% of participants were unemployed, 70% were employed and 10% had their own business in the experimental group whereas in the control group, 30% were unemployed, 30% employed, 10% were involved in agriculture and 30% of them had their own business. There was no significant difference found between the two groups in terms of employment ( $\chi^2=3.800$ ,  $p>0.05$ ). In both the groups, maximum participants belonged to the middle socio-economic status and there was no significant difference between the two groups in respect to their socio-economic status ( $\chi^2=1.286$ ,  $p>0.05$ ), 60% experimental participants were from urban background, 30% were from semi-urban background and 10% were from rural background whereas 50% of the control participants were from semi urban background, 40% were from urban background and 10% were from rural background. No significant difference was found between the two groups in respect of their place of residence also ( $\chi^2=0.900$ ,  $p>0.05$ ). It was also found that maximum participants of both the groups were Hindu by religion ( $\chi^2=1.00$ ,  $p>0.05$ ) and were residing in nuclear family ( $\chi^2=0.00$ ,  $p>0.05$ ). Thus, it can be concluded that there was no significant difference between the experimental and control group in any of the socio demographic characteristics i.e., age, marital status, occupation, socio-economic status, socio-cultural background, religion, family type and place of residence.

TABLE-1: COMPARISON BETWEEN EXPERIMENTAL AND CONTROL GROUP ON SOCIO-DEMOGRAPHIC

## DETAILS (CATEGORY VARIABLES)

| S. No | Variables             |                 | Groups             |               | Chi square (df) | P Value |
|-------|-----------------------|-----------------|--------------------|---------------|-----------------|---------|
|       |                       |                 | Experimental group | Control group |                 |         |
| 1.    | Age                   | 20-30 Yrs       | 4 (40%)            | 3 (30%)       | 0.220<br>(1)    | 0.639   |
|       |                       | 30-40 Yrs       | 6 (60%)            | 7 (70%)       |                 |         |
| 2.    | Sex                   | Male            | 10 (100%)          | 10 (100%)     |                 |         |
| 3.    | Marital Status        | Married         | 6 (60%)            | 8 (80%)       | 3.086<br>(2)    | 0.214   |
|       |                       | Un-married      | 4 (40%)            | 1 (10%)       |                 |         |
|       |                       | Widower/divorce | 0 (00%)            | 1 (10%)       |                 |         |
| 4.    | Occupation            | Unemployed      | 2 (20%)            | 3 (30%)       | 3.800<br>(3)    | 0.284   |
|       |                       | Employed        | 7 (70%)            | 3 (30%)       |                 |         |
|       |                       | Agriculture     | 0 (00%)            | 1 (10%)       |                 |         |
|       |                       | Business        | 1 (10%)            | 3 (30%)       |                 |         |
| 5.    | Socio-economic Status | Lower           | 1 (10%)            | 3 (30%)       | 1.286<br>(2)    | 0.526   |
|       |                       | Middle          | 8 (80%)            | 6 (60%)       |                 |         |
|       |                       | Upper           | 1 (10%)            | 1 (10%)       |                 |         |
| 6.    | Place of Residence    | Rural           | 1 (10%)            | 1 (10%)       | 0.900<br>(2)    | 0.638   |
|       |                       | Semi - Urban    | 3 (30%)            | 5 (50%)       |                 |         |
|       |                       | Urban           | 6 (60%)            | 4 (40%)       |                 |         |
| 7.    | Religion              | Hindu           | 5 (50%)            | 7 (70%)       | 1.00<br>(2)     | 0.607   |
|       |                       | Islam           | 1 (10%)            | 1 (10%)       |                 |         |
|       |                       | Christian       | 4 (40%)            | 2 (20%)       |                 |         |
| 8.    | Family Type           | Joint           | 1 (10%)            | 1 (10%)       | 0.00<br>(1)     | 1.000   |
|       |                       | Nuclear         | 9 (90%)            | 9 (90%)       |                 |         |

The clinical variables which were categorical in nature were analyzed using Chi-square test. The comparison between experimental and control group on the clinical variables has been shown in Table 2. After analysis, it was found that among the experimental group, 90% had an insidious onset and 10% had an acute onset while in the case of control group 100% patients had insidious onset. The progress of illness was deteriorating in all the patients of the experimental group (100%) while it was deteriorating in 90% and improving in 10% patients of the control group. The course of illness was found continuous in 90% and episodic in 10% of experimental group patients while it was found continuous in all the control group patients (100%). A comparison between the experimental and control group regarding mode of onset ( $\chi^2=1.053$ ,  $p>0.05$ ), course of illness ( $\chi^2=1.053$ ,  $p>0.05$ ) and progress of illness (chi-square=1.053,  $p>0.05$ ) shows that there was no significant difference between the experimental and control group in terms of these three variables. Thus, it is clear that the mode of onset was insidious, course was continuous, and progress of illness was deteriorating in maximum participants of both the experimental and control group. These findings suggest that both groups were approximately the same on these variables.

**TABLE-2: COMPARISON BETWEEN EXPERIMENTAL AND CONTROL GROUP ON CLINICAL DETAILS****(CATEGORY VARIABLES)**

| S.No | Variables              |               | Groups                |               | Chi square<br>(df) | p<br>value |
|------|------------------------|---------------|-----------------------|---------------|--------------------|------------|
|      |                        |               | Experimental<br>group | Control group |                    |            |
| 1    | Mode of Onset          | Acute         | 1 (10%)               | 0 (00%)       | 1.053<br>(1)       | 0.305      |
|      |                        | Insidious     | 9 (90%)               | 10 (100%)     |                    |            |
| 2    | Course of Illness      | Continuous    | 9 (90%)               | 10 (100%)     | 1.053<br>(1)       | 0.305      |
|      |                        | Episodic      | 1 (10%)               | 0 (00%)       |                    |            |
| 3    | Progress of<br>Illness | Deteriorating | 10 (100%)             | 9 (90%)       | 1.053<br>(1)       | 0.305      |
|      |                        | Improving     | 0 (00%)               | 1 (10%)       |                    |            |

Table 3 shows the comparison between the experimental and control group on the different socio-demographic and clinical variables that were continuous in nature. To compare both groups on these variables, Mann-Whitney U Test was used and for description purpose mean value was calculated for these variables. After the analysis, it was found that the mean score for education was  $11.00 \pm 0.91$  and  $11.30 \pm 0.75$  for the experimental and control group respectively and no significant difference was found between experimental and control group in terms of educational level ( $Z=0.472$ ,  $p>0.05$ ). The mean age at illness onset for the experimental and control groups was found  $20.00 \pm 1.34$  years and  $18.70 \pm 1.24$  years respectively. Similarly, the mean duration of illness (in years) for the experimental and control groups was found  $14.30 \pm 1.68$  years and  $14.80 \pm 2.15$  years respectively. Analysis revealed that there was no significant difference between experimental and control group regarding age of onset ( $Z=0.873$ ,  $p>0.05$ ) and duration of illness ( $Z=0.594$ ,  $p>0.05$ ). These findings suggest that experimental and control group were approximately the same on these variables.

**TABLE-3: COMPARISON BETWEEN EXPERIMENTAL AND CONTROL GROUP ON SOCIO-DEMOGRAPHIC DETAILS (CONTINUOUS VARIABLES)**

| S. No | Variable               | Group (Mean $\pm$ SD) |                  | Mean Rank             |                  | U<br>Value | Z Value | p Value |
|-------|------------------------|-----------------------|------------------|-----------------------|------------------|------------|---------|---------|
|       |                        | Experimental<br>Group | Control<br>Group | Experimental<br>Group | Control<br>Group |            |         |         |
| 1.    | Education              | $11.00 \pm 0.91$      | $11.30 \pm 0.75$ | 9.90                  | 11.10            | 44.00      | -0.472  | 0.637   |
| 2.    | Age of onset           | $20.00 \pm 1.34$      | $18.70 \pm 1.24$ | 11.65                 | 09.35            | 38.50      | -0.873  | 0.383   |
| 3.    | Duration of<br>illness | $14.30 \pm 1.68$      | $14.80 \pm 2.15$ | 09.80                 | 11.20            | 43.00      | -0.532  | 0.594   |

**TABLE-4: COMPARISON BETWEEN FIRST SESSION AND TENTH SESSION OF EEG NEURO-FEEDBACK IN TERMS OF MEAN FREQUENCY OF DIFFERENT WAVES IN EXPERIMENTAL GROUP**

| S. No | Variable                  | Group (Mean $\pm$ SD) |                 | Wilcoxon Sign Rank Test |               |         |         |
|-------|---------------------------|-----------------------|-----------------|-------------------------|---------------|---------|---------|
|       |                           |                       |                 | Mean Rank               |               | Z Value | P Value |
|       |                           | Pre-Assessment        | Post Assessment | Negative Rank           | Positive Rank |         |         |
| 1.    | Alpha peak frequency mean | 9.17 $\pm$ 0.44       | 6.72 $\pm$ 2.47 | 6.25                    | 2.50          | -2.293  | 0.022   |
| 2.    | Theta mean                | 14.34 $\pm$ 5.35      | 6.36 $\pm$ 5.44 | 5.89                    | 2.00          | -2.599  | 0.009   |
| 3.    | Low alpha mean            | 10.89 $\pm$ 3.76      | 5.15 $\pm$ 4.46 | 6.50                    | 1.50          | -2.497  | 0.013   |
| 4.    | High alpha mean           | 7.04 $\pm$ 2.54       | 3.00 $\pm$ 2.72 | 6.00                    | 1.00          | -2.701  | 0.007   |
| 5.    | Alpha mean                | 13.05 $\pm$ 4.53      | 5.98 $\pm$ 5.21 | 5.89                    | 2.00          | -2.599  | 0.009   |
| 6.    | Beta mean                 | 10.74 $\pm$ 3.05      | 4.02 $\pm$ 3.29 | 6.00                    | 1.00          | -2.701  | 0.007   |

**COMPARISON BETWEEN EXPERIMENTAL AND CONTROL GROUP ON DIFFERENT VARIABLES AT BASELINE:** To compare the experimental and control group on cognitive functioning, the scores of both the groups on were compared using Mann-Whitney U Test. After analysis, it was found that the mean score for MAST for the experimental and control group was 15.60 $\pm$ 3.27 and 12.80 $\pm$ 3.82 respectively and that there was no significant difference between both the groups on MAST Scores at pre assessment (Z= -1.555, p>0.05). Similarly in AUDIT, the mean score was found to be 30.70 $\pm$ 4.14 and 28.10 $\pm$ 5.47 for both the groups respectively (Z=-1.138, p>0.05). This finding indicates that there was no significant difference between the two groups on the frequency and severity of alcohol use.

Thus, based on the above findings, it can be concluded that there was no significant difference between both groups in terms of cognitive functioning.

**TABLE-5: COMPARISON BETWEEN EXPERIMENTAL AND CONTROL GROUP ON DIFFERENT VARIABLES AT BASE LINE**

| S. No | Variable    | Group (Mean $\pm$ SD) |                  | Mean Rank          |               | U value | Z Value | p Value |
|-------|-------------|-----------------------|------------------|--------------------|---------------|---------|---------|---------|
|       |             | Experimental Group    | Control Group    | Experimental Group | Control Group |         |         |         |
| 1.    | MAST Score  | 15.60 $\pm$ 3.27      | 12.80 $\pm$ 3.82 | 12.55              | 08.45         | 29.50   | -1.555  | 0.120   |
| 2.    | AUDIT Score | 30.70 $\pm$ 4.14      | 28.10 $\pm$ 5.47 | 12.00              | 09.00         | 35.00   | -1.138  | 0.255   |

Table 6 shows the comparison between experimental and control group on the scores of Cognitive Symptoms Checklist which was done using Mann-Whitney U Test. It was found after analyzing the data that the CSC mean total score was 88.00 $\pm$ 69.85 and 79.30 $\pm$ 20.94 for the experimental and control group respectively and that there was no significant difference between both the groups (Z=-0.530, p>0.05). The mean score in the attention and concentration domain was 24.80 $\pm$ 5.30 for the experimental group and 20.30 $\pm$ 7.13 for the control group and there was no significant difference between the two groups in this domain (Z=-1.631, p>0.01). In the language domain, the mean score was found 14.40 $\pm$ 14.30 and 12.60 $\pm$ 3.89 for the experimental and control group respectively. There was no significant difference between both the groups in the language domain also (Z=-0.304, p>0.05). The mean score was 15.40 $\pm$ 19.09 and 13.30 $\pm$ 6.63 for experimental and control group respectively in the memory domain and no significant difference was found between these two groups (Z=0.492, p>0.05). In the visual processes' domain, the mean score was found 16.40 $\pm$ 20.58 for the experimental group and 13.30 $\pm$ 6.63 for the control group and further, no significant difference was found between both groups on this domain (Z=-0.530, p>0.05). These findings indicate that there was no significant difference between

the two groups in respect to different domains of CSC and corresponding daily functioning due to cognitive disturbances. Hence, it can be said that both groups were approximately the same on these variables prior to the intervention.

**TABLE-6: COMPARISON BETWEEN EXPERIMENTAL AND CONTROL GROUP ON COGNITIVE SYMPTOMS CHECKLIST AT BASE LINE**

| S. No. | Variables                 | Group (Mean $\pm$ SD) |                   | Mean Rank          |               | U Value | Z Value | p Value |
|--------|---------------------------|-----------------------|-------------------|--------------------|---------------|---------|---------|---------|
|        |                           | Experimental Group    | Control Group     | Experimental Group | Control Group |         |         |         |
| 1.     | Total Score               | 88.00 $\pm$ 69.85     | 79.30 $\pm$ 20.94 | 09.80              | 11.20         | 43.00   | -0.530  | 0.596   |
| 2.     | Attention & Concentration | 24.80 $\pm$ 5.30      | 20.30 $\pm$ 7.13  | 12.65              | 08.35         | 28.50   | -1.631  | 0.103   |
| 3.     | Language                  | 14.40 $\pm$ 14.30     | 12.60 $\pm$ 3.89  | 10.10              | 10.90         | 46.00   | -0.304  | 0.761   |
| 4.     | Memory                    | 15.40 $\pm$ 19.09     | 13.30 $\pm$ 6.63  | 09.85              | 11.15         | 43.50   | -0.492  | 0.623   |
| 5.     | Visual Processes          | 16.40 $\pm$ 20.58     | 15.10 $\pm$ 8.37  | 09.80              | 11.20         | 43.00   | -0.530  | 0.596   |
| 6.     | Executive Function        | 17.00 $\pm$ 16.82     | 18.00 $\pm$ 10.49 | 09.30              | 11.70         | 38.00   | -0.909  | 0.363   |

**EFFICACY OF EEG NEURO-FEEDBACK TRAINING:** To find out the efficacy of intervention program, differences between the baseline and after intervention scores were calculated for both the experimental and control groups by using Wilcoxon's Sign Rank Test. For the same purpose comparison was made between experimental and control group on post assessment by using Mann-Whitney U Test to find out group differences in cognitive functioning.

After the analysis, the mean score on MAST was found 13.30 $\pm$ 2.58 and 12.50 $\pm$ 3.50 for the experimental and control group respectively in post assessment. Further no significant difference was found between both the groups on MAST scores ( $Z = -0.269$ ,  $p > 0.05$ ). The mean AUDIT score was found 23.40 $\pm$ 4.72 for the experimental group and 27.30 $\pm$ 5.35 for the control group and similarly, again, no significant difference was found between both groups on this test ( $Z = -1.632$ ,  $p > 0.05$ ). This indicates that there was no significant difference between the two groups in the level and severity of alcohol use. Although, they were abstinent from alcohol during the post assessment sessions but since these are screening tools, their answers were based upon the time of their alcohol intake.

**TABLE-7: COMPARISON BETWEEN EXPERIMENTAL GROUP AND CONTROL GROUP ON DIFFERENT VARIABLES AT POST ASSESSMENT**

| S. No | Variable    | Group (Mean $\pm$ SD) |                  | Mean Rank          |               | U Value | Z Value | p Value |
|-------|-------------|-----------------------|------------------|--------------------|---------------|---------|---------|---------|
|       |             | Experimental Group    | Control Group    | Experimental Group | Control Group |         |         |         |
| 1.    | MAST Score  | 13.30 $\pm$ 2.58      | 12.50 $\pm$ 3.50 | 10.85              | 10.15         | 46.50   | -0.269  | 0.788   |
| 2.    | AUDIT Score | 23.40 $\pm$ 4.72      | 27.30 $\pm$ 5.35 | 08.35              | 12.65         | 28.50   | -1.632  | 0.103   |

Table 8 shows the comparison between experimental group and control group on different variables of cognitive symptoms checklist at post assessment which was done using Mann-Whitney U Test. After analysis, the mean CSC total score was found 49.20 $\pm$ 44.86 and 86.10 $\pm$ 23.88 for the experimental and control group respectively. In attention and concentration domain, the mean score was found 13.70 $\pm$ 5.37 for the experimental group and 21.90 $\pm$ 7.41 for the control group. In the language domain, the mean score was found 8.00 $\pm$ 11.38 and 14.40 $\pm$ 4.99 for the experimental and control group respectively. In the memory domain, the mean score was found 8.90 $\pm$ 11.15 and 14.20 $\pm$ 5.99 for the experimental and control group respectively. All of these findings revealed that



experimental group scored significantly lower on these domains in comparison to control group ( $p < 0.05$ ). On this test, lower score suggests better cognitive functioning and less cognitive symptoms, hence, experimental group was better in comparison to control group on the domains of CSC. Apart from the above findings, no significant difference was found between experimental and control groups in the domain of visual processes and executive functioning ( $p > 0.05$ ). In the visual processes' domain, the mean score was found  $8.30 \pm 10.32$  for the experimental group and  $17.40 \pm 10.09$  for the control group. In the executive functions' domain, the mean score was found  $10.30 \pm 12.27$  and  $18.20 \pm 11.85$  for the experimental and control group respectively. These findings revealed that though experimental group performed better on these domains in comparison to control group, its performance was not significantly better.

**TABLE-8: COMPARISON BETWEEN EXPERIMENTAL GROUP AND CONTROL GROUP ON COGNITIVE SYMPTOMS CHECKLIST AT POST ASSESSMENT**

| S. No | Variable                  | Group (Mean $\pm$ SD) |                   | Mean Rank          |               | U Value | Z Value | p Value |
|-------|---------------------------|-----------------------|-------------------|--------------------|---------------|---------|---------|---------|
|       |                           | Experimental Group    | Control Group     | Experimental Group | Control Group |         |         |         |
| 1.    | Total Score               | 49.20 $\pm$ 44.86     | 86.10 $\pm$ 23.88 | 07.15              | 13.85         | 16.50   | -2.242  | 0.011   |
| 2.    | Attention & Concentration | 13.70 $\pm$ 5.37      | 21.90 $\pm$ 7.41  | 07.55              | 13.45         | 20.50   | -2.242  | 0.025   |
| 3.    | Language                  | 8.00 $\pm$ 11.38      | 14.40 $\pm$ 4.99  | 07.10              | 13.90         | 16.00   | -2.580  | 0.010   |
| 4.    | Memory                    | 8.90 $\pm$ 11.15      | 14.20 $\pm$ 5.99  | 07.85              | 13.15         | 23.50   | -2.006  | 0.045   |
| 5.    | Visual Processes          | 8.30 $\pm$ 10.32      | 17.40 $\pm$ 10.09 | 08.05              | 12.95         | 25.50   | -1.858  | 0.063   |
| 6.    | Executive Function        | 10.30 $\pm$ 12.27     | 18.20 $\pm$ 11.85 | 08.35              | 12.65         | 28.50   | -1.627  | 0.104   |

Table 9 shows the comparison between the different test variables in the pre-test and post-test assessment sessions of the experimental group. For this analysis, Wilcoxon Sign Rank Test was used. After the analysis, it was found that the mean score for MAST was found  $15.60 \pm 3.27$  and  $13.30 \pm 2.58$  in the pre-test and post-test assessment sessions respectively. In AUDIT, the mean score for each of the sessions were  $30.70 \pm 4.14$  and  $23.40 \pm 4.72$ .

**TABLE-9: COMPARISON BETWEEN PRE AND POST ASSESSMENT IN EXPERIMENTAL GROUP ON DIFFERENT VARIABLES**

| S. No | Variable    | Group (Mean $\pm$ SD) |                  | Wilcoxon Sign Rank Test |               |         |         |
|-------|-------------|-----------------------|------------------|-------------------------|---------------|---------|---------|
|       |             | Pre-Assessment        | Post Assessment  | Mean Rank               |               | Z Value | p Value |
|       |             |                       |                  | Negative Rank           | Positive Rank |         |         |
| 1.    | MAST Score  | 15.60 $\pm$ 3.27      | 13.30 $\pm$ 2.58 | 05.50                   | 00.00         | -2.829  | 0.005   |
| 2.    | AUDIT Score | 30.70 $\pm$ 4.14      | 23.40 $\pm$ 4.72 | 05.50                   | 00.00         | -2.814  | 0.005   |

Table 10 shows the comparison between the scores of pre and post assessment phase in the different domains of cognitive symptoms checklist for the experimental group. For this comparison, Wilcoxon Sign Rank Test was used. After the analysis, the mean score on CSC total score was found  $88.00 \pm 69.85$  and  $49.20 \pm 44.86$  in pre-test and post-test phase of the experimental group respectively. A significant difference was found between these two phases of assessment ( $Z = -2.803$ ,  $p < 0.05$ ). This finding indicates that the experimental group had improved significantly on this domain of CSC in the post assessment phase as compared to the pre-assessment phase. In the attention and concentration domain, the mean score was found  $24.80 \pm 5.30$  and  $13.70 \pm 5.37$  in the pre and post-test assessment sessions respectively. The difference between these two assessment phases was found significant ( $Z = -2.810$ ,



$p < 0.05$ ) indicating that the experimental group had improved significantly in the attention and concentration domain from the pre-intervention phase to the post-assessment phase. The mean score in the language domain was found  $14.40 \pm 14.30$  and  $8.00 \pm 11.38$  in pre-test and post-test sessions respectively. Here also, the difference between the two assessment phases was found significant ( $Z = -2.668$ ,  $p < 0.05$ ), indicating that the experimental group had improved from the pre-assessment phase to the post assessment phase. The mean score in the memory domain was found  $15.40 \pm 19.09$  and  $8.90 \pm 11.15$  pre-test and post-test phases. The difference between these two phases was also found significant ( $Z = -2.668$ ,  $p < 0.05$ ), suggesting that the experimental group had improved in this domain also in the post assessment phase as compared to the pre-assessment phase. In visual processes domain, the mean score was found  $16.40 \pm 20.58$  and  $8.30 \pm 10.32$  in the pre-test phase and post-test phase respectively. The difference between these two assessment phases was found to be significant ( $Z = -2.536$ ,  $p < 0.05$ ), indicating that the experimental group had improved significantly in this domain also on post assessment as compared to the pre-assessment phase. The mean score in the executive functions' domain was found  $17.00 \pm 16.82$  and  $10.30 \pm 12.27$  in the pre-test and post-test phase respectively. Here, the difference between the assessments of both phases was not found significant ( $Z = -2.670$ ,  $p < 0.01$ ) indicating that though the experimental group had improved in this domain of CSC, this improvement was not significant. Thus, based on the obtained findings, it can be summarized that the difference between the assessment of two sessions was found to be significant in all the domains of CSC except the executive functions' domain indicating that the experimental group showed improvements in all the domains of CSC except the domain of executive functions in post assessment.

**TABLE-10: COMPARISON BETWEEN PRE AND POST ASSESSMENT IN EXPERIMENTAL GROUP ON COGNITIVE SYMPTOMS CHECKLIST**

| S. No | Variables                 | Group (Mean $\pm$ SD) |                   | Wilcoxon Sign Rank Test |               |         |         |
|-------|---------------------------|-----------------------|-------------------|-------------------------|---------------|---------|---------|
|       |                           |                       |                   | Mean Rank               |               | Z Value | P Value |
|       |                           | Pre-Assessment        | Post Assessment   | Negative Rank           | Positive Rank |         |         |
| 1.    | Total Score               | 88.00 $\pm$ 69.85     | 49.20 $\pm$ 44.86 | 05.50                   | 00.00         | -2.803  | 0.005   |
| 2.    | Attention & concentration | 24.80 $\pm$ 5.30      | 13.70 $\pm$ 5.37  | 05.50                   | 00.00         | -2.810  | 0.005   |
| 3.    | Language                  | 14.40 $\pm$ 14.30     | 8.00 $\pm$ 11.38  | 05.50                   | 00.00         | -2.668  | 0.008   |
| 4.    | Memory                    | 15.40 $\pm$ 19.09     | 8.90 $\pm$ 11.15  | 05.50                   | 00.00         | -2.668  | 0.008   |
| 5.    | Visual Processes          | 16.40 $\pm$ 20.58     | 8.30 $\pm$ 10.32  | 04.50                   | 00.00         | -2.536  | 0.011   |
| 6.    | Executive Function        | 17.00 $\pm$ 16.82     | 10.30 $\pm$ 12.27 | 05.50                   | 00.00         | -2.670  | 0.008   |

Table 11 shows the comparison between pre-assessment and post assessment scores of the control group on different measures. For this analysis, Wilcoxon Sign Rank Test was used. After the analysis, it was found that the mean score was found  $12.80 \pm 3.82$  and  $12.50 \pm 3.50$  for MAST in the pre and post assessment sessions respectively. The mean AUDIT score was found  $28.10 \pm 5.47$  and  $27.30 \pm 5.35$  in the pre and post assessment sessions respectively.

**TABLE-11: COMPARISON BETWEEN PRE AND POST ASSESSMENT IN CONTROL GROUP ON DIFFERENT VARIABLES**

| S. No | Variable    | Group (Mean $\pm$ SD) |                  | Wilcoxon Sign Rank Test |               |         |         |
|-------|-------------|-----------------------|------------------|-------------------------|---------------|---------|---------|
|       |             |                       |                  | Mean Rank               |               | Z Value | p Value |
|       |             | Pre-Assessment        | Post Assessment  | Negative Rank           | Positive Rank |         |         |
| 1.    | MAST Score  | 12.80 $\pm$ 3.82      | 12.50 $\pm$ 3.50 | 02.67                   | 02.00         | -1.134  | 0.257   |
| 2.    | AUDIT Score | 28.10 $\pm$ 5.47      | 27.30 $\pm$ 5.35 | 05.93                   | 04.50         | -1.512  | 0.131   |

Table 12 shows the comparison between the pre and post assessment phase in the different domains of cognitive symptoms checklist of the control group. For this comparison, Wilcoxon Sign Rank Test was used. After the analysis, it was found that the mean total score on CSC was found  $79.30 \pm 20.94$  and  $86.10 \pm 23.88$  in the pre and post assessment sessions respectively. A significant difference was found between both the assessment phases ( $Z = -2.524$ ,  $p < 0.01$ ). This finding indicates that the control group had deteriorated further on this domain in the post assessment phase as compared to the pre-assessment phase. The mean score on the attention and concentration domain was found  $20.30 \pm 7.13$  and  $21.90 \pm 7.41$  in the pre and post assessment sessions respectively. No significant difference was found between both the assessment phases on this domain ( $Z = -1.696$ ,  $p > 0.05$ ) indicating that there was no significant change in the control group on this domain in the post assessment phase as compared to the pre-assessment phase. In the language domain, the mean score was found  $12.60 \pm 3.89$  and  $14.40 \pm 4.99$  in the pre and post assessment sessions respectively. Significant difference was found between the two phases on this domain ( $Z = -2.214$ ,  $p < 0.01$ ) indicating that the control group had deteriorated further on this domain in the post assessment phase as compared to the pre-assessment phase. The mean score in the memory domain was  $13.30 \pm 6.63$  and  $14.20 \pm 5.99$  of both the sessions respectively. There was no significant difference between both the assessment phases ( $Z = -0.736$ ,  $p > 0.01$ ) indicating that there was no significant change in the control group on this domain in the post assessment phase as compared to the pre-assessment phase. The mean score in visual processes domain was found  $15.10 \pm 8.37$  and  $17.40 \pm 10.09$  respectively for the pre and post assessment sessions. Significant difference was found between both the assessment phases on this domain ( $Z = -2.120$ ,  $p < 0.01$ ). This finding indicates that the control group had deteriorated further on this domain in the post assessment phase as compared to the pre-assessment phase. The mean score in executive function domain was found  $18.00 \pm 10.49$  and  $18.20 \pm 11.85$  in the pre and post assessment sessions respectively. There was no significant difference between the pre-and post-assessment phases on the scores of this domain ( $Z = -0.085$ ,  $p > 0.05$ ) indicating that there was no significant change in the control group on this domain in the post assessment phase as compared to the pre-assessment phase. The overall findings suggest that there was no significant change in the scores of attention and concentration, memory and executive function domains. Apart from this, however there was significant change in the domains of CSC total score, language and visual processes domain in the post assessment phase as compared to the pre-assessment phase which indicates that control group deteriorated further in the post assessment phase in comparison to the pre-assessment phase.

**TABLE-12: COMPARISON BETWEEN PRE AND POST ASSESSMENT IN CONTROL GROUP ON COGNITIVE SYMPTOM CHECKLIST**

| S. No | Variable                  | Group (Mean $\pm$ SD) |                   | Wilcoxon Sign Rank Test |               |         |         |
|-------|---------------------------|-----------------------|-------------------|-------------------------|---------------|---------|---------|
|       |                           |                       |                   | Mean Rank               |               | Z Value | P Value |
|       |                           | Pre-Assessment        | Post Assessment   | Negative Rank           | Positive Rank |         |         |
| 1.    | Total Score               | $79.30 \pm 20.94$     | $86.10 \pm 23.88$ | 00.00                   | 04.50         | -2.524  | 0.012   |
| 2.    | Attention & Concentration | $20.30 \pm 7.13$      | $21.90 \pm 7.41$  | 04.00                   | 04.00         | -1.696  | 0.090   |
| 3.    | Language                  | $12.60 \pm 3.89$      | $14.40 \pm 4.99$  | 00.00                   | 03.50         | -2.214  | 0.027   |
| 4.    | Memory                    | $13.30 \pm 6.63$      | $14.20 \pm 5.99$  | 03.00                   | 02.33         | -0.736  | 0.461   |
| 5.    | Visual Processes          | $15.10 \pm 8.37$      | $17.40 \pm 10.09$ | 01.50                   | 04.42         | -2.120  | 0.034   |
| 6.    | Executive Function        | $18.00 \pm 10.49$     | $18.20 \pm 11.85$ | 04.83                   | 03.38         | -0.085  | 0.932   |

**DURABILITY OF EEG NEURO-FEEDBACK TRAINING:** To find out the durability of intervention program, comparison between post assessment scores and follow up scores on the frequency and severity of alcohol use, cognitive functioning of the experimental and control group was done using Wilcoxon Sign Rank Test.

After the analysis, it was found that the mean MAST score was  $13.30 \pm 2.58$  and  $11.40 \pm 2.01$  in the post assessment and follow up assessment respectively. Significant difference was found between both the assessment phases on this domain ( $Z = -2.850$ ,  $p < 0.01$ ). This finding indicates that the experimental group not only maintained the therapeutic gain on this domain as measured on the follow up session but also showed further improvement. The mean AUDIT score was found  $23.40 \pm 4.72$  in the post assessment

session and  $18.90 \pm 4.04$  in the follow up session. The difference between both the assessment phases was found significant ( $Z = -2.809$ ,  $p < 0.01$ ), indicating that the experimental group maintained the therapeutic gain and showed further improvement on this domain. Overall findings suggest that the difference obtained between the post and follow up scores of all the variables was significant and that the therapeutic gain obtained by the experimental group after intervention was maintained by them on follow up. Apart from maintaining the therapeutic gain they further improved on most of the domains.

**TABLE 13: COMPARISON BETWEEN POST AND FOLLOW-UP ASSESSMENT IN EXPERIMENTAL GROUP ON DIFFERENT VARIABLES**

| S. No. | Variable    | Group (Mean $\pm$ SD) |                  | Wilcoxon Sign Rank Test |               |         |         |
|--------|-------------|-----------------------|------------------|-------------------------|---------------|---------|---------|
|        |             | Post Assessment       | Follow Up        | Mean Rank               |               | Z Value | p Value |
|        |             |                       |                  | Negative Rank           | Positive Rank |         |         |
| 1.     | MAST Score  | 13.30 $\pm$ 2.58      | 11.40 $\pm$ 2.01 | 05.50                   | 00.00         | -2.850  | 0.004   |
| 2.     | AUDIT Score | 23.40 $\pm$ 4.72      | 18.90 $\pm$ 4.04 | 05.50                   | 00.00         | -2.809  | 0.005   |

Table 14 shows the comparison between the post assessment and follow up assessment scores of the experimental group on Cognitive Symptom Checklist. For this analysis, Wilcoxon Sign Rank Test was used. After the analysis, it was found that the mean CSC total score was  $49.20 \pm 44.86$  and  $41.70 \pm 41.02$  in the post assessment and follow up assessment respectively. Significant difference was found between both the assessment phases on this domain ( $Z = -2.670$ ,  $p < 0.01$ ). This finding indicates that the experimental group had maintained the therapeutic gain on follow up on this domain and showed further improvement. The mean score in the attention and concentration domain was found  $13.70 \pm 5.37$  in post assessment and  $11.30 \pm 4.85$  in follow up session respectively. The obtained difference between the post assessment and follow up assessment phase was found significant on this domain ( $Z = -2.410$ ,  $p < 0.01$ ) indicating that the experimental group had maintained the therapeutic gain as measured in the follow-up phase in this domain. In the language domain, the mean score was  $8.00 \pm 11.38$  in post assessment session and  $6.80 \pm 10.30$  in follow up session. Significant difference was found between both the assessment phases on this domain ( $Z = -2.414$ ,  $p < 0.01$ ). This finding indicates that the experimental group maintained the therapeutic gain on this domain in the follow-up assessment phase. The mean score in the memory domain was  $8.90 \pm 11.15$  and  $7.70 \pm 9.78$  in the post assessment and follow up sessions respectively. The difference between both the assessment phases was found significant on this domain ( $Z = -2.232$ ,  $p > 0.01$ ) indicating that the experimental group had maintained the therapeutic gain on follow up. In the visual processes' domain, the mean score was  $8.30 \pm 10.32$  and  $7.10 \pm 9.55$  in the post assessment and follow up sessions respectively. Significant difference was found between the post assessment and follow up assessment phase on this domain ( $Z = -2.414$ ,  $p < 0.01$ ). This finding indicates that the experimental group had maintained the therapeutic gain on follow up. The mean score in the executive functions' domain was  $10.30 \pm 12.27$  and  $8.80 \pm 11.29$  in the post assessment and follow up sessions respectively. The difference between both the assessment phases was found significant on this domain ( $Z = -2.032$ ,  $p < 0.01$ ) indicating that the experimental group had maintained the therapeutic gain on follow up on this domain also. Overall findings suggest that the obtained difference between all the domains of CSC on post and follow up assessment was found to be significant and that the therapeutic gain obtained after intervention was maintained on follow up session by the experimental group.

**TABLE-14: COMPARISON BETWEEN POST AND FOLLOW-UP ASSESSMENT IN EXPERIMENTAL GROUP ON COGNITIVE SYMPTOM CHECKLIST**

| S. No | Variable                  | Group (Mean $\pm$ SD) |                   | Wilcoxon Sign Rank Test |               |         |         |
|-------|---------------------------|-----------------------|-------------------|-------------------------|---------------|---------|---------|
|       |                           | Post Assessment       | Follow up         | Mean Rank               |               | Z Value | p Value |
|       |                           |                       |                   | Negative Rank           | Positive Rank |         |         |
| 1.    | Total Score               | 49.20 $\pm$ 44.86     | 41.70 $\pm$ 41.02 | 05.00                   | 00.00         | -2.670  | 0.008   |
| 2.    | Attention & concentration | 13.70 $\pm$ 5.37      | 11.30 $\pm$ 4.85  | 04.00                   | 00.00         | -2.410  | 0.016   |
| 3.    | Language                  | 8.00 $\pm$ 11.38      | 6.80 $\pm$ 10.30  | 04.00                   | 00.00         | -2.414  | 0.016   |
| 4.    | Memory                    | 8.90 $\pm$ 11.15      | 7.70 $\pm$ 9.78   | 03.50                   | 00.00         | -2.232  | 0.026   |
| 5.    | Visual Processes          | 8.30 $\pm$ 10.32      | 7.10 $\pm$ 9.55   | 04.00                   | 00.00         | -2.414  | 0.016   |
| 6.    | Executive Function        | 10.30 $\pm$ 12.27     | 8.80 $\pm$ 11.29  | 03.00                   | 00.00         | -2.032  | 0.042   |

Table 15 shows the comparison between the post and follow-up assessment scores of the control group on different test variables. For this analysis, Wilcoxon Sign Rank Test was used. After the analysis, it was found that the mean MAST score was 12.50 $\pm$ 3.50 and 11.30 $\pm$ 2.94 in the post assessment and follow up session respectively. Significant difference was found between both the post assessment and follow-up assessment phases on this domain ( $Z=-2.401$ ,  $p<0.01$ ) indicating that the performance of the control group improved on this domain on follow up. The mean AUDIT score was 27.30 $\pm$ 5.35 in the post assessment session and 23.30 $\pm$ 3.59 in the follow up session. The difference between the post-assessment phase and follow-up assessment phase was found significant on this domain ( $Z=-2.812$ ,  $p<0.01$ ). This finding indicates that the control group had improved on follow-up in this domain. The overall findings suggest that improvement was seen in the control group in all the domains. The improvement in these domains in the control group can be attributed to the fact that this group was receiving treatment as usual in the hospital because of which the symptoms reduced in this group.

**TABLE-15: COMPARISON BETWEEN POST AND FOLLOW-UP ASSESSMENT IN CONTROL GROUP ON DIFFERENT VARIABLES**

| S. No | Variable    | Group (Mean $\pm$ SD) |                  | Wilcoxon Sign Rank Test |               |         |         |
|-------|-------------|-----------------------|------------------|-------------------------|---------------|---------|---------|
|       |             | Post Assessment       | Follow Up        | Mean Rank               |               | Z Value | p Value |
|       |             |                       |                  | Negative Rank           | Positive Rank |         |         |
| 1.    | MAST Score  | 12.50 $\pm$ 3.50      | 11.30 $\pm$ 2.94 | 04.00                   | 00.00         | -2.401  | 0.016   |
| 2.    | AUDIT Score | 27.30 $\pm$ 5.35      | 23.30 $\pm$ 3.59 | 5.50                    | 00.00         | -2.812  | 0.005   |

Table 16 shows the comparison between the post and follow-up assessment scores of the control group on Cognitive Symptom Checklist. For this analysis, Wilcoxon Sign Rank Test was used. After the analysis, it was found that the mean CSC total score was 86.10 $\pm$ 23.88 and 79.10 $\pm$ 24.99 in the post assessment and follow up sessions respectively. Significant difference was found between both the post assessment and follow-up assessment phase ( $Z=-2.677$ ,  $p<0.01$ ) indicating that the control group improved on this domain in the follow up session as compared to the post assessment phase. The mean score in the attention and concentration domain was 21.90 $\pm$ 7.41 in the post assessment phase and 19.50 $\pm$ 6.51 in follow-up phase. The difference between both the assessment phases was found significant ( $Z=-2.536$ ,  $p<0.01$ ). This finding indicates that the control group had improved on this domain in the follow up session as compared to the post assessment phase. In the language domain, the mean score was 14.40 $\pm$ 4.99 in post assessment session and 12.70 $\pm$ 4.98 in follow up session. Significant difference was found between both the post assessment and follow-up assessment phase ( $Z=-2.701$ ,  $p<0.01$ ) indicating that the control group had improved on this domain in the follow up session as compared to the post assessment phase. The mean score in the memory domain was 14.20 $\pm$ 5.99 and 13.10 $\pm$ 6.02 in the post assessment and follow up sessions respectively. The difference between both the assessment phases was

found significant ( $Z=-2.428$ ,  $p<0.01$ ) indicating that the control group had improved on this domain in the follow up session as compared to the post assessment phase. In the visual processes' domain, the mean score was  $17.40\pm10.09$  and  $16.70\pm9.78$  in the post assessment and follow up sessions respectively. No significant difference was found between both the assessment phases on this domain ( $Z=-1.890$ ,  $p<0.01$ ) indicating that the control group had improved on this domain in the follow up session as compared to the post assessment phase but the obtained difference between both the sessions was not significant. The mean score in the executive functions' domain was  $18.20\pm11.85$  and  $17.10\pm11.14$  in the post assessment and follow up sessions respectively. Significant differences were found between both the post assessment and follow-up assessment phases ( $Z=-2.264$ ,  $p<0.01$ ) indicating that the control group had improved on this domain in the follow-up session as compared to the post assessment phase. The overall findings suggest that the control group showed improvements in the above-mentioned domains of CSC on follow-up assessment except on the visual processes domain which may be attributed to the fact that the control group was also receiving treatment as usual in the hospital as compared to the experimental group.

**TABLE-16: COMPARISON BETWEEN POST AND FOLLOW-UP ASSESSMENT IN CONTROL GROUP ON COGNITIVE SYMPTOMS CHECKLIST**

| S. No | Variable                  | Group (Mean $\pm$ SD) |                   | Wilcoxon Sign Rank Test |               |         |         |
|-------|---------------------------|-----------------------|-------------------|-------------------------|---------------|---------|---------|
|       |                           | Post Assessment       | Follow up         | Mean Rank               |               | Z Value | p Value |
|       |                           |                       |                   | Negative Rank           | Positive Rank |         |         |
| 1.    | Total Score               | 86.10 $\pm$ 23.88     | 79.10 $\pm$ 24.99 | 05.00                   | 00.00         | -2.677  | 0.007   |
| 2.    | Attention & Concentration | 21.90 $\pm$ 7.41      | 19.50 $\pm$ 6.51  | 04.50                   | 00.00         | -2.536  | 0.011   |
| 3.    | Language                  | 14.40 $\pm$ 4.99      | 12.70 $\pm$ 4.98  | 05.00                   | 00.00         | -2.701  | 0.007   |
| 4.    | Memory                    | 14.20 $\pm$ 5.99      | 13.10 $\pm$ 6.02  | 04.00                   | 00.00         | -2.428  | 0.015   |
| 5.    | Visual Processes          | 17.40 $\pm$ 10.09     | 16.70 $\pm$ 9.78  | 02.50                   | 00.00         | -1.890  | 0.059   |
| 6.    | Executive Function        | 18.20 $\pm$ 11.85     | 17.10 $\pm$ 11.14 | 03.50                   | 00.00         | -2.264  | 0.024   |

Table 17 shows the comparison between experimental and control group on different test variables at the follow-up assessment phase. This analysis was done using Mann-Whitney U Test. After the analysis, the mean score on MAST was found  $11.40\pm2.01$  and  $11.30\pm2.94$  for the experimental and control group respectively in the follow-up assessment phase. The difference between the experimental group and control group at the follow-up assessment phase was found significant ( $Z=-0.077$ ,  $p>0.05$ ). This finding indicates that the experimental group had maintained its therapeutic gains in comparison to the control group at the follow-up assessment phase and had showed further improvement. The mean AUDIT score was  $18.90\pm4.04$  of the experimental group and  $23.30\pm3.59$  of the control group at the follow-up assessment phase. There was no significant difference between the experimental group and control group on this domain in the follow-up assessment phase ( $Z=-2.278$ ,  $p<0.05$ ). This finding shows that the experimental group had improvement significantly from the post assessment phase to the follow-up assessment phase, but improvements were seen in the control group also because of which the difference was not significant.

**TABLE-17: COMPARISON BETWEEN EXPERIMENTAL GROUP AND CONTROL GROUP ON DIFFERENT VARIABLES AT FOLLOW-UP**

| S. No | Variable    | Group (Mean $\pm$ SD) |                  | Mean Rank          |               | U Value | Z Value | p Value |
|-------|-------------|-----------------------|------------------|--------------------|---------------|---------|---------|---------|
|       |             | Experimental Group    | Control Group    | Experimental Group | Control Group |         |         |         |
| 1.    | MAST Score  | 11.40 $\pm$ 2.01      | 11.30 $\pm$ 2.94 | 10.40              | 10.60         | 49.00   | -0.077  | 0.939   |
| 2.    | AUDIT Score | 18.90 $\pm$ 4.04      | 23.30 $\pm$ 3.59 | 7.50               | 13.50         | 20.00   | -2.278  | 0.023   |

Table 18 shows the comparison between experimental group and control group on different variables of cognitive symptoms checklist at the follow-up assessment phase. For this purpose, Mann-Whitney U Test was used. After the analysis, it was seen that the mean CSC total score was  $41.70 \pm 41.02$  of the experimental group and  $79.10 \pm 24.99$  of the control group. Significant difference was found between the experimental and control group in the follow-up assessment phase on this domain ( $Z = -2.571$ ,  $p < 0.01$ ). This finding indicates that the therapeutic gain obtained by the experimental group was maintained at the follow-up assessment phase on this domain in comparison to the control group. In attention and concentration domain, the mean score was  $11.30 \pm 4.85$  of the experimental group and  $19.50 \pm 6.51$  of the control group. There was significant difference between the experimental group and control group on this domain at the follow-up assessment phase ( $Z = -2.466$ ,  $p < 0.01$ ). This finding indicates that the experimental group had gained from the intervention program and maintained the therapeutic gain at the follow-up assessment phase on this domain as compared to the control group. In the language domain, the mean score was  $6.80 \pm 10.30$  and  $12.70 \pm 4.98$  of the experimental and control group respectively. Significant difference was found between the experimental and control group on this domain at the follow-up assessment phase ( $Z = -2.540$ ,  $p < 0.01$ ) indicating that experimental group showed improvement and maintained it at follow-up on this domain in comparison to the control group. In the memory domain, the mean score was  $7.70 \pm 9.78$  and  $13.10 \pm 6.02$  of the experimental and control group respectively. The difference between both the experimental group and control group was found significant on this domain also ( $Z = -2.084$ ,  $p < 0.01$ ) indicating that the experimental group showed improvement and maintained it at follow-up assessment phase in comparison to the control group. In the visual processes' domain, the mean score was  $7.10 \pm 9.55$  of the experimental group and  $16.70 \pm 9.78$  of the control group. Significant difference was found between both the experimental group and control group on this domain at follow-up assessment phase ( $Z = -2.052$ ,  $p < 0.01$ ). This finding indicates that the experimental group showed improvement and maintained it at follow-up assessment phase in comparison to the control group. In the executive functions' domain, the mean score was  $8.80 \pm 11.29$  and  $17.10 \pm 11.14$  of the experimental and control group respectively. The difference between both the experimental and control group was not significant on this domain at the follow-up assessment phase ( $Z = -1.820$ ,  $p < 0.01$ ). This finding suggests that the experimental group was unable to gain from the therapeutic process and maintain it at follow-up assessment phase on this domain. Overall findings suggest that the experimental group maintained the therapeutic gain in all the domains except executive functions in comparison to the control group.

**TABLE-18: COMPARISON BETWEEN EXPERIMENTAL GROUP AND CONTROL GROUP ON COGNITIVE SYMPTOM CHECKLIST AT FOLLOW-UP**

| S. No | Variables                 | Group (Mean $\pm$ SD) |                   | Mean Rank    |         | Mann-Whitney U Test | Z Value | P Value |
|-------|---------------------------|-----------------------|-------------------|--------------|---------|---------------------|---------|---------|
|       |                           | Experimental          | Control           | Experimental | Control |                     |         |         |
| 1.    | Total Score               | $41.70 \pm 41.02$     | $79.10 \pm 24.99$ | 7.10         | 13.90   | 16.00               | -2.571  | 0.010   |
| 2.    | Attention & Concentration | $11.30 \pm 4.85$      | $19.50 \pm 6.51$  | 7.25         | 13.75   | 17.50               | -2.466  | 0.014   |
| 3.    | Language                  | $6.80 \pm 10.30$      | $12.70 \pm 4.98$  | 7.15         | 13.85   | 16.50               | -2.540  | 0.011   |
| 4.    | Memory                    | $7.70 \pm 9.78$       | $13.10 \pm 6.02$  | 7.75         | 13.25   | 22.50               | -2.084  | 0.037   |
| 5.    | Visual Processes          | $7.10 \pm 9.55$       | $16.70 \pm 9.78$  | 7.80         | 13.20   | 23.00               | -2.052  | 0.040   |
| 6.    | Executive Function        | $8.80 \pm 11.29$      | $17.10 \pm 11.14$ | 8.10         | 12.90   | 26.00               | -1.820  | 0.069   |

Overall results showed that the experimental group improved significantly in comparison to the control group after EEG Neuro-feedback training. Cognitive functioning of the individuals with alcohol dependence syndrome improved significantly post the therapeutic intervention. Gains related to most of the functions were sustained at a follow-up of five months.



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